

# 2004 Project Report

## *Winter Wheat Breeding and Genetics*

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## **CROP REPORT**

Winter wheat production in 2004 was estimated at 56.25 million bushels, down 9% from last year's. Grain yield averaged 45 bushels per acre, which is two bushels above last year's, and is the second highest in the state's history. Producers harvested 1.25 million from 1.65 acres, down 13% from 2003.

In 2004, the winter wheat breeding program conducted testing in eight sites throughout South Dakota. These environments included Aurora and Brookings (Brookings Co.), Platte (Douglas Co.), Highmore (Hyde Co.), Selby (Walworth Co.), Winner (Tripp Co.), Wall (Pennington Co.), the Northeast Research Farm near Watertown (Codington Co.), Kennebec (Lyman Co.), and both irrigated and dry land environments at the Dakota Lakes Research Farm east of Pierre (Hughes Co.). Crop performance testing also was conducted at an additional five sites west of the Missouri River in cooperation with John Rickertsen and Bruce Swan (SDSU West River Agricultural Research and Extension Center, Rapid City).

Fall stand establishment at most testing locations was below average. After a very dry mild winter, the crop was rated at 58 percent poor to very poor by the State Statistics Report. The Kennebec site in Lyman Co. was lost due to high winds that covered the nursery with drifting soil. Dry conditions early in the growing season significantly pushed the winter wheat flowering ahead of the five years' average. However, six weeks of cool wet weather in May significantly extended the grain filling duration ahead of the five years' average in the eastern parts of the state, resulting in record yield in some of the eastern parts of the state.

## **BREEDING PROGRAM**

### **New Release**

'Wendy', the first hard white winter wheat from South Dakota, was released to seed producers for planting in 2004. Wendy is an early maturing line that combines good noodle quality, excellent winter survival, and high yield potential. For more information on Wendy, please visit our web site at: <http://plantsci.sdstate.edu/triticum/index.htm>.

### **Foundation Seed Increases**

One line (SD97W609) is being increased for Foundation Seed with potential release in 2006. SD97W609 was developed from the cross 'Abilene'/'Karl' and is a semi-dwarf, early-maturing (similar to Wendy) hard white winter wheat with good winter survival ability and excellent yield potential. It has excellent baking quality in predictive testing and in large-scale testing in the 2005 Wheat Quality Council. It has high test weight, intermediate levels of polyphenoloxidase enzyme, average protein, very short coleoptile, and good sprouting resistance. It is moderately resistant to stem rust and WSMV, and is moderately susceptible to leaf rust.

Two lines (SD98102 and SD97538) are being grown in an off-season nursery in Arizona for purification and preliminary increase. SD98102 was developed from the cross 2076-W12-11/'Karl 92'//NE89526. It had very good yield performance, good milling, and average baking quality attributes. It is moderately resistant to stem rust and is moderately susceptible to leaf rust and WSMV. SD97538 was developed from the cross NE90518/Martino93. It has the highest yield potential among the South Dakota experimental lines. It has fair baking quality attributes.

### **Regional Nurseries**

The Northern Regional Performance Nursery (NRPN) was planted at Brookings, Winner, and the spring wheat stubble plots at Dakota Lakes (DLSWS). The NRPN consisted of four check varieties and 36 experimental lines from five public programs. Ten advanced experimental lines were included from the SDSU Winter Wheat Breeding Program. Average grain yield and other characteristics for 2004 NRPN are presented in Table 1. In addition to the NRPN, the Southern Regional Performance Nursery (SRPN) was planted at Brookings and Dakota Lakes on pea stubble (DLP). While the SDSU breeding program does not typically enter lines into the SRPN, evaluation of this nursery in South Dakota is important both as a means of germplasm exchange and in determining the range of adaptation of elite material from southern plains and western programs.

In addition to the regional yield nurseries, the Regional Germplasm Observation Nursery (RGON) was planted at Watertown and at Brookings in the mist-irrigated *Fusarium* head blight disease nursery. This nursery consisted of 254 entries from nine different breeding programs and a periodic set of six checks, planted in double-row (3-foot long) plots with a single replication per entry. Thirty South Dakota advanced lines were entered in 2004 RGON.

### **CPT Variety Trial**

The South Dakota Crops Performance Testing (CPT) Variety Trial, under the coordination of the SDSU Crops Performance Testing Program (Dr. Bob Hall, Manager), was planted at 14 sites across South Dakota. These environments included most of the sites where winter wheat breeding activities are ongoing and several other sites in western South Dakota that are coordinated by personnel at the West River Agricultural Research and Extension Center (John Rickertsen, SDSU). In 2004, the nursery included 30 entries, consisting of 14 released varieties, 15 advanced experimental lines from our program and one from the University of Nebraska.

Seven of the fifteen experimental lines from the breeding program evaluated in the 2004 CPT (Table 2) were retained for further testing in 2005:

SD97059-2	ND8889/NE90574
SD97W609	Abilene/Karl
SD97380-2	Rawhide/Siouxland
SD97538	NE90518/Martinof 93
SD98102	2076-W12-11/Karl92//NE89526
SD00W024	SD94139W/SD94217W
SD00032	CEP17/Jerry//SD94160

**Table 1. Grain yield, Test weight and Agronomic Data for the 2004 NRPN in South Dakota. (Entries are ranked in descending order by statewide yield average).**

