

Report of the 2015 Uniform Regional Scab Nursery for Spring Wheat Parents

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The Uniform Regional Scab Nursery for Spring Wheat Parents (URSN) was grown for the 20th year in 2015. Six locations (Brookings, SD, St. Paul and Crookston, MN, and Prosper, Langdon, and Carrington ND) were planted.

A total of 33 entries was included in the 2015 URSN, in addition to the resistant checks 2375, BacUp, and ND2710, and the susceptible checks Wheaton and Oslo. The entries were contributed by three university, one industry, and two Canadian federal wheat breeding programs.

A core set of traits evaluated at the nursery locations included Fusarium head blight (FHB) incidence, FHB severity, and disease index (incidence x severity). In addition, visual scabby kernel ratings (VSK \cong tombstone) and grain deoxynivalenol content were provided from two or more locations. Additional agronomic trait data are presented in individual location summary tables for locations where they were measured. Overall means for traits over locations are presented, as are relative rankings for incidence, severity, disease index, VSK and DON. Correlation coefficients are provided between incidence, severity, disease index, and VSK. Molecular marker genotypes for a set of FHB resistance QTLs and other traits are provided for entries. Adult plant leaf and stem rust reactions are also presented.

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Cooperators for the 2015 Uniform Regional Scab Nursery for Spring Wheat Parents

South Dakota State University (Brookings):

Karl Glover

University of Minnesota (St. Paul, Crookston):

Jim Anderson and Ruth Dill-Macky

North Dakota State University (Prosper, Langdon):

Mohamed Mergoum

USDA-ARS, Cereal Crops Research Unit (Fargo, ND):

Shiaoman Chao

USDA-ARS, Cereal Disease Laboratory (St. Paul, MN):

Jim Kolmer, Yue Jin

Table 1. Entries for the Uniform Regional Scab Nursery for Spring Wheat Parents, 2015.

Entry No.	Name	Pedigree	Year First Entered		Source
1	2375		CHECK		
2	Wheaton		CHECK		
3	Bacup		CHECK		
4	Oslo		CHECK		
5	ND2710		CHECK		
6	SD4559	2009-19013/SD4181	2015	K. Glover	SDSU
7	SD4582	PI67392/SD3618//ND750	2015	K. Glover	SDSU
8	SD4595	SD4148/BRICK	2015	K. Glover	SDSU
9	SD4605	SD4253/SD4181	2015	K. Glover	SDSU
10	SD4607	SD4253/SD4243	2015	K. Glover	SDSU
11	MN11326-3	Sabin//Prairie Red/Tom	2015	J. Anderson	UMN
12	MN12265-1	MN02072-7//RB07/MN00187-3-1	2015	J. Anderson	UMN
13	MN12307-3	Faller*2/MN00209-3-1 Sabin//Norden/(Wheaton/Abura	2015	J. Anderson	UMN
14	MN12423-5	RIL83)	2015	J. Anderson	UMN
15	MN12545-3	MN06102/Faller	2015	J. Anderson	UMN
16	MT1219	MT0643/MTHW0771	2015	L. Talbert	MSU
17	MT1316	GLENN/MT0747	2015	L. Talbert	MSU
18	MT1337	MT0830/MT0858	2015	L. Talbert	MSU
19	MT1338	MT0830/MT0858	2015	L. Talbert	MSU
20	BW483	99B60-EJ2G/KANE D1125/Alsen//BW346/3/BW370/9	2015	S. Kumar	AAFC-BRC
21	BW485	9B60-EJ26	2015	S. Kumar	AAFC-BRC
22	BW499	Waskada/BW361	2015	S. Kumar	AAFC-BRC
23	BW961	Alsen/Waskada	2015	R. Cuthbert	AAFC-SPARC
24	07S0068-11	MN01180/KNUDSON	2015	J. Smith	Syngenta
25	08S0303-16	N97-0329ES/SD3546)//FALLER 01S0107-7/01S0238-7W//SY	2015	J. Smith	Syngenta
26	08S0339-23	INGMAR 01S0107-13/01S0238-	2015	J. Smith	Syngenta
27	08S0341-15	5W//00S0287-16/KNUDSON 01S0247-17/NORPRO//01S0107-	2015	J. Smith	Syngenta
28	08S0347-23	7/01S0238-7W	2015	J. Smith	Syngenta
29	14-13-97 'S'	ND819 'S'	2015	M. Mergoum	NDSU
30	14-13-106 'S'	ND744'S'/Alsen	2015	M. Mergoum	NDSU
31	14-13-135 'S'	MN00261-4/Alsen	2015	M. Mergoum	NDSU
32	14-13-14 'S'	ND824 'S'	2015	M. Mergoum	NDSU
33	14-13-21 'S'	9950146ES/Glenn	2015	M. Mergoum	NDSU

