Northern Uniform Winter Wheat Scab Nursery (NUWWSN)

Report on 2001-2002 Nursery

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This report is a compilation and analysis of data from the cooperative assessment of resistance to Fusarium Head Blight (scab) (causal agent *Fusarium graminearum* (teleomorph: *Gibberella zeae* Schwabe.)) in winter wheat germplasm adapted to the northern regions of North America. Funding for the evaluation comes from the U.S. Wheat and Barely Scab Initiative, state and provincial agricultural experiment stations, USDA-ARS, and private companies.

This report contains preliminary data that has not been confirmed and thus is not suitable for general release to the public. Interpretation of the presented results may be modified with additional research. Confirmed results should be published through established channels. This report is to be used as a tool for the cooperators in the NUWWSN, their staff, and persons having direct interest in the development of wheat germplasm and agricultural research programs.

This report and data is not intended for unrestricted publication or distribution and should not be used in or referred to in publicity or advertising. Use of this data may be granted for certain purposes upon written request to the agency or agencies involved.

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MATERIALS AND METHODS

Entries:

There were 46 lines and four checks in the 2002 trial (Table 1). The lines were from 11 breeding programs. Three entries (MO981020, IL96-6472, and IL97-1828) besides the four checks were also in the 2001 NUWWSN. There were 49 entries in the 2001 nursery, 29 entries in the 2000 nursery, and 28 in the 1999 nursery.

Tests:

The entries were successfully evaluated in 13 field tests (locations) and five greenhouse tests (Table 2). Data was obtained from 14 cooperators while seed was sent to 18 cooperators. Four field evaluations failed for various reasons.

Traits:

Data was collected on heading date (HD), height (HGT), disease severity (SEV), disease incidence (INC), disease index (IND), kernel rating (KR), percent scabby seed (%SS), and DON (Table 3). Severity was also assessed in the greenhouse assays (SEV-GH). Data was not collected on all traits in all tests (Table 3). Some groups collected additional data that are summarized and described in Table 16.

Cooperators in Kansas collected disease index data at five different times. We used the index data average over five dates, as suggested by the Kansas cooperators.

INC data was collected at South Dakota State University but was not used in the means over tests or in other analyses as all entries received a score of 100%.

Data Analyses:

Most cooperators sent entry means (not raw data) with some summary statistics from their trials. These means and statistics are presented in the appropriate tables and no additional within test analyses were performed. The entry means from individual tests were used to

analyze results over tests. We used the LSMEANS option in PROC GLM to calculate the means over tests as there was some imbalance to the data. Entries 45 and 46 were not included in all tests so the means for these entries are probably quite affected by the LS estimation procedure: the data was quite balanced for all other entries. ANOVAs (model: trait = entry + test) were conducted for each trait and the entry x test mean square (residual or error in this model) was used as the error term to calculate a LSD (0.05) for entry means over tests. R^2 values in the table indicate the proportion of total sum of squares accounted for by entry and test effects while $1-R^2$ is the proportion of total sum of squares due to the entry x test interaction (ETI) effect. There was no test for significance for this interaction.

Based on $1-R^2$, the ETI appeared quite large for disease index, incidence, and severity from the field and greenhouse trials, so multivariate statistics (Yan et al., 2000 Crop Science 40:597-605) were used to analyze the interaction and group those tests that produced similar results for each trait. Entry means were then calculated (LSMEANS again) over the tests that produced similar rankings (Tables 8, 9, 10, and 14). A group of tests that produced similar entry rankings and results is called a megaenvironment. Among the tests within a megaenvironment there is generally little ETI, and the means from the tests within a megaenvironment are generally correlated. This suggests that the tests within a megaenvironment form a set of tests that provide similar information.

Correlations were calculated between all traits using entry means averaged over all appropriate tests.