Entry	Grain yield (bushels/acre)					TW <sup>1</sup>	HEAD <sup>3</sup>	SCR <sup>3</sup>	HEIGHT <sup>4</sup>	LODGING <sup>5</sup>	WSMV <sup>5</sup>
	AVE <sup>1</sup>	rank <sup>2</sup>	BRK	DLS	WIN	(lb/ bu)	(days)	(1-5)	(in.)	(1-5)	(0-5)
NE99656-1	73.8	1	108	58	55	59.5	3.8	4.0	41	3.7	0.5
NE01643	71.2	2	105	57	52	59.2	3.0	3.0	38	1.7	2.0
SD00258	70.1	4	105	53	53	58.3	5.2	3.8	42	1.0	3.5
NE01422	69.5	18	113	44	52	59.2	0.6	3.5	39	1.0	0.5
NE01564	68.4	5	101	51	54	58.8	1.0	3.3	36	1.0	0.0
NW97S412-1	67.2	7	100	54	48	56.5	5.8	3.5	35	1.0	1.0
NE99533-5	66.7	20	104	50	45	60.6	0.6	3.3	36	1.3	0.5
SD97394-1	66.1	22	104	47	47	59.4	1.2	3.8	43	1.7	3.5
SD00111	65.9	23	104	50	44	58.8	1.0	4.0	40	2.0	4.0
SD97059-2	65.7	25	104	47	46	57.1	5.1	3.7	42	1.0	4.0
NW97S139-1	65.6	9	99	56	42	57.3	2.5	3.7	38	1.3	1.5
NE99489	65.5	15	100	54	43	57.7	1.9	4.0	40	1.0	2.5
MT00159	65.1	11	97	54	44	56.0	7.7	4.0	41	1.0	3.5
SD98102	64.7	14	97	52	45	58.7	3.8	3.8	40	1.7	2.5
SD97380-2	64.3	12	96	53	44	57.8	0.5	3.7	40	1.0	3.5
SD00032	63.9	17	95	50	46	58.8	3.1	3.7	44	1.7	0.5
N02Y5117	63.9	21	96	49	46	58.1	1.6	2.3	37	1.0	4.5
NE00658	63.7	26	99	50	42	57.3	1.9	3.5	40	1.0	1.0
HARDING	63.3	6	86	53	51	57.9	5.1	3.0	41	1.7	3.5
SD97W671-1	63.2	30	99	50	40	58.8	2.7	3.7	36	1.0	2.5
DW	63.0	3	81	60	48	55.9	5.7	3.2	36	1.0	0.0
NW98S104	62.3	8	86	54	46	58.2	4.3	3.7	38	1.7	1.5
NE99464	62.3	24	93	52	42	59.8	3.3	3.0	37	1.0	3.0
NUPLAINS	61.5	13	87	49	48	59.7	5.1	3.2	37	1.0	2.0
NE99533-3	61.2	36	97	47	39	60.2	0.5	2.8	34	1.0	0.5
SD99073	61.2	31	94	44	46	58.2	1.3	2.5	41	2.0	3.0
NE00633	61.1	32	94	46	43	58.3	1.1	3.7	39	1.7	2.0
MTR9997	60.0	27	88	53	38	56.8	6.1	3.7	40	1.0	0.0
MORELAND	59.8	29	88	54	37	53.2	3.0	3.8	32	1.3	2.0
NW97S218-1t	59.8	33	92	46	42	57.0	6.6	3.3	35	1.0	1.5
NEKOTA	59.8	19	84	53	43	57.5	0.8	3.7	37	1.3	1.0
N02Y5078	59.4	16	82	41	55	59.5	1.5	2.8	35	1.0	2.0
NW98S097	58.6	10	78	52	46	58.0	3.8	2.5	36	1.0	4.0
MT0097	57.1	40	96	43	32	55.2	8.2	3.8	38	1.0	4.0
N02Y5106	57.0	38	88	49	34	58.2	0.8	3.2	34	1.0	2.0
SD97W609	56.7	39	90	38	42	58.2	0.0	3.2	34	1.0	2.5
N02Y5075	55.5	28	75	39	52	59.6	1.8	2.7	34	1.0	1.0
KHARKOF	55.2	34	79	46	41	59.4	6.7	2.2	46	5.0	2.5
N02Y5072	52.2	35	70	41	45	58.7	2.0	2.5	34	1.0	3.0
N02Y5065	52.1	37	71	39	46	59.5	1.3	3.0	36	1.0	0.5
MEAN	62.6		93	50	45	58.2	3.0	3.3	46	1.4	2.1
†CV%	10.6		8	12	15	2.0	0.7	18.1	2	28.4	47.4
LSD <sub>0.05</sub>	10.9		12	10	11	1.1	2.2	0.8	2	0.6	2.0

1 Grain Yield and test weight (TW) averages include data from Brookings (BRK), Dakota Lakes Spring Wheat Stubble environment (DLS) and Winner (WIN).

2 Grain Yield Rank excludes data from Brookings an exceptionally high yielding environment.

3 HEAD and SCR were scored at Brookings and Dakota Lakes. Relative heading date (HEAD) is the number of days beyond the minimum heading date for the nursery. Agronomy Score (SCR) is the appearance of the standing crop a week before harvest (5 is best)

4 Plant height in inches (HEIGHT) was measured at Brookings only.

5† LODGING (5 is flat) and disease (5 is worst) data are tentative (high CV%) and were taken in a normal field environment at Brookings (lodging) and Winner (Wheat Streak Mosaic Virus, WSMV).

**Table 2. Grain yield, Test weight and Agronomic Data for the 2004 Crops Performance Testing (CPT) Variety Trial. (Entries are ranked in descending order by statewide yield average).**

Entry	Grain Yield <sup>1</sup> (bushels per acre)												TW <sup>†</sup>	HD <sup>‡</sup>	HI <sup>§</sup>	SCR <sup>§</sup>	LD <sup>¶</sup>	TSHI <sup>¶</sup>	WSMV <sup>¶</sup>	
	Ave <sup>1</sup>	2-yr	3-yr	rank <sup>2</sup>	BRK	DLP	HIM	PLA	SEL	SIU	WAL	WAT	WIN	(lb/bu)	(days)	(in)	(1-5)	(1-5)	(1-9)	(0-5)
SD97538*	65	61		1	103	55	78	63	77	29	53	47	58	58.5	5	29	4.4	2.0	4.5	2.5
SD92107-5	63	59	53	2	96	52	78	76	71	26	61	42	49	58.3	8	31	4.0	1.3	5.5	3.5
SD00W024*	63			4	99	53	71	71	70	28	59	44	53	58.7	9	30	3.3	3.5	4.5	1.0
SD97059-2*	62	61		3	98	51	82	62	72	24	52	52	52	57.8	7	32	4.7	1.8	5.5	4.0
SD97394-1	62			10	99	58	77	62	75	29	47	46	51	59.1	5	33	4.0	3.5	4.5	4.5
SD98102*	62	60	53	5	92	54	78	69	73	30	49	53	49	58.9	6	31	4.6	2.3	3.5	3.5
WAHCO	62	61	54	9	100	53	78	63	70	26	57	37	52	57.8	4	30	4.3	2.3	3.5	4.0
HARDING	61	58	52	6	93	46	76	72	68	26	56	45	52	58.1	8	31	3.6	1.8	3.0	2.5
JERRY	61	58	51	8	106	46	79	62	71	29	53	45	40	57.5	8	33	3.3	2.8	5.5	5.0
SD00258?	61			7	103	47	73	66	70	23	50	47	52	58.1	8	31	4.2	2.0	5.5	4.5
MILLENNIUM	60	60	54	11	100	47	74	60	70	30	47	46	55	59.1	6	31	4.3	1.0	3.5	4.0
SD99073	60			13	91	57	76	61	66	24	49	46	51	58.5	4	30	3.4	2.5	5.0	3.0
JAGALENE	59	60	55	18	82	58	73	55	72	25	52	39	60	60.1	4	26	4.0	1.0	2.5	0.0
NE99533-4*	59			17	90	55	73	60	67	29	50	44	50	60.2	3	27	3.7	1.3	1.0	1.0
SD97250	59	56	51	12	88	54	74	63	64	27	46	56	49	58.5	4	30	4.2	2.5	5.0	3.0
ALLIANCE	59	57	51	14	83	53	72	64	71	29	46	50	51	58.9	3	28	3.2	2.0	4.5	2.5
SD00111	58			19	84	55	76	59	71	24	46	46	48	58.9	4	30	4.3	2.5	4.0	4.0
SD97380-2*	58	58		15	90	51	77	59	67	24	45	48	47	58.5	3	31	4.3	2.3	6.0	5.0
SD00032*	57			16	90	53	71	57	68	19	46	53	49	58.7	5	31	4.3	1.5	3.0	4.0
TANDEM	57	55	50	20	84	53	71	63	65	26	51	42	46	59.6	5	29	3.6	2.5	3.0	3.5
SD97W671-1	57	57		21	88	55	76	53	67	21	47	41	46	58.6	5	28	4.0	2.0	3.5	3.0
WESLEY	56	57	51	22	96	47	72	60	58	25	48	42	39	57.4	3	25	3.9	1.0	1.0	4.0
SD97W609*	56	58	52	25	86	50	67	58	69	22	39	38	44	57.9	2	26	4.1	1.3	3.0	2.5
TREGO	55	56	51	23	82	49	68	59	63	27	36	49	57	60.5	3	27	3.8	1.5	3.0	0.5
NEKOTA	55	55	50	27	86	51	72	58	60	27	45	31	47	58.4	2	26	3.5	1.5	1.0	2.5
SD00W041	54			28	78	45	69	56	65	21	49	25	56	58.2	7	31	3.3	1.0	7.0	0.0
ARAPAHOE	54	56	51	24	79	45	74	57	71	21	40	34	47	57.7	4	30	4.1	1.8	2.5	3.5
CRIMSON	54	55	48	30	80	53	67	57	66	27	48	41	38	59.2	8	32	3.4	1.8	1.5	2.0
EXPEDITION	53	56	51	26	91	45	62	58	62	21	47	39	40	59.3	1	26	3.5	1.8	6.5	3.0
WENDY	53	57	53	29	86	42	66	48	65	25	45	39	50	59.1	0	24	3.8	1.3	3.0	2.0
MEAN	59	58	52		91	51	73	61	68	26	49	44	49	58.7	5	29	3.9	1.9	3.8	2.9
†CV%	12	12	13	11	13	18	7	12	7	17	8	16	12	1.6	1	5	19.3	41.3	35.5	39.2
‡LSD <sub>0.05</sub>	4	2	2		16	NS	8	10	7	NS	6	14	8	0.5	1	1	0.7	1.1	2.8	2.4