Table 2. 2015 Uniform Regional Scab Nursery for Spring Wheat Parents, Brookings, SD.

Line	Incidence %	Severity %	Disease Index	Tombstone %
2375	100.0	36.8	36.8	38.3
Wheaton	100.0	50.0	50.0	80.0
Bacup	100.0	46.7	46.7	81.7
Oslo	100.0	46.3	46.3	63.3
ND2710	98.3	30.7	30.3	40.0
SD4559	100.0	35.0	35.0	30.0
SD4582	88.3	21.2	18.8	20.0
SD4595	95.0	29.7	28.3	26.7
SD4605	100.0	31.8	31.8	35.0
SD4607	100.0	41.2	41.2	33.3
MN11326-3	96.7	32.0	31.1	31.7
MN12265-1	98.3	35.2	34.7	50.0
MN12307-3	100.0	33.0	33.0	33.3
MN12423-5	95.0	24.5	23.3	28.3
MN12545-3	98.3	37.2	36.6	53.3
MT1219	100.0	50.3	50.3	55.0
MT1316	100.0	43.0	43.0	41.7
MT1337	100.0	47.0	47.0	36.7
MT1338	98.3	45.5	44.8	41.7
BW483	100.0	47.0	47.0	51.7
BW485	100.0	47.2	47.2	48.3
BW499	96.7	33.7	32.9	86.7
BW961	100.0	42.7	42.7	50.0
07S0068-11	100.0	41.7	41.7	45.0
08S0303-16	100.0	46.2	46.2	63.3
08S0339-23	98.3	33.2	32.6	35.0
08S0341-15	100.0	42.8	42.8	65.0
08S0347-23	100.0	43.3	43.3	56.7
14-13-97 'S"	100.0	41.2	41.2	43.3
14-13-106 'S"	100.0	40.3	40.3	40.0
14-13-135 'S"	100.0	36.7	36.7	28.3
14-13-14 'S"	96.7	34.2	33.1	40.0
14-13-21 'S"	100.0	44.2	44.2	48.3
Mean	98.8	39.1	38.8	46.1
LSD	3.8	9.5	9.9	15.9
CV	2.4	18.7	19.9	35.1

Table 3. 2015 Uniform Regional Scab Nursery for Spring Wheat Parents, Crookston, MN.