RESULTS

All traits

Entry was a significant source of variance for all traits. There was little ETI for heading date, height, kernel rating, % scabby seed, or DON as entry + test effects accounted for more than 77% of the treatment sum of squares (Table 4). Thus, entry means over all tests are appropriate estimators of genetic value.

ETI seemed to be an important source of variation of disease severity from field and greenhouse trials, disease incidence, and disease index. Each is discussed below.

Disease incidence from field trials

The ETI accounted for incidence accounted for 30% of the treatment sum of squares. Seven of the nine tests were place into two megaenvironments. One megaenvironment consisted of IL+VA and the other consisted of IN+KY+MO+NY+OH. The correlation of entry means within a megaenvironment was generally greater than 0.50. Entry means were obtained over tests within a megaenvironment and are presented in Table 8.

The NE and ONT tests did not fit in any megaenvironment and behaved as outlier tests. The correlation between outlier tests or tests in different megaenvironment was generally less than 0.28. The correlation between the two megaenvironments was 0.12, suggesting that entry ranking might vary between the two megaenvironments. Indeed, if we were to select the five entries with lowest incidence in each megaenvironment, only one of the selections (IL97-6755) would be the same in both megaenvironments (Table 8). Only three (IL97-6755, IL97-1828, and MO981020) of the best 10 selections would be the same in both megaenvironments. None of five selections for highest incidence would be the same in both megaenvironments. IL97-6755 had the lowest incidence in both megaenvironments, but would be ranked 10^{th} in NE and 28^{th} in ONT. Better selection concordance would be expected between ONT and NE, or between either outlier test and either megaenvironment. None of the best 10 entries selected for low incidence in either megaenvironment would be among the five worst in the other megaenvironment.

The entry means for incidence in the IL+VA megaenvironment were positively correlated with heading date and height, suggesting the earlier lines may have escaped some

disease. The opposite trend was present in the IN+KY+MO+NY+OH megaenvironment, perhaps explaining why these two megaenvironments gave different entry rankings.

Disease severity from field trials

The ETI accounted for field disease severity accounted for 25% of the treatment sum of squares. Six of nine tests were places into two megaenvironments (IL+KY+MO+VA and IN+OH) (Table 9). The remaining four tests (NE, NY, ONT, and SD) were outliers. The correlation among entry means within a megaenvironment was generally greater than 0.50. The correlation of entry means among the outlier tests, or among the tests in different megaenvironments was generally less than 0.35.

The correlation of entry means between the two megaenvironments was 0.43, though entry ranking differed and would affect selection. Only one of five selections for low severity would be the same in both megaenvironment (MO980829) (Table 9). There was better concordance if selection pressure is relaxed as six of 10 selections for low severity would be the same in both megaenvironments. None of the five lines selected for high severity were the same in both megaenvironments. One entry (KY92C-0158-63) among the 10 entries with lowest severity in the IN+OH megaenvironment would be among the five worst in the IL+KY+MO+VA megaenvironment.

Disease index

The ETI interaction for index accounted for 24% of the treatment sum of squares. The ETI pattern for index is very similar to that found for field severity as tests that in the same severity-megaenvironment were also in the same index-megaenvironment. Similar results were reported in 2001. Nine of the 13 tests were placed into two megaenvironments: IL+KY+MO+VA and AR(2)+IN+KS+OH. The correlation among tests within a megaenvironment generally exceeded 0.50. The remaining tests (NE, NY, ONT and SD) appeared to be outliers as the correlation among these tests, or with the tests in the megaenvironments, was generally less than 0.35. The existence of two megaenvironments and four outlier tests show the complex ETI pattern for disease index.

The correlation of entry means between the two megaenvironments was 0.10. Assuming selection of five entries for low index in each megaenvironment, only two entries (IL97-1828 and MO980829) would be selected in both megaenvironments. If the ten entries with the lowest index values were selected in both megaenvironments, only four (IL97-1828, MO980829, IL97-6755, and MO981020) would be selected in both megaenvironments. No entry would be select among the five entries with the highest index in both megaenvironments. None of the 10 entries selected for low index in either megaenvironment would be among the five worst in the other megaenvironment.