\* indicates retention of experimental line for another year of testing in 2005 CPT. ? indicates selection for the 2005 NRPN but not 2005 CPT.

1 2004 Grain Yield (GY) and test weight (TW) averages include BRK(Brookings), DLP(Dakota Lakes Pea Stubble near Pierre), HIM(Highmore), PLA(Platte), SEL (Selby), SIU(Sturgis), WAL(Wall), WAT(Northeast farm near Watertown), and WIN(Winner).

2-‡ An alternative Grain Yield Rank for 2004 (Rank) excludes data with high coefficient of variation (CV%) and non-significant differences from the overall average (NS for LSD at Dakota Lakes and Sturgis).

3 Relative Heading Date (HD) is averaged across Brookings, Dakota Lakes, Highmore, Selby and Watertown.

4 Plant height (HI) is the average of measurements from Brookings, Platte, Selby, Sturgis and Wall.

5 Agronomy Score (SCR) is a score of overall appearance of the standing crop within a week before harvest. This score is an average of observations at Brookings, Dakota Lakes, Highmore and Selby.

6† Lodging (LD, 5 is flat) and disease (5 is worst) data are tentative (high CV%) and were taken in a normal field environment at Brookings (lodging); Selby (height of progression of tar spot, TSHI); and Winner (Wheat Streak Mosaic Virus, WSMV).

**Table 3. Grain yield, Testweight and Agronomic Data for the 2004 Advanced Yield Trial (AYT). (Entries are ranked in descending order by statewide yield average).**

Entry	Grain Yield <sup>1</sup> (bushels per acre)										TW <sup>4</sup>	HD <sup>5</sup>	HT <sup>6</sup>	LD <sup>7</sup>	TSHT <sup>7</sup>	TSSEV <sup>7</sup>	WSMV <sup>7</sup>
	Ave <sup>3</sup>	HI RANK <sup>2</sup>	Norm RANK <sup>3</sup>	BRK	DLP	HIM	NEB	SEL	WAL	WIN	(lb/ bu)	(days)	(in.)	(1-5)	(1-9)	(1-9)	(0-5)
SD01W064**	68.9	3	2	96	68	92	61	64	47	55	59.3	6	31	2	1	2	3
SD98W175-1*	68.0	11	1	97	67	82	60	60	47	64	60.1	6	28	1	4	6	3
NE01643**	67.1	4	4	103	66	80	55	59	45	62	58.7	5	31	2	6	7	3
SD96240-3-1**	66.2	1	12	104	66	87	48	62	48	48	56.4	7	29	2	2	4	5
SN96-71*	65.8	2	14	106	65	83	54	61	47	43	59.2	5	31	1	6	8	4
SD00W024(*)	65.5	20	7	96	61	77	55	58	56	56	58.9	9	31	3	2	3	5
SD01054*	65.5	21	6	92	73	80	52	64	49	47	57.3	8	32	1	4	5	4
SD01474*	64.8	12	10	94	58	84	62	64	49	43	56.6	7	29	1	1	3	3
SD01181*	64.8	18	8	90	61	84	51	62	54	51	57.2	8	33	2	5	4	1
SD01104**	64.8	34	3	82	69	81	53	60	54	55	58.7	9	32	1	3	6	0
SD01058*	64.7	19	9	94	57	79	56	60	50	56	58.5	3	29	1	5	6	5
SD01122**	64.5	9	13	96	63	84	47	60	49	52	57.6	8	32	2	5	5	3
SD01273*	64.0	35	5	89	63	74	55	56	53	59	59.8	2	31	2	2	5	1
SD01069	64.0	8	19	99	64	82	55	59	56	34	59.0	9	37	2	6	4	5
NE99533-4 (*)	63.7	10	18	96	67	83	56	58	40	45	59.5	2	27	1	2	6	2
SD01099	63.7	14	16	94	53	84	54	59	54	50	58.4	11	36	1	4	7	5
SD01183	63.3	5	25	103	58	79	46	64	49	44	57.6	6	33	2	3	7	5
TREGO	63.3	24	11	97	60	72	51	66	34	64	60.1	2	28	2	4	7	1
SD00111	62.6	6	33	95	60	87	47	58	40	51	58.4	4	31	3	5	5	5
SD01082	62.5	28	15	95	62	74	51	57	44	55	59.4	6	34	2	4	8	3
SD00258	62.5	16	24	93	55	83	51	63	43	50	58.0	8	32	1	5	6	5
SD97394-1	62.5	22	20	93	57	79	53	64	42	50	59.0	4	31	3	3	8	5
HARDING	62.2	17	27	91	55	83	43	60	51	52	58.1	8	32	2	5	5	3
SD01308	62.0	15	32	99	61	78	55	52	47	41	58.3	5	31	3	4	7	3
SD99073	61.8	33	17	88	59	76	51	59	49	51	58.4	4	30	3	3	5	4
SD00032	61.7	13	35	94	60	83	49	63	40	43	58.2	6	33	2	4	7	3
NE01506	61.6	27	21	91	53	78	51	57	42	60	58.6	2	30	1	6	3	5
SD01388	61.2	25	29	92	66	77	50	58	46	39	57.6	3	29	1	3	5	5
SN96-35	61.1	7	41	98	53	83	46	56	51	40	58.5	11	30	1	7	8	2
SD01327	60.9	26	31	93	59	76	57	58	41	42	58.6	1	33	2	5	4	3
SD01028	60.8	31	28	87	64	78	43	61	46	46	57.1	9	31	2	5	4	4
SD01W062	60.5	29	34	86	62	83	60	58	35	40	59.0	6	30	1	4	5	3
TANDEM	60.4	41	22	89	61	71	49	62	45	45	59.3	5	31	3	4	6	4
SD01457	60.4	38	23	84	70	77	48	56	39	49	58.8	6	29	1	4	5	5
SD01186	59.8	42	30	84	57	76	47	53	44	58	58.8	7	35	2	4	4	4
WENDY	59.4	36	37	86	55	76	54	56	39	50	58.5	0	26	1	4	4	3
ARAPAHOE	59.1	44	26	84	56	69	50	62	46	47	57.8	5	32	3	5	6	4
SD97250-2	59.1	23	44	91	54	79	50	57	36	47	57.9	3	31	3	4	7	4
SD01136	59.0	39	38	82	60	79	51	51	44	47	57.4	4	30	2	4	8	4
WESLEY	58.9	30	42	90	53	78	56	53	41	42	56.9	3	28	1	4	3	3
SD00W041	58.5	43	36	85	49	71	52	54	42	56	58.4	7	32	2	5	5	2
SD01W009	58.4	37	40	86	67	76	55	52	32	41	58.5	4	28	1	4	5	4
EXPEDITION	58.4	40	39	94	54	67	55	60	38	41	58.6	0	29	2	4	7	4
SD98W345-1	58.3	32	43	90	55	74	52	51	37	49	58.6	5	29	1	4	3	2
SD01385	53.9	45	45	82	56	65	42	52	33	48	59.0	4	29	2	5	6	4
MEAN	62.2			92	60	79	52	59	45	49	58.4	5	31	2	4	5	3
†CV%	9.7			9	12	6	8	9	10	13	2.0	1	5	38	28	35	27
‡LSD <sub>0.05</sub>	3.6			14	12	7	7	8	7	11	0.7	1	1	1	2	4	2

\*\* or (\*) Indicates selection for advancement to or continuation in 2005 CPT. \*\* or \* indicates retention for second year of testing in AYT in 20

‡ LSD<sub>0.05</sub> indicates the "least significant difference" for comparing entries with 95 % confidence.