Line	Incidence %	Severity %	Disease Index	VSK %	DON ppm	Heading d from 6-1	30 SSW ¹ g	micro TWT ² g
2375	97.5	53.6	52.5	18.3	15.4	39	10.6	10.0
Wheaton	100.0	70.8	70.8	51.7	62.1	43	3.7	-
Bacup	100.0	26.8	26.8	10.7	10.6	36	11.0	10.9
Oslo	100.0	78.0	78.0	40.0	33.2	39	5.5	-
ND2710	87.5	11.2	9.8	6.7	7.8	40	22.1	11.5
SD4559	100.0	34.4	34.4	8.0	9.4	36	11.1	10.1
SD4582	92.5	13.0	11.9	4.7	3.8	37	19.4	11.9
SD4595	97.5	34.8	33.8	10.0	15.1	38	12.8	10.5
SD4605	92.5	44.7	41.4	13.0	14.4	38	12.0	10.2
SD4607	97.5	44.0	42.7	10.7	11.4	38	12.0	11.1
MN11326-3	85.0	14.6	13.0	6.0	5.5	41	14.8	11.0
MN12265-1	97.5	34.4	33.6	8.0	7.4	39	11.8	10.9
MN12307-3	90.0	15.9	15.0	7.3	10.8	40	15.7	11.2
MN12423-5	80.0	11.5	9.3	5.3	6.9	40	18.2	11.6
MN12545-3	95.0	16.8	15.9	5.3	6.4	40	14.9	11.6
MT1219	-	-	-	-	-	-	-	-
MT1316	-	-	-	-	-	-	-	-
MT1337	-	-	-	-	-	-	-	-
MT1338	-	-	-	-	-	-	-	-
BW483	-	-	-	-	-	-	-	-
BW485	-	-	-	-	-	-	-	-
BW499	-	-	-	-	-	-	-	-
BW961	-	-	-	-	-	-	-	-
07S0068-11	97.5	27.9	27.5	10.7	12.0	39	14.9	10.7
08S0303-16	100.0	37.8	37.8	10.3	13.1	40	9.7	10.8
08S0339-23	100.0	29.1	29.1	7.3	7.2	39	13.6	10.7
08S0341-15	97.5	40.6	39.5	18.0	27.0	38	8.9	9.6
08S0347-23	100.0	37.7	37.7	11.0	17.4	39	12.9	10.5
14-13-97 'S'	87.5	30.5	28.7	8.7	11.8	38	11.6	10.5
14-13-106 'S'	100.0	29.4	29.4	6.7	9.1	39	12.8	11.4
14-13-135 'S'	87.5	10.4	9.5	4.0	3.6	44	16.0	11.7
14-13-14 'S'	95.0	36.6	34.5	11.7	14.2	39	9.2	-
14-13-21 'S'	90.0	14.6	13.3	6.0	6.1	40	16.6	11.2
Alsen	97.5	39.7	39.0	6.0	5.8	39	11.3	11.1
Wheaton*	100.0	78.3	78.3	61.7	75.1	43	4.2	-
MN00269	100.0	56.0	56.0	25.0	24.8	45	3.5	-
Mean	95.2	34.7	33.9	14.0	16.0	39.5	12.2	11.0
LSD	15.9	20.9	21.3	8.1		1.5	3.4	0.9
CV	8.2	29.8	31.1	28.7		2.4	13.7	3.9

¹ 30 SSW = 30 spike seed weight. This is the sample used to determine VSK.

² Weight of the VSK sample that fits in a 15.7 mL copper vessel measuring 20 mm in diameter and 50 mm in height

* Wheaton was accidentally planted a second time in place of Roblin.

Missing entries were not received in time to plant in the nursery.

Bold entries are extra entries not used in downstream analyses

Table 4. 2015 Uniform Regional Scab Nursery for Spring Wheat Parents, St. Paul, MN.

Line	Incidence %	Severity %	Disease Index	VSK %	DON ppm	Heading d from 6-1	30 SSW ¹ g	micro TWT ² g
2375	90.0	26.5	24.0	13.5	3.9	25	22.4	10.6
Wheaton	96.7	76.8	74.3	75.0	18.5	29	10.2	7.1
Bacup	78.3	21.4	18.8	6.0	2.7	25	21.0	11.3
Oslo	100.0	68.7	68.7	37.5	13.7	26	10.2	8.1
ND2710	50.0	11.5	6.0	4.0	1.4	25	32.1	11.8
SD4559	70.0	12.9	9.2	5.0	2.7	25	27.9	11.4
SD4582	55.0	14.7	8.4	2.5	1.2	25	27.1	11.8
SD4595	78.3	15.8	12.4	12.0	4.6	25	28.4	11.5
SD4605	71.7	25.8	18.3	7.0	3.2	25	30.4	11.1
SD4607	63.3	12.5	8.1	9.0	2.0	25	28.6	11.5
MN11326-3	78.3	18.8	14.6	7.0	3.4	26	24.9	11.1
MN12265-1	86.7	22.7	19.9	10.5	3.2	25	25.3	10.9
MN12307-3	96.7	21.7	21.0	10.0	5.3	25	25.4	10.9
MN12423-5	70.0	17.7	13.0	4.0	1.6	25	29.4	11.5
MN12545-3	76.7	13.4	11.3	5.0	0.6	28	28.5	11.4
MT1219	-	-	-	-	-	-	-	-
MT1316	-	-	-	-	-	-	-	-
MT1337	-	-	-	-	-	-	-	-
MT1338	-	-	-	-	-	-	-	-
BW483	-	-	-	-	-	-	-	-
BW485	-	-	-	-	-	-	-	-
BW499	-	-	-	-	-	-	-	-
BW961	-	-	-	-	-	-	-	-
07S0068-11	85.0	35.2	31.0	17.5	3.7	26	27.4	10.5
08S0303-16	86.7	19.4	16.6	10.0	3.3	29	25.0	10.8
08S0339-23	83.3	23.7	20.1	8.0	3.4	25	25.5	11.0
08S0341-15	96.7	40.4	39.8	21.0	8.6	25	20.5	10.3
08S0347-23	98.3	42.7	42.3	15.0	8.3	26	23.3	10.4
14-13-97 'S'	93.3	30.4	28.7	13.5	4.2	25	23.0	10.4
14-13-106 'S'	98.3	32.2	31.8	11.0	6.2	25	21.3	10.6
14-13-135 'S'	63.3	12.4	8.2	5.0	2.0	30	22.9	11.1
14-13-14 'S'	96.7	36.9	35.9	16.0	5.4	25	22.2	10.6
14-13-21 'S'	55.0	16.1	8.7	4.0	1.3	26	27.6	11.5
Alsen	78.3	26.2	21.8	7.0	3.2	25	19.8	10.5
Wheaton*	98.3	77.0	75.6	50.0	13.2	29	10.8	8.4
MN00269	96.7	76.0	73.4	55.0	9.9	29	10.8	8.8
Mean	81.8	30.3	27.2	15.8	5.0	26.1	23.3	10.6
LSD	23.4	18.6	18.8	14.5		2.3	8.4	1.1
CV	14.1	30.5	34.2	45.5		4.4	17.8	5.3