The entry means for index from the AR(2)+IN+KS+OH megaenvironment were negatively correlated to heading date and height, suggesting that later lines escaped some affect of the disease. Entry means from the other megaenvironment were positively correlated with heading date. Thus, the ETI for index may be partially explained by heading date and disease escape. A similar trend was apparent for incidence.

Disease Severity in Greenhouse

The ETI accounted for 27% of the treatment sum of squares and three of the five tests were placed in a megaenvironment (AR+IL+MO). Correlations among these three tests all exceeded 0.55. The IN and KY tests were outliers, though both were more correlated to the megaenvironment ($r = 0.42$) than to each other ($r = 0.22$). Assuming selection of the best six entries in each AR+IL+MO, IN, and KY, only about 25% of the selections would be the same

between any two tests. Only 20% of the entries selected for high severity would be the same between two tests.

Correlations among traits

Correlations among traits are shown in Table 1. Using entry means over all tests, heading date and height were not highly correlated to any disease trait (exceptions occurred in certain megaenvironments as discussed above). There was a high correlation among three heading traits (incidence, severity, and index), and among the three kernel traits (kernel rating, % scabby seed, and DON). The correlation between the head and kernel traits were also significant as was the correlation of the field disease traits with greenhouse severity. Field severity and index were correlated to greenhouse severity, and this relationship held even when severity and index were average within megaenvironments.

Most resistant and susceptible entries

Entries were rated for seven disease traits comparing the entry values to the best and worst values for each of the seven disease traits (Tables 4, 5). Two entries from Missouri and three from Illinois had low values for all seven traits. One entry from New York and one from Missouri had low scores for six of seven traits. These seven most resistant lines all had low scores for incidence, index, kernal rating, percent scabby seed, and severity in the greenhouse. The probable source of resistance for these seven entries is presented in Table 6.

Fourteen entries had high scores for at least five disease traits. Most of these 14 had high scores for incidence, field severity, disease index, and kernel rating. Two entries had high scores for all seven traits, including the susceptible check Pioneer 2545.