1‡ Grain Yield (GY) average is across all locations: BRK (Brookings), DLP (Dakota Lakes Pea Stubble), HIM (Highmore), NEBR (Mead, Nebras SEL (Selby), WAL (Wall) and WIN (Winner).

2 "Hi Rank" is the rank for grain yield across unusually high yielding locations, Brookings and Highmore.

3 "Norm Rank" is the rank for grain yield for locations with normal yields (all locations except Brookings or Highmore).

4 Test weight (TW) average includes all locations except Mead, Nebraska.

5 Relative Heading Date (HD) is averaged across Brookings, Dakota Lakes, Highmore, and Selby.

6 Plant height (HT) is the average of measurements from Brookings, Selby, Wall, and Mead, Nebraska.

7† Lodging (LD, 5 is flat) and disease (5 is worst) data are tentative (high CV%) and were taken in a normal field environment at Brookings (lodging), Selby (height of progression, TSHT and severity of tanspot, TSSEV), and Winner (Wheat Streak Mosaic

## **South Dakota Advanced Yield Trial (AYT)**

The 2004 Advanced Yield Trial (AYT) was grown at seven sites in South Dakota. The AYT included 45 entries, consisting of 34 advanced experimental lines from our program, three advanced experimental lines from Nebraska, two Canadian lines, and six checks. Eight of the 34 experimental lines were whites.

The screening tests performed on entries in the AYT included wheat streak mosaic virus field adult plant screening (Dr. Marie Langham, SDSU), multiple-race seedling stem rust screening, field FHB screening, and field leaf and stem rust screening. The SDSU program also evaluated pre-harvest sprouting tolerance, PPO enzyme activity, coleoptile length, protein levels, and mixograph performance. Based on field performance data (Tables 3) and screening results, five lines were advanced to statewide yield trials (CPT) in 2005:

SD01W064	RussianPI592033/NE92458//Nekota
SD96240-3-1	NE87513/USSR#67
SD01122	Harding/KS84063-9-39-3-4W
SD01104	NE94482/TXGH125888-120*4/FS2
NE01643	NE94482 (Arapahoe/Abilene//NE86488) / ND8974

## **Preliminary Yield Trial (PYT)**

The 2004 Preliminary Yield Trials were separated into two PYT Red nurseries (to improve experimental design) and one PYT White nursery. The nurseries were planted on dry land pea stubble at Dakota Lakes, on spring wheat stubble at Selby, on spring wheat stubble at Winner, and on fallow at Wall. Brookings (millet stubble) was added as a fifth site in 2004 to facilitate collection of data, especially sprouting tolerance data.

Among the 100 red lines in the 2004 PYT Red nurseries, 14 had been identified during the previous year as exceptional for resistance to bulk stem rust races and field leaf rust races, upper 16% of grain yield and test weight, and not being deficient in lodging, appearance, protein, sedimentation or winter hardiness. Only one of the 14 red lines (SD02480, pedigree = Tandem/Cougar) was subsequently advanced to 2005 AYT. However, seven of the 13 lines that were eventually advanced from 2004 PYT to 2005 AYT had been in the top three percent for yield in the previous year. For advancement from the 2004 PYT Red nurseries to the 2005 AYT nursery, the top 20% yielding lines were considered. Breeding lines with three or more inadequacies (from a list of 10 disease, agronomic, and quality traits) were eliminated, leaving 12 top performers. Two of the lines, SD02752 (CO910424/Hondo) and SD02819 (SD94149/SD96240), had all positive traits except for lower than average predicted baking quality. Another top performing line with excellent predicted baking quality but moderate susceptibility to seedling stem rust, SD02091 (Nekota/W95-301), was advanced to 2005 AYT. Another line, SD02501 (Tandem/SD96233), that yielded at the top at Winner but low for other locations, had an excellent combination of all other traits and was also added to the 2005 AYT list.

Among the 39 lines in the 2004 PYT White nursery 15 had been identified as exceptional for gluten quality (a combination of high sedimentation values and moderately low protein), resistance

**Table 4. Grain yield, Testweight and Agronomic Data for the 2004 Preliminary Yield Trial Red-1 (PYTR-1). (Entries are ranked in descending order by statewide yield average).**