¹ 30 SSW = 30 spike seed weight. This is the sample used to determine VSK.

² Weight of the VSK sample that fits in a 15.7 mL copper vessel 20 mm in diameter and 50 mm in height

* Wheaton was accidentally planted a second time in place of Roblin

Missing entries were not received in time to be planted in the nursery.

Bold entries are extra entries not used in downstream analyses

Table 5. 2015 Uniform Regional Scab Nursery for Spring Wheat Parents, Prosper, ND.

Line	Incidence %	Severity %	Disease Index
2375	100	65.1	65.1
Wheaton	100	76.0	76.0
Bacup	100	45.9	45.9
Oslo	100	69.8	69.8
ND2710	100	26.1	26.1
SD4559	100	32.9	32.9
SD4582	100	26.6	26.6
SD4595	100	57.0	57.0
SD4605	100	54.3	54.3
SD4607	100	55.5	55.5
MN11326-3	100	40.5	40.5
MN12265-1	100	45.1	45.1
MN12307-3	100	50.6	50.6
MN12423-5	100	48.8	48.8
MN12545-3	100	44.5	44.5
MT1219	100	76.0	76.0
MT1316	100	59.5	59.5
MT1337	100	83.6	83.6
MT1338	100	68.0	68.0
BW483	100	45.6	45.6
BW485	100	53.4	53.4
BW499	100	42.1	42.1
BW961	100	47.4	47.4
07S0068-11	100	52.9	52.9
08S0303-16	100	48.9	48.9
08S0339-23	100	50.2	50.2
08S0341-15	100	54.1	54.1
08S0347-23	100	61.4	61.4
14-13-97	100	58.5	58.5
14-13-106	100	49.6	49.6
14-13-135	100	57.6	57.6
14-13-14	100	65.6	65.6
14-13-21	100	49.9	49.9
Mean			53.4
LSD			12.9
CV			17.2

Table 6. 2015 Uniform Regional Scab Nursery for Spring Wheat Parents, Langdon, ND.