Table 1. Entries in the 2002 Northern Uniform Winter Wheat Scab Nursery

Entry	Source	Name	Pedigree
1	VANSANFORD	KY90C-054-6	FFR555W/2548
2	VANSANFORD	KY93C-0876-66	ABI88*2451/KY85C-35-4//2510
3	VANSANFORD	KY92C-0010-17	T63/VA85-54-290
4	VANSANFORD	KY92C-0158-63	VA85-54-290/KY85C-35-4
5	GRIFFEY	VA01W447	WUHAN//90-52-82/COKER 9835/3/COKER 9803
6	GRIFFEY	VA01W461	PC-11(SHANGHAI4/CHILL"S":SCAB-RES)/3/92-51-39(IN71761A4-31-5-48//71-54-147/MCN1813)//FFR555W/RCT/4/COKER 9803
7	GRIFFEY	VA01W462	PC-7(CHILL"S"/YM16:SCAB RES)/3/92-51-39//COKER 9803/RCT/4/93-52-55
8	GRIFFEY	VA01W465	PC-7(CHILL"S"/YM16:SCAB RES)/PIONEER 2548//PIONEER 2684
9	GRIFFEY	VA01W469	MADISON/VR95B717
10	OHM	P97397J1-4-1-4	96204//GOLDFIELD/INW9824
11	OHM	P97395B1-4-5-9	INW9811/ERNIE//INW9824/ERNIE
12	OHM	P97395B1-4-2-7	INW9811/ERNIE//INW9824/ERNIE
13	OHM	P981128A1-23-1	INW9824/PATTON
14	OHM	P981238A1-1-11	ERNIE//91193/X117
15	SNELLER	OH708	IL85-3132-1/IRENA//OH449/VA86-54-290
16	SNELLER	OH712	IL85-3132-1/FRONDOSO//OH449/VA85-54-290
17	SNELLER	OH719	ZM8725/HOPEWELL
18	SNELLER	OH720	ZM8725/HOPEWELL
19	SNELLER	OH685	GLORY/OH449
20	KOLB	IL96-6472	IL90-11637/L880437
21	KOLB	IL97-1828	P8183I1-16-2-1-2-3-3/IL90-4813
22	KOLB	IL97-6755	IL90-4813//IL85-3132-1/Ning 7840
23	KOLB	IL97-7010	IL90-6364//IL90-9464/Ning 7840
24	KOLB	IL98-6718	IL89-14800/Patterson
25	BAENZIGER	MILLENNIUM	Arapahoe/Abilene/NE86488
26	BAENZIGER	NE98632	Niobrara/NE91525
27	BAENZIGER	NE99543	Alliance/Karl 92
28	SORRELLS	NY89052SP-9	88119(Geneva/84004/6-1MR)/Geneva
29	SORRELLS	NY89086-7120	Houser/F29-76
30	SORRELLS	NY89082-7159	88120(Geneva/84004/6-2MR)/Harus
31	SORRELLS	NY89064SP-7139	88029(84061(6120-15/F29-76)/Augusta)/Harus
32	SORRELLS	NY89088-7401	Houser/Recital
33	COSTA	MDV11-52	Coker 9803/Freedom
34	BEAZER	M94*1549-1	SW85*36/SW85-145
35	BEAZER	M95-2994-1	E86-42/SW85*94
36	MCKENDRY	MO980829	MO 11769/Madison
37	MCKENDRY	MO981020	MO 11769/Madison
38	MCKENDRY	MO000925	MO 12278/Coker 9663
39	MCKENDRY	MO000926	Ernie/AP Hickory
40	MCKENDRY	MO000969	MO 12278/Pioneer 2571
41	LIPPS	PATTERSON	check
42	LIPPS	FREEDOM	check
43	LIPPS	PIONEER 2545	check
44	LIPPS	ERNIE	check
45	WARD	D9046-1	
46	WARD	D9070-1	

Table 2. Testing information

Field Tests
INSTITUTE: University of Arkansas (AR) COOPERATORS(S): G. Miilus, P. Rohman, C. Weight TEST LOCATION: Fayetteville and Kibler, AR
INSTITUTE: University of Illinois (IL) COOPERATOR(S): F.L. Kolb, L.K. Smith, N.J. Smith TEST LOCATION: Urbana,IL FERTILIZER: Fall: 40 lbs N/A, P and K ok, no spring topdress PLOT SIZE: 1 row x 3' REPS: 4 SEEDING DATE: 10/2/01 HARVEST DATE: 7/4/02 IRR/MISTING METHOD: Mist system applied 12"/hr. Misted 5:30 - 7am and 7:30 - 9 pm INOCULATION METHOD: Grain spawn (wheat) + corn stalk debris inoculated with spores PRECIPITATION DURING GRAIN FILL: Almost none, mist system applied 0.12 in/hr. until turned off on 6/3/02 AVE. TEMP. DURING GRAIN FILL: Cool early, hot later DATE/FEEKES WHEN RATED: Field rating 25-26 days after flowering, GH rating 28 days after inoculation. COMMENTS: Very high incidences, slow onset of symptoms and spread of symptoms in the heads.
INSTITUTE: Purdue University (IN) COOPERATOR(S): H. Ohm TEST LOCATION: Lafayette, IN FERTILIZER: 25 lb N at seeding, 90 lb N topdressed, ample P and K; seeded in disced cornstalks. PLOT SIZE: 5' x 4' REPS: 4 IRR/MISTING METHOD: Fine mist, 7-10 am and 6-9 pm on non rainy days from 20 April to 31 May. INOCULATION METHOD: Natural, plus 1 floret of 10 spikes of each entry were inoculated at flowering. PRECIPITATION DURING GRAIN FILL: Data AVE. TEMP. DURING GRAIN FILL: Data DATE/FEEKES WHEN RATED: Natural infection-30 d after flowering; Inoculated-25 d after inoculation. COMMENTS: Plant growth and winter survival were excellent. Temperatures were unseasonably cool from mid May (beginning of flowering) until early June, delaying disease development, but natural infection and inoculations were very good.
INSTITUTE: Kansas State University (KS) COOPERATOR(S): W. Bockus, M. A. Davis TEST LOCATION: Manhatten, KS FERTILIZER: None needed PLOT SIZE: Single 5' row REPS: 4 SEEDING DATE: 10/2/01 HARVEST DATE: 6/25/02 IRR/MISTING METHOD: Sprinklers 3 min/hour from 9:00 p.m. to 6:00 a.m. during anthesis and heading INOCULATION METHOD: Colonized corn kernels (3 applications for a total of 10 g/sq. ft.) DATE/FEEKES WHEN RATED: Average of four ratings (May 28, June 7, and June 11)
INSTITUTE: University of Kentucky (KY) COOPERATOR(S): A.J. Stewart, B. Kennedy, and D. Van Sanford TEST LOCATION: Lexington, KY FERTILIZER: P, K acc. to soil tests; 110# N, split application. PLOT SIZE: 2 rows 4' long REPS: 2 SEEDING DATE: 10/26/01 HARVEST DATE: 6/13/02 INOCULATION METHOD: Scabby corn PRECIPITATION DURING GRAIN FILL: 4.72 Inches AVE. TEMP. DURING GRAIN FILL: 65.1 F DATE/FEEKES WHEN RATED: 10.5+21 days