Entry	GRAIN YIELD (bushels per acre)							TW <sup>1</sup>	HEAD <sup>3</sup>	HEIGHT <sup>3</sup>	LODGING <sup>4</sup>	WSMV <sup>4</sup>
	AVE <sup>1</sup>	Rank <sup>2</sup>	BRK	DLP	SEL	WAL	WIN	(lb/bu)	(days)	(inches)	(1-5)	(0-5)
SD02835	72.4	4	116	73	78	54	40	60.3	5	34	3.5	4.5
SD02480*	70.1	1	102	80	73	47	48	59.9	6	33	3.5	2.0
SD02024*	69.9	5	109	73	75	49	44	57.9	7	31	1.5	1.0
SD02288	68.9	7	106	67	74	47	51	58.7	4	36	5.0	2.0
SD02175	68.8	6	104	72	69	56	43	59.7	11	37	2.0	3.0
SD02039*	67.8	3	93	83	69	50	44	61.2	5	38	2.0	3.5
SD02091*	67.7	14	107	70	69	45	48	60.2	4	30	1.0	2.5
SD02056	67.7	8	104	72	69	43	50	58.7	3	34	3.5	3.5
SD02446	67.3	16	107	68	72	46	43	58.3	6	32	2.5	3.0
SD02114	67.2	22	111	72	61	48	44	57.4	3	29	1.0	4.5
SD02386	67.1	17	107	62	73	42	52	59.1	3	32	5.0	4.0
SD02279*	66.8	12	102	77	66	49	39	59.1	7	34	2.5	5.0
SD02051	66.5	9	99	72	76	43	42	59.2	5	35	4.5	4.0
SD02636	66.4	26	110	67	65	48	42	59.1	9	38	4.0	0.0
SD02423	66.4	25	109	70	72	47	34	58.2	7	36	3.5	4.5
SD02640	66.4	36	113	68	70	48	33	58.6	5	33	2.5	4.0
SD02068*	66.1	21	104	63	67	49	48	59.5	3	34	3.0	3.5
SD02601	65.9	23	105	61	68	51	45	61.1	4	36	3.5	3.0
SD02018*	65.8	2	83	80	71	52	43	60.0	8	34	1.5	3.5
SD02397	65.8	32	108	69	71	36	45	60.0	6	31	1.0	3.0
SD02059	65.7	18	101	71	68	40	48	58.9	4	33	3.5	2.0
SD02004	65.4	19	100	66	67	46	48	58.4	2	33	4.0	2.5
Millennium	64.9	15	93	71	68	42	51	60.0	5	31	2.0	3.0
SD02053	64.7	27	102	69	67	42	43	58.9	3	33	3.5	3.5
SD02170	64.6	13	92	69	70	52	40	56.5	8	35	1.5	3.5
SD02580	64.6	34	103	68	70	35	46	59.4	5	33	5.0	3.5
SD02067	64.3	37	104	71	70	40	36	57.7	6	34	4.0	4.5
Trego	64.0	38	103	66	66	41	45	60.9	2	29	3.0	1.0
SD02582	63.7	40	102	58	68	37	53	59.2	3	33	4.5	3.0
Alliance	63.6	11	85	69	68	47	49	59.1	1	30	3.0	3.0
Tandem	63.5	10	85	67	64	49	53	60.6	4	31	3.5	3.0
SD02094	63.4	31	97	68	62	42	48	60.1	4	32	1.5	4.5
SD02062	62.9	29	93	66	70	44	42	59.1	3	33	3.0	2.0
SD02604	62.9	42	100	75	65	50	24	60.7	6	37	3.5	3.0
SD02490	62.9	24	91	70	68	45	40	57.9	8	34	4.5	1.5
Harding	62.9	20	88	64	67	50	45	58.5	6	32	2.0	3.5
SD02630	62.7	47	101	70	61	41	41	59.4	6	33	1.0	4.0
Jerry	62.6	41	98	67	67	47	34	57.7	9	34	3.0	5.0
SD02198	62.3	39	95	70	66	35	45	58.3	6	33	2.5	0.5
SD02188	62.1	35	92	63	69	44	42	59.2	10	36	1.0	2.0
SD02689	62.1	49	100	60	66	42	42	58.7	8	36	2.5	3.5
SD02218	61.7	28	87	71	68	45	38	55.7	8	32	1.0	4.5
SD02399	61.2	55	104	71	67	38	26	57.9	7	35	1.0	4.5
SD02500	61.1	43	91	67	59	45	43	59.5	4	34	4.0	2.0
Arapahoe	61.1	30	84	68	68	43	43	58.4	2	33	3.0	4.0
SD02251	61.0	33	85	56	75	38	51	57.8	3	37	3.0	3.0
Wesley	60.6	45	89	65	64	41	43	58.1	2	27	1.0	4.0
SD02821	60.4	51	95	64	63	42	38	58.5	5	32	1.0	2.5
SD02016	60.0	48	88	70	66	41	35	58.5	5	34	1.5	3.5
SD02303	59.9	52	96	63	60	39	42	58.7	7	36	2.5	4.0
SD02398	59.6	50	88	66	65	39	39	58.2	5	33	1.0	4.5
SD02850	59.4	53	94	65	61	43	35	60.8	5	36	4.0	3.5
SD02017	59.2	44	82	71	70	38	35	58.8	5	34	1.0	3.5
SD02308	59.0	57	98	66	61	45	25	58.7	9	36	2.5	5.0
SD02234	57.4	56	88	57	59	46	36	58.3	6	33	1.5	4.5
SD02010	57.4	46	74	72	60	38	43	59.5	4	32	2.0	4.5
SD02149	57.2	58	96	58	62	41	30	57.9	4	32	2.0	5.0
Expedition	56.2	59	92	62	56	39	32	59.4	0	29	2.0	2.5
Wendy	56.1	54	78	59	67	40	37	59.7	0	27	1.0	2.5
SD02312	53.8	60	91	57	58	38	25	58.4	3	33	2.0	4.5
MEAN	63.5		97	68	67	44	42	59.0	5	33	2.6	3.3
CV%	12.4		14	10	7	10	16	2.0	1	5	47.0	22.2
LSD <sub>0.05</sub>	6.9		27	13	9	9	14	1.1	1	2	2.4	1.5

\* Selected for advancement to 2005 Advanced Yield Trials (AYT).

1 Grain Yield (GY) and Testweight (TW) averages include data from Brookings (BRK), Dakota Lakes Pea Stubble (DLP), Selby (SEL), Wall (WAL) and Winner (WIN).

2 Grain Yield Rank excludes data from Brookings an exceptionally high yielding environment.

3 Relative heading date (HEAD) is an average of data from Brookings, Dakota Lakes and Selby. Plant height (HEIGHT) is an average of data from Brookings, Selby, Wall and Winner.

4† LODGING (5 is flat) and disease (5 is worst) data are tentative (high CV%) and were taken in a normal field environment at Brookings (lodging) and Winner (Wheat Streak Mosaic Virus, WSMV).

**Table 5. Grain yield, Testweight and Agronomic Data for the 2004 Preliminary Yield Trial Red-2 (PYTR-2). (Entries are ranked in descending order by statewide yield average).**