Line	Incidence %	Severity %	Disease Index
2375	100	64.3	64.3
Wheaton	100	89.6	89.6
Bacup	100	53.7	53.7
Oslo	100	75.8	75.8
ND2710	100	35.7	35.7
SD4559	100	42.8	42.8
SD4582	100	35.8	35.8
SD4595	100	46.2	46.2
SD4605	100	45.2	45.2
SD4607	100	47.3	47.3
MN11326-3	100	44.0	44.0
MN12265-1	100	41.0	41.0
MN12307-3	100	36.1	36.1
MN12423-5	100	42.5	42.5
MN12545-3	100	38.0	38.0
MT1219	100	81.2	81.2
MT1316	100	71.3	71.3
MT1337	100	84.6	84.6
MT1338	100	73.8	73.8
BW483	100	47.2	47.2
BW485	100	44.6	44.6
BW499	100	33.8	33.8
BW961	100	48.0	48.0
07S0068-11	100	52.7	52.7
08S0303-16	100	52.1	52.1
08S0339-23	100	44.1	44.1
08S0341-15	100	69.1	69.1
08S0347-23	100	62.6	62.6
14-13-97	100	53.8	53.8
14-13-106	100	48.4	48.4
14-13-135	100	55.0	55.0
14-13-14	100	55.7	55.7
14-13-21	100	52.9	52.9
Mean			53.6
LSD			11.8
CV			15.7

Table 7. 2015 Uniform Regional Scab Nursery for Spring Wheat Parents, Carrington, ND.

Line	Incidence %	Severity %	Disease Index
2375	100	29.2	29.2
Wheaton	100	39.9	39.9
Bacup	77.5	16.1	12.5
Oslo	100	19.0	19.0
ND2710	100	13.7	13.7
SD4559	77.5	14.2	11.0
SD4582	100	10.0	10.0
SD4595	100	13.0	13.0
SD4605	100	18.5	18.5
SD4607	77.5	13.3	10.3
MN11326-3	100	25.7	25.7
MN12265-1	100	47.6	47.6
MN12307-3	100	23.9	23.9
MN12423-5	100	30.5	30.5
MN12545-3	100	17.4	17.4
MT1219	100	52.6	52.6
MT1316	100	45.1	45.1
MT1337	100	24.9	24.9
MT1338	100	24.3	24.3
BW483	100	10.3	10.3
BW485	100	22.3	22.3
BW499	85	11.6	9.9
BW961	100	21.9	21.9
07S0068-11	100	24.8	24.8
08S0303-16	100	30.1	30.1
08S0339-23	100	30.8	30.8
08S0341-15	100	29.7	29.7
08S0347-23	100	22.5	22.5
14-13-97	100	20.3	20.3
14-13-106	100	16.7	16.7
14-13-135	100	22.7	22.7
14-13-14	100	32.4	32.4
14-13-21	100	25.9	25.9
Mean			24.6
LSD			20.3
CV			58.9

Table 8. 2015 Uniform Regional Scab Nursery for Spring Wheat Parents - Summary of Means.

Line	Incidence %	Incidence Rank	Severity %	Severity Rank	Disease Index	Disease Index Rank	Tombstone/VSK %	Tombstone/VSK Rank	DON ppm	DON Rank
No. of Locations	6	6	6	6	6	3	2	2	2	2
ND2710	89.3	1	21.5	2	20.2	2	16.9	9	4.6	7
SD4582	89.3	2	20.2	1	18.6	1	9.1	1	2.5	1
SD4607	89.7	3	35.6	14	34.2	13	17.7	10	6.7	12
MN12423-5	90.8	4	29.2	5	27.9	5	12.6	3	4.3	5
14-13-21 'S"	90.8	5	33.9	11	32.5	11	19.4	13	3.7	4
SD4559	91.3	6	28.7	4	27.5	4	14.3	4	6.1	10
14-13-135 'S"	91.8	7	32.4	9	31.6	9	12.4	2	2.8	2
Bacup	92.6	8	35.1	12	34.1	12	32.8	22	6.7	11
MN11326-3	93.3	9	29.2	6	28.1	6	14.9	5	4.5	6
SD4605	94.0	10	36.7	16	34.9	15	18.3	11	8.8	18
MN12545-3	95.0	11	27.9	3	27.3	3	21.2	14	3.5	3
SD4595	95.1	12	32.7	10	31.8	10	16.2	6	9.9	21
BW499	95.4	13	30.3	8	29.7	7	86.7	33	-	-
14-13-97 'S"	96.8	14	39.1	20	38.5	20	21.8	15	8.0	15
08S0339-23	96.9	15	35.2	13	34.5	14	16.8	7	5.3	8
MN12265-1	97.1	16	37.7	18	37.0	17	22.8	17	5.3	9
07S0068-11	97.1	17	39.2	21	38.4	19	24.4	19	7.9	14
MN12307-3	97.8	18	30.2	7	29.9	8	16.9	8	8.1	16
08S0303-16	97.8	19	39.1	19	38.6	21	27.9	21	8.2	17
2375	97.9	20	45.9	26	45.3	26	23.4	18	9.7	19
14-13-14 'S"	98.1	21	43.5	24	42.9	24	22.6	16	9.8	20
08S0341-15	99.0	22	46.1	27	45.8	27	34.7	23	17.8	23
Wheaton	99.4	23	67.2	33	66.8	33	68.9	32	40.3	25
MT1338	100	24	52.9	28	52.7	28	41.7	25	-	-
08S0347-23	100	25	45.0	25	45.0	25	27.6	20	12.9	22
14-13-106 'S"	100	26	36.1	15	36.0	16	19.2	12	7.7	13
Oslo	100	27	59.6	30	59.6	30	46.9	27	23.5	24
MT1219	100	28	65.0	32	65.0	32	55.0	31	-	-
MT1316	100	29	54.7	29	54.7	29	41.7	26	-	-
MT1337	100	30	60.0	31	60.0	31	36.7	24	-	-
BW483	100	31	37.5	17	37.5	18	51.7	30	-	-
BW485	100	32	41.9	23	41.9	23	48.3	28	-	-
BW961	100	33	40.0	22	40.0	22	50.0	29	-	-