Table 2. (Continued)

INSTITUTE: University of Nebraska (NE)	COOPERATOR(S): S. Baenziger, J. Watkins, J. Schimelfenig
TEST LOCATION: Mead, NE	
FERTILIZER: None needed	
PLOT SIZE: 1 x 10'	REPS: 1
SEEDING DATE: 9/27/01	
IRR/MISTING METHOD: Misting from risers	
INOCULATION METHOD: Spray 70,000 conidia/ml - 4 times during maturity between 5/17 - 5/31	
PRECIPITATION DURING GRAIN FILL: 1.73 inches	
AVE. TEMP. DURING GRAIN FILL: 95-100 F	
DATE/FEEKES WHEN RATED: 11.2 date-6/14/02 (21 days after best inoculation)	
COMMENTS: All had tan anthers by 5/31/2	
INSTITUTE: Cornell University (NY)	COOPERATOR(S): M.Sorrells, G.Bergstrom
TEST LOCATION: Ithaca, NY	
FERTILIZER: 45kg/h 10-20-20	
PLOT SIZE: 1.2Mx0.3M	REPS: 6
SEEDING DATE: 9/27/01	
IRR/MISTING METHOD: Mist	
INOCULATION METHOD: Infected corn	
PRECIPITATION DURING GRAIN FILL: 7.19 inches	
AVE. TEMP. DURING GRAIN FILL: 65.6 F	
DATE/FEEKES WHEN RATED: 6/27/02	
INSTITUTE: University of Guelph (ONT)	COOPERATOR(S): L. Tamburic, A. Schaafsma, A. Smid
TEST LOCATION: Ridgetown, Ont.	
PLOT SIZE: 1 row x 4M	REPS: 4
INOCULATION METHOD: Inoculated at anthesis with macroconidida of F. graminearum (50,000 spores/ml)	
INSTITUTE: The Ohio State University (OH)	COOPERATOR(S): P. Lipps, C. Sneller, L. Herald
TEST LOCATION: Wooster, OH	
FERTILIZER: 300 lb 6-24-24 fall, 60 lb N (Ammonium nitrate)	
PLOT SIZE: 1 row x 5'	REPS: 3
SEEDING DATE: 9/27/01	HARVEST DATE: 7/3/02
IRR/MISTING METHOD: Mist sprinkler (6:00-9:30 AM and 9:00-10:30PM)	
INOCULATION METHOD: Infected corn kernels spread 3 weeks prior to anthesis	
PRECIPITATION DURING GRAIN FILL: 3.94 Inches	
DATE/FEEKES WHEN RATED: 16-20 days after anthesis	
COMMENTS: Means of 20 heads per plot	
INSTITUTE: University of Missouri (MO)	COOPERATOR(S): A. McKendry
TEST LOCATION: Columbia, MO	
PLOT SIZE: 4 row plot	
IRR/MISTING METHOD: Overhead mist	
INOCULATION METHOD: Spray 4-row plots with macroconidia concentrated to 50,000 spores/ml.	
DATE/FEEKES WHEN RATED: Ten heads/plot were rated, 18-21 days post-inoculation.	