Entry	GRAIN YIELD (bushels per acre)						TW <sup>1</sup>	HEAD <sup>3</sup>	HEIGHT <sup>3</sup>	LODGING <sup>4</sup>	WSMV <sup>4</sup>	
	AVE <sup>1</sup>	Rank <sup>2</sup>	BRK	DLP	SEL	WAL	WIN	(lb/bu)	(days)	(inches)	(1-5)	(0-5)
SD02466*	70.1	2	104	80	71	53	43	56.9	8	31	1.0	3.5
SD02465	70.0	6	111	75	76	44	44	55.4	9	31	1.5	4.0
SD02771*	69.5	1	96	72	73	50	55	59.0	8	34	3.0	3.0
SD02286*	68.6	7	106	73	69	48	47	57.5	9	36	3.0	4.0
SD02692	68.5	13	111	67	76	47	42	58.4	10	36	2.0	4.0
SD02215	68.3	4	102	74	75	45	45	56.8	9	32	2.5	4.0
SD02338	67.7	5	100	78	70	45	46	60.4	7	37	4.0	3.5
SD02834	67.5	3	94	73	75	48	47	59.2	7	34	3.0	3.5
SD02752*	67.3	11	103	79	62	46	47	60.2	7	31	1.0	2.0
Jerry	67.2	12	103	74	70	49	39	57.7	9	35	3.5	5.0
SD02727	66.5	9	99	69	73	45	46	59.4	6	34	1.5	2.0
SD02819*	66.2	19	105	72	66	35	53	60.5	5	32	1.5	1.0
SD02534	65.9	14	100	71	68	46	44	59.1	9	39	3.5	4.0
SD02545	65.4	10	93	74	74	42	43	57.6	9	35	2.5	3.5
Harding	65.4	8	93	67	70	52	45	58.6	7	33	1.5	2.5
SD02802	65.0	27	106	76	69	39	36	58.6	4	32	5.0	1.0
SD02498	64.9	18	98	73	68	40	45	58.9	5	35	4.5	3.0
SD02740	64.6	16	96	65	68	41	53	59.8	6	33	1.0	1.5
SD02331	64.5	15	94	66	72	44	46	58.9	8	31	3.5	1.0
Trego	64.4	31	104	74	64	30	50	60.8	3	28	3.5	0.0
SD02790	64.0	28	101	71	64	46	39	58.2	7	34	2.5	1.5
SD02872	63.8	25	97	66	66	45	45	58.6	7	33	4.5	2.0
SD02184	63.6	48	111	60	68	49	30	57.6	12	33	2.5	2.5
Tandem	63.1	23	93	78	64	35	45	60.0	6	31	3.5	2.5
SD02836	63.0	40	104	70	74	45	23	57.6	6	34	2.0	4.5
SD02451	62.9	34	98	65	70	39	43	56.9	8	33	3.0	3.5
SD02736	62.8	49	108	61	68	31	45	59.0	5	32	4.0	4.0
SD02646	62.8	53	109	66	59	37	43	59.8	7	33	2.0	2.5
SD02226	62.7	43	105	71	65	43	30	56.7	9	30	2.0	4.0
Millennium	62.7	32	96	68	69	34	46	59.0	7	32	2.5	4.0
Arapahoe	62.6	33	96	62	75	34	46	58.4	4	32	1.5	2.5
SD02713	62.6	17	86	76	60	39	52	60.7	5	32	1.5	1.5
Alliance	62.5	36	98	65	69	41	40	58.6	3	31	3.5	3.0
SD02499	62.4	22	89	75	65	40	43	58.9	6	34	4.5	2.5
SD02791	62.2	39	99	71	68	34	38	59.2	5	30	2.5	4.5
SD02449	62.2	41	102	70	66	36	37	55.5	7	30	3.5	2.0
SD02532	62.0	21	85	72	66	50	36	58.0	8	34	2.5	4.0
SD02400	62.0	26	90	76	65	39	40	58.0	4	32	1.0	3.5
SD02874	61.9	30	92	64	69	37	48	58.2	5	33	2.5	4.0
SD02496	61.9	35	94	74	63	38	41	59.9	5	33	2.0	1.0
SD02317	61.8	42	100	62	65	39	43	57.6	1	36	2.5	4.0
SD02602	61.7	46	101	67	61	41	38	59.7	3	31	1.5	3.0
SD02186	61.6	20	82	73	63	48	41	58.5	11	35	1.5	0.0
SD02142	61.4	51	101	60	67	43	36	58.0	9	33	1.0	1.5
SD02187	61.2	29	88	68	64	47	39	57.9	9	34	1.5	2.5
SD02873	61.2	38	94	66	69	39	39	57.8	6	37	1.5	5.0
SD02632	61.2	52	101	64	67	37	37	59.3	7	36	1.0	1.5
SD02077	60.9	45	97	62	67	38	40	59.6	6	32	1.0	4.0
SD02144	60.9	37	91	62	69	45	37	59.1	9	34	1.0	1.5
Wendy	60.8	56	102	71	61	32	38	59.1	0	27	1.0	3.0
SD02025	60.3	55	99	64	60	36	42	60.6	2	32	1.5	1.5
SD02741	60.1	54	97	69	64	34	36	59.0	3	32	2.0	4.5
SD02173	59.5	47	91	61	72	42	31	58.7	8	33	2.0	4.5
SD02501*	58.9	24	72	72	61	36	53	59.9	7	33	3.0	1.0
Wesley	58.9	58	94	75	55	33	37	57.9	5	25	1.0	4.0
SD02057	58.2	50	85	70	62	29	46	57.9	6	31	3.0	1.5
SD02065	58.2	59	95	68	62	26	39	58.1	5	30	1.0	3.0
SD02411	57.8	44	80	68	69	40	31	56.8	7	34	3.0	4.0
SD02854	56.3	57	80	64	62	36	40	60.7	4	37	3.5	3.0
Expedition	56.1	60	99	54	55	37	36	58.5	0	30	1.5	3.0
MEAN	63.1		97	69	67	41	42	58.6	6	33	2.4	2.9
CV	10.7		11	8	6	13	17	2.0	1	5	42.6	33.3
LSD	5.9		21	10	8	10	14	1.1	1	2	2.0	1.9

\* Selected for advancement to 2005 Advanced Yield Trials (AYT).

1 Grain Yield (GY) and Testweight (TW) averages are adjusted by the least square means method and include data from Brookings (BRK), Dakota Lakes Pea Stubble (DLP), Selby (SEL), Wall (WAL) and Winner (WIN).

2 Grain Yield Rank excludes data from Brookings, an exceptionally high yielding environment.

3 Relative heading date (HEAD) is an average of data from Brookings, Dakota Lakes and Selby. Plant height (HEIGHT) is an average of data from Brookings, Selby, Wall and Winner.

4† LODGING (5 is flat) and disease (5 is worst) data are tentative (high CV%) and were taken in a normal field environment at Brookings (lodging) and Winner (Wheat Streak Mosaic Virus, WSMV).

**Table 6. Grain yield, Testweight and Agronomic Data for the 2004 Preliminary Yield Trial White (PYTW). (Entries are ranked in descending order by statewide yield average).**

Entry	GRAIN YIELD (bushels per acre)							TW <sup>1</sup>	HEAD <sup>3</sup>	HEIGHT <sup>3</sup>	LODGING <sup>4</sup>	WSMV <sup>4</sup>
	AVE <sup>1</sup>	Rank <sup>2</sup>	BRK	DLP	SEL	WAL	WIN	(lb/bu)	(days)	(inches)	(1-5)	(0-5)
SD02W068	66.7	1	97	70	61	47	58	61.3	4	37	3.0	1.0
SD02W013	66.1	2	97	72	64	47	51	59.5	4	31	1.0	3.0
Harding	65.4	6	103	70	61	48	44	58.6	7	35	1.5	4.0
SD02W005	64.2	9	101	74	62	48	36	59.2	7	33	1.0	2.0
Trego	64.0	4	95	70	56	38	62	61.0	2	28	1.5	1.5
Arapahoe	64.0	8	97	65	67	40	50	59.1	2	34	3.0	2.5
SD02W129*	63.6	5	94	70	62	52	41	58.1	7	31	2.5	3.5
SD02W070*	63.2	3	86	67	57	44	61	61.4	5	33	1.0	1.5
SD02W014	62.5	7	90	73	61	44	44	59.1	3	29	1.0	2.5
SD02W069	62.2	10	95	67	52	52	46	60.6	6	39	2.5	3.5
SD02W065	62.2	11	96	68	53	48	46	59.4	0	35	2.0	2.0
SD02W131	62.0	14	98	60	67	45	41	59.1	7	33	2.0	3.0
SD02W130*	62.0	13	97	73	58	36	46	60.2	6	32	2.0	3.0
SD02W139	61.6	21	100	58	60	47	43	60.4	3	37	1.5	3.5
SD02W128	61.3	15	94	67	61	47	37	57.5	8	33	3.0	3.0
SD02W124*	61.0	17	94	59	63	36	53	60.7	3	30	2.0	3.0
SD02W120	60.3	19	92	61	58	40	50	60.0	3	33	3.5	2.0
SD02W125*	60.3	29	101	56	57	43	44	58.7	5	32	1.5	3.5
SD02W063	60.0	12	87	70	60	48	36	56.6	8	37	1.0	4.5
SD02W137	59.9	24	95	63	58	49	34	59.8	8	39	2.0	4.0
SD02W123	59.8	26	97	57	64	38	43	59.2	4	32	2.0	3.0
SD02W121	59.7	22	91	47	61	45	55	60.3	3	32	3.0	4.0
Expedition	59.6	28	97	63	62	40	36	59.0	0	31	2.0	1.5
SD02W011	59.2	16	84	68	60	44	39	59.2	4	33	1.0	4.0
SD02W126*	59.0	30	96	59	59	43	38	59.3	2	29	2.0	3.0
SD02W040	58.9	20	85	71	54	51	33	56.0	9	38	1.5	3.5
SD02W067	58.7	23	89	56	56	46	47	59.8	1	36	2.0	0.5
SD02W132*	58.6	31	96	61	58	43	35	58.0	7	33	1.0	3.5
SD02W052	58.5	18	82	73	52	44	42	58.9	8	30	1.0	1.5
SD02W122	57.7	36	98	54	51	42	44	58.6	8	33	2.5	3.5
SD02W053	57.5	27	86	67	48	44	42	58.6	7	30	2.0	1.5
SD02W039	57.2	25	83	71	57	55	20	56.0	8	38	1.0	5.0
SD02W133	57.2	35	94	55	56	40	41	58.5	4	30	3.0	3.0
SD02W036	56.8	34	89	57	56	55	27	55.7	8	40	1.5	3.0
SD02W090	56.8	32	88	67	51	37	41	58.3	3	28	1.0	0.5
SD02W057	55.5	33	82	70	58	38	30	55.8	8	34	1.5	2.5
Wesley	53.6	42	91	51	50	41	35	57.7	2	27	1.0	0.0
SD02W045	53.5	38	79	56	52	46	34	55.8	8	38	1.0	3.5
SD02W044	53.4	41	85	53	53	49	28	55.4	8	38	1.0	3.5
SD02W038	53.2	39	80	54	54	47	31	54.8	8	38	1.5	2.5
SD02W042	53.1	40	81	64	51	52	19	55.2	8	39	1.5	4.0
SD02W020	52.8	37	74	64	50	46	29	58.1	6	38	1.5	2.5
SD02W037	51.9	43	84	55	48	49	23	55.4	8	38	1.5	2.5
Wendy	51.8	44	85	44	59	35	36	58.5	1	28	1.0	3.0
SD02W041	47.5	45	70	45	54	39	30	56.6	1	34	1.0	2.5
MEAN	59.0		91	62	57	45	40	58.4	5	34	1.7	2.8
CV%	11.7		9	15	9	10	16	2.2	1		40.6	33.4
LSD <sub>0.05</sub>	6.1		17	18	10	9	13	1.2	2		1.4	1.9