missing values: no data

Table 9. Correlation coefficients among traits, by location.

Correlation Between	Brookings	Crookston	St. Paul	Prosper	Langdon	Carrington
Incidence & Severity	0.73	0.64	0.69			0.36
Incidence & Disease Index	0.76	0.66	0.75			0.44
Incidence & Tombstone/VSK	0.36	0.41	0.53			
Incidence & DON		0.40	0.67			
Severity & Disease Index	1.00	1.00	0.99	1.00	1.00	1.00
Severity & Tombstone/VSK	0.59	0.86	0.90			
Severity & DON		0.79	0.95			
Disease Index & Tombstone/VSK	0.58	0.86	0.89			
Disease Index & DON		0.80	0.95			
Tombstone/VSK & DON		0.96	0.94			

Table 10. Correlation coefficients among traits, using means across locations.

	Incidence %	Severity %	Disease Index	VSK %
Incidence %				
Severity %	0.73			
Disease Index	0.75	1.00		
VSK %	0.55	0.57	0.58	
DON ppm	0.57	0.89	0.88	0.93

Table 11. Leaf and stem rust reactions in inoculated field nurseries, 2015 Uniform Regional Scab Nursery for Spring Wheat Parents, St. Paul, MN. (J. Kolmer and Y. Jin, USDA-ARS, St. Paul, MN).

Line	Leaf Rust	Stem Rust
2375	30MRMS	TR
Wheaton	10MR	0
Bacup	60MS	TR
Oslo	50MRMS	10MR
ND2710	60S	TR
SD4559	10MRMS	20RMR
SD4582	TR	10MR
SD4595	5R	10RMR
SD4605	TR	0
SD4607	5RMR	20RMR
MN11326-3	5R	0
MN12265-1	10RMR	0
MN12307-3	40S	10R
MN12423-5	10RMR	TR
MN12545-3	30S	TR
MT1219	50MRMS	TR
MT1316	60MS	10R
MT1337	90S	TR
MT1338	50S	5R
BW483	-	-
BW485	-	-
BW499	-	-
BW961	-	-
07S0068-11	10RMR	10MR
08S0303-16	10RMR	TR
08S0339-23	5R	TMR
08S0341-15	5R	10R
08S0347-23	TR	10MRMS
14-13-97 'S"	50S	0
14-13-106 'S"	TR	TR
14-13-135 'S"	TR	0
14-13-14 'S"	80S	TR
14-13-21 'S"	5R	TR

Data from inoculated trials using a mixture of races.

Missing data are for entries received too late to plant in rust nursery.

Table 12. Allele Sizes of Molecular Markers Associated with Selected Traits/Genes (S. Chao, USDA-ARS, Fargo, ND).