\* Selected for advancement to 2005 Advanced Yield Trials (AYT).

1 Grain Yield (GY) and Testweight (TW) averages are adjusted by the least square means method and include data from Brookings (BRK), Dakota Lakes Pea Stubble (DLP), Selby (SEL), Wall (WAL) and Winner (WIN).

2 Grain Yield Rank excludes data from Brookings, an exceptionally high yielding environment.

3 Relative heading date (HEAD) is an average of data from BRK, DLP and SEL. Plant height (HEIGHT) is an average of data from BRK, SEL and WAL.

environment at Brookings (lodging) and Winner (Wheat Streak Mosaic Virus, WSMV).

to bulk stem rust races and field leaf rust races, and above average yields. All seven of the white experimental entries that were eventually advanced to the 2005 AYT nursery were among the 15 early star performers. Six of these are progeny of a cross between an Oregon line (OR908482) and SD93267 (Shield/Roughrider//SD76598-7/Agassiz), which has very low PPO activity. The other star performer, SD02W070, [NE95417W/SD93364 (SD93364 = Brule/TAM105 //NE82651)], has similar gluten quality and sprouting tolerance, higher test weight, and higher PPO activity compared to the other white lines.

### **Early Yield Trial (EYT)**

A 2:1 ratio of red to white lines (540 hard red lines and 270 hard white lines) was selected from head rows for yield testing in the 2004 EYT at Brookings and Winner. Continuing the pattern set the previous year, plots were full-sized 7-row plots instead of 3-row plots. Partial EYT nurseries, of lines with enough seed, were planted at Selby. A check plot of Arapahoe was planted every tenth plot. Yield and test weight were analyzed by moving means analysis in two directions and adjusted in relation to adjacent check plots. Lines that yielded in the top 50 % were considered for advancement to 2005 PYT White. Of those lines, 8% were discarded for poor pre-harvest sprouting tolerance (tested at harvest time), 6% for leaf rust susceptibility and 5% for seedling stem rust susceptibility. Test weight, tan spot severity, agronomic score, lodging, predicted baking score and PPO activity were other major criteria. For advancement to 2005 PYT Red, 40 % of selections were from the top third for yield, and all but one of the remaining lines was selected from among the next third for yield. The list was further reduced by 10% each for field leaf rust and stem rust susceptibilities. Other criteria were the same as for whites, except that PPO activity and sprouting tolerance were not considered.

### **Head Row Nursery**

The 2004 head row nursery consisted of 21,591 head-rows selected from 128  $F_4$  populations (different cross combinations), 135  $F_5$  re-selected populations, and 23  $F_6$  scab-screening re-selections of crosses between spring and winter wheat. Of the 73 white populations and the 190 red populations, 24 white entries and 111 red entries were re-selections from the 2003 EYT nursery. Fifty heads were picked from each re-selected EYT entry. The other entries were obtained by picking 150 heads from each selected entry in the  $F_3$  nursery. Selections were based on pedigree and visual observation of plants at maturity. Heads of progeny of red x white crosses were threshed individually and evaluated for seed color before placing in the appropriate nursery.

### **Early Generation Bulk Populations**

#### *a) $F_3$ and $F_4$ Bulk Generations*

The 2004  $F_3$  nursery of bulk populations was planted at Brookings and Dakota Lakes from seed of 297  $F_2$  bulk populations selected by culling the bottom 15% for grain yield. The  $F_3$  plots consisted of 132 red, 96 white, and 58 red x white bulk populations from crosses made in 2001. Additionally, 11 white populations originating from crosses made in 2000 were sorted from seed of red x white crosses harvested in Arizona. Of the white populations, 87 were from single crosses, 4 were from 3-way crosses, and 16 were from mixtures of populations. Of the red populations, 97 were from single crosses, 22 were from three-way crosses or backcrosses, and 13 were from mixtures of populations. Of the red x white populations, 33 were from single crosses, 19 were from 3-way crosses and 6 were from mixtures of populations.

### *b) F<sub>2</sub> Generation*

The 2004 F<sub>2</sub> nursery of bulk populations (293 entries, equivalent to the previous year) was planted at 50-75 grams of seed per location in full-sized plots (65 ft<sup>2</sup>) at a two-location nursery (Aurora and Highmore) and a one-location nursery at Highmore. Another exclusive nursery at Aurora was planted with 238 entries (79 more than the previous year mostly as an increase in the number of red x white crosses) that had 26 -50 grams of seed per entry. No off-season nursery was planted. The F<sub>2</sub> plots consisted of 200 red and 106 white bulk populations and 188 populations from red x white crosses made in 2001. Thirty-five of these populations were mixtures from crosses with F<sub>1</sub> yields of less than 25 grams. Crosses were allocated to the mixtures based on common parentage. Additionally, 37 populations from crosses between adapted winter wheat and scab-tolerant spring wheat were represented in the F<sub>2</sub> nursery.

In 2004, all F<sub>2</sub> entries were advanced to the 2005 F<sub>3</sub> nursery except for some that were lost during processing.

### **Greenhouse Crossing and Increase Program**

The basic strategy of the greenhouse crossing program is to make adapted/adapted and adapted/un-adapted//adapted crosses (three-way crosses) with adapted winter wheat from our program and neighboring programs and un-adapted (e.g., spring wheat or other exotic germplasm) material with special desirable traits. Unique germplasm with resistance to FHB, WSMV, aphids, stem and leaf rusts, and hard white grain characteristics continue to be used in the crossing program. During 2004, 852 successful crosses were made during two greenhouse cycles (583 in the spring and 269 in the fall).

### **RESEARCH SUPPORT PROJECTS**

Basic research support projects included: end-use quality enhancements and inheritance studies on resistance to *Fusarium* head blight (FHB), stem rust, and freeze survival.

#### ***Fusarium* Head Blight**

In 2004, we screened 1498 genotypes in the FHB mist-irrigated field nursery. The percentage of the South Dakota experimental lines that were superior to the FHB resistant check 'Expedition' [Disease index (incidence % \* severity% / 100) = 16.8%] was 14.6%. Advanced lines were also evaluated in the greenhouse using needle inoculation and were also screened for the 3BS QTL associated with the Sumai3 type resistance. Six genotypes consisting of susceptible winter wheat 'Nekota' and '2137', moderately susceptible winter wheat 'Harding', moderately resistant spring wheat 'ND2710' and 'BacUp' and resistant spring wheat 'Ning7840' were crossed in a partial diallel mating design to determine combining ability of FHB resistance. F<sub>1</sub> crosses were evaluated in the greenhouse, and F<sub>2</sub> crosses were screened under both greenhouse and mist-irrigated field conditions. One parent 'Nekota' was excluded from the diallel mating design at the field condition because of few F<sub>2</sub> seed and poor plant stand. In the greenhouse, both F<sub>1</sub> and F<sub>2</sub> were artificially point inoculated at anthesis, whereas F<sub>2</sub> crosses in the field condition were artificially inoculated by a combination of corn spawn spread at jointing stage and inoculums suspension spray at anthesis. Disease index percentage of the crosses was analyzed using Griffing's method 4 and model 1. General combining ability was highly significant (P<0.01) in both greenhouse and field conditions, but specific combining ability was significant (P<0.05) only in F<sub>2</sub> crosses in the greenhouse condition. The results showed that both additive and non-additive gene effects are involved in the inheritance of FHB resistance.

## **Stem and leaf rusts**

Though our present stem rust (SR) resistance sources are effective, there is always concern that the resistance might break down at some point in the future. We are working on transferring several novel/under-utilized broad-spectrum stem rust resistance genes into selected adapted lines. Research studies in coming years will focus on assessment of positive or negative effects of these genes with regard to yield, quality, or other agronomic traits. The first backcross cycle was conducted in the spring of 2004. The same concept will be utilized in building parents with broad, durable resistance for crossing with high yield potential germplasm that lack in SR resistance but possess good leaf spotting disease resistance. We are also building several populations for mapping markers associated with resistance of these sources in collaboration with Dr. Yang Yen, SDSU Molecular Biologist. Our objectives are to: 1) to conduct a preliminary screen for the few existing markers linked with stem rust resistance genes, to assess the potential for using these markers in selection for the respective resistance genes, and 2) to begin to search for molecular markers linked to the novel and under-utilized genes mentioned above. Resistance in most of these unique sources is believed to be conferred by a single major gene. The F<sub>2</sub> generation of resistant-by-susceptible line is being increased in the greenhouse. We look towards marker assisted selection as a complement and not a replacement to more traditional methods, and we believe that it offers unique opportunities for enhancing the efficiency of variety development.

Future research will utilize a combination of greenhouse and field screening to breed for durable resistance to leaf rust (LR). The EYT, PYT, AYT, and CPT entries will be screened in the greenhouse and in the field (transplanted nurseries). The head-row nursery will be planted on spring wheat stubble at Dakota Lakes Research Farm every other year to stimulate disease expression and facilitate screening for both LR and SR.

## **Winter Hardiness**

Multi-year, replicated field-testing forms the basis for the improvement of winter survival ability in our new wheat cultivars. Physiological and molecular markers of freeze resistant genotypes also will be required to complement field-testing especially during milder years. We have established collaboration with Dr. Fedora Sutton, SDSU Plant Molecular Physiologist to conduct studies geared towards understanding the physiological basis and identifying genes and proteins necessary for freeze survival.

## **Combined PPO and Sedimentation Test**

The goal for breeding white wheat for South Dakota markets is to develop dual-purpose varieties that can be used for either breads or noodles. Noodle color stability is affected by activity of the enzyme polyphenoloxidase (PPO) and can be predicted in early generations by an assay using L-DOPA, an artificial amino acid, and 5 seeds. Gluten strength, a major factor in quality of bread, can be measured in early generations with a protocol that measures the size of the sediment layer after mixing 1 gram of ground meal in a solution of lactic acid and sodium dodecyl sulfate.

We endeavored to combine these protocols to make use of a single ground sample for each entry and to decrease the amount of time for testing. The 1-gram sample would increase the size of the PPO sample to be more representative, without increasing the total amount of grain used in early generation testing. Results of protocol development and two years of data using the new

protocol were presented as a poster, “Development of Combined Meal PPO and Sedimentation Protocol,” at the 2004 National Wheat Workers Workshop in Kansas City, Missouri.

The most promising combined protocol (5 ml lactic acid, 4 mL 10 mM L-DOPA in 150 mM MOPS buffer, with ambient temperature of 24° C. m 1.0 °, with measurement of sedimentation at 41 minutes and color at 42 minutes) provided acceptable PPO and sedimentation scores. The stability of PPO values in the combined protocol (coefficient of variation = 12.8 %) was greatly improved compared to the stability of PPO values in the 5-grain visual PPO test (C.V. = 22.3 %). Stability of sedimentation values in the combined protocol (C.V. = 3.4 %) matched stability of sedimentation values in the standard meal sedimentation test (C.V. = 4.5 %).

Skewness of PPO and sedimentation values obscured distinctions among larger values. Skewness is not a problem for PPO screening since the test is used primarily to eliminate the worst 10 or 20 % of entries. On the other hand, skewed sedimentation values do not fit our current use of the data to select lines that have high gluten quality (as determined by subtracting protein Z-scores from sedimentation Z-scores).

Simultaneously with development of the combined protocol, efforts were made to increase the efficiency of the individual protocols. The speed of preparation and testing with each of the individual protocols was doubled by overlapping batches or by increasing the number of samples in each batch and was inherently faster than the new combined protocol. Despite the advantages for PPO evaluation, the combined protocol was abandoned in favor of the streamlined individual protocols.

### **Hard white wheat as a main component of Baladi bread**

There has been an ever-increasing demand for wheat products such as bread in Africa. To cut down the production cost and to make bread available at affordable price, up to 30 percent sorghum or millet flour is blended into the wheat flour in a few African countries. Products made with composite flour have been well accepted in Kenya, Nigeria, Senegal, and the Sudan. It has been found that blending up to 30 percent sorghum with 70 percent wheat produced flat Baladi bread comparable to that made of 100 percent wheat. Hard white (HW) wheat is highly desirable in this blend. A South Dakota experimental HW wheat ‘SD97W609’ was found to possess excellent bread baking quality and is expected to be an excellent choice for flour blends used for producing this kind of bread. The objective of this project is to analyze breads made with composite flour of the Sudanese white sorghum variety ‘Tabat’ and South Dakota HW wheat line SD97W609 and to gain an understanding of the unique quality of this bread. This project will be done in collaboration with Dr. Padmanaban Krishnan, Professor at the Nutrition, Food Science and Hospitality Department at SDSU and Dr. Abdelmoneim I. Mustafa, Professor of Food Science at the University of Khartoum in the Sudan. The research will be conducted by a Sudanese student, Ranya F. Abdelghafor at SDSU. Loaf and flat Baladi breads will be made with composite flour of white sorghum and white hard wheat. A wide range of chemical, Rheological and baking analyses will be performed on the samples. Emphasis will be placed on dough mixing properties, physical characteristics of the bread in addition to sensory evaluation.