Trait/Gene	HMW Glutenins / Glu-1A	HMW Glutenins / Glu-1D	Grain Protein Content / GPC	Leaf Rust / Lr34	Leaf Rust / Lr21	Tan Spot / tsn1	Scab / Fhb1	Scab / Fhb 5A		Stem Rust / Sr25			Stem Rust / Sr2	Photoperiod / PpdD1_D2	Height / Rht- B1	Height / Rht- D1
Marker	umn19		Gpc-B1	l4	Lr21	fcp397	Fhb1	barc 180	barc186	Sr25			gwm533		Rht-B1	Rht-D1
Chromosome	1A	1D	6B	7D	1D	5B	3B	5A		7D			3B	2D	4B	4D
2375	341	C	A	T	T	G	C	194	211	183	206	211	C	C	C	C
Wheaton	341	C	A	T	T	-	C	191	201	183	206	211	C	C	C	A
Bacup	359	C	A	T	T	G	C	197	211	183	200	206	C	C	C	C
Oslo	359	G	A	A	T	-	C	191	201	183	206	211	C	C	T	C
ND2710	359	C	A	T	T	G	T	200	201	183	200	206	C	T	C	C
SD4559	341	C	A	A	T	G	T	191	201	183	206	211	C	C	C	C
SD4582	341	C	A	A/T	C	-	T	203	211	183	206	211	C	T	C	C
SD4595	341	C	A	T	T	G	C/T	191	201	183	206	211	C	C	C	C
SD4605	341	C	A	A/T	T	G	C	187	201	183	206	211	C	T	C	C
SD4607	341	C	A	T	T	G	C	191	201	183	206	211	C	T	C	C
MN11326-3	359	C	A	T	T	G	T	200	201	183	200	206	C	C	C	C
MN12265-1	341	C	A	T	C	-	T	203	211	183	206	211	C	C	T	C
MN12307-3	341	C	A	A	C	G	T	203	211	183	206	211	C	T	T	C
MN12423-5	359	C	-	T	T	G	T	200	201	183	200	206	C	C	C	C
MN12545-3	341	C	A	A	C	-	T	203	201	183	206	211	C	T	T	C
MT1219	341	C	A	A	T	-	C	191	201	183	206	211	C	T	C	A
MT1316	359	C	A	A	C	G	C	197	201	183	206	211	C	T	T	C
MT1337	359	C	A	A	T	G	-	191	201	183	206	211	C	T	T	C
MT1338	359	G	A	T	T	G	-	191	201	206	211	231	C	T	T	C
BW483	341	C	A	A	C	G	-		201	183	206	211	-	T	-	C
BW485	341	C	A	A	C	G	T		211	183	206	211	-	T	C	C
BW499	341	C	A	A	T	G	C		201	183	206	211	-	T	C	C
BW961	341	C	A	A/T	T	G	T		211	183	206	211	-	T	T	C
07S0068-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08S0303-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08S0339-23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08S0341-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08S0347-23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14-13-97 'S'	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14-13-106 'S'	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14-13-135 'S'	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14-13-14 'S'	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14-13-21 'S'	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Please see next page for more details on marker allele/gene associations.

Table 12 continued, Key to Traits.

Trait	Marker	Gene	Chromosome	Size (base)
HMW Glutenins	umn19	Glu-1A	1A	Ax2*=341, Ax1=359
HMW Glutenins		Glu-1D	1D	G=Poor, C=Good
Grain protein content	Gpc-B1	GPC	6B	T=High, A=Low
Leaf rust	l4	Lr34	7D	T=Resistance, A=Susceptible
Leaf rust	Lr21	Lr21	1D	T=Susceptible, C=Resistance
Tan Spot	fcp397	tsn1	5B	G=Susceptible, -- =Resistance
Scab	Fhb1	Fhb1	3B	T=Resistance, C=Susceptible
Scab	barc180	Fhb 5A	5A	203=Resistance
Scab	barc186	Fhb 5A	5A	211=Resistance
Stem rust	Sr25	Sr25	7D	200=Resistance
Stem rust	gwm533	Sr2	3B	C=Susceptible, T=Resistance
Photoperiod		PpdD1_D2	2D	T=Sensitive, C=Insensitive
Plant height	Rht-B1	Rht-B1	4B	C=wild type, T=dwarf
Plant height	Rht-D1	Rht-D1	4D	C=wild type, A=dwarf