Table 2. (Continued)

INSTITUTE: South Dakota State University (SD) COOPERATOR(S): Amir Ibrahim TEST LOCATION:
INSTITUTE: Virginia Tech University COOPERATOR(S): C. Griffey, J. Wilson, and D. Nabati TEST LOCATION: Blacksburg, VA FERTILIZER: 25-80-100 Preplant; 65-0-0 applied 4/5/02 PLOT SIZE: 20 ft 2(4ft x 5ft) REPS: 3 SEEDING DATE: 10/5/01 HARVEST DATE: 7/2 and 7/6/02 IRR/MISTING METHOD: Overhead mist irrigation INOCULATION METHOD: Colonized maize seed applied at booting stage PRECIPITATION AT GRAIN FILL: Approximately 1.76 inches of rain AVE. TEMP. DURING GRAIN FILL: 62.9 F DATE/FEEKES WHEN RATED: 5/15/02; approx. 10.5 COMMENTS: Reading at approximately 35-40 days after inoculation
Greenhouse Tests
INSTITUTE: University of Arkansas (AR) COOPERATORS(S): G. Miilus, P. Rohman, C. Weight TEST LOCATION: Fayetteville, AR COMMENTS: Center floret inoculation, mean of 4 reps with 4 to 8 heads per rep.
INSTITUTE: University of Illinois (IL) COOPERATOR(S): F.L. Kolb, L.K. Smith, N.J. Smith TEST LOCATION: Urbana,IL
INSTITUTE: Purdue University (IN) COOPERATOR(S): G. Shaner TEST LOCATION: Lafayette, IN
INSTITUTE: University of Kentucky (KY) COOPERATOR(S): A.J. Stewart, B. Kennedy, and D. Van Sanford TEST LOCATION: Lexington, KY
INSTITUTE: Michigan State University (MI) COOPERATOR(S): R. Ward TEST LOCATION: East Lansing, MI COMMENTS: Materials and Planting: 46 entries were planted and assessed for FHB resistance in greenhouse this year. 12 seedlings were transplanted in 4 pots per genotype after 8 weeks of vernalization treatment. Scab Inoculating: Around 10-12 heads per genotype were inoculated by single-floret injection during heading and flowering. The inoculum was spore suspension of F. graminearum, at 50,000 spores/ml. Misting irrigation was given 3 days after inoculation. Then, inoculated plants were moved to greenhouse. Disease scoring: Number of scabby spikelets were counted 3 weeks after inoculation. The average of all the inoculated heads were calculated for each genotype. The figure listed in the table is the average number of scabby spikelets.
INSTITUTE: University of Missouri (MO) COOPERATOR(S): A. McKendry TEST LOCATION: Columbia, MO COMMENTS: Greenhouse data result from point inoculations at first anthesis of a single floret in a central spikelet using 10 micro L of a 50,000 spore/mL suspension of macroconidia. Plants were misted for 72 hours and rated at 21 days post-inoculation.

Table 3. Description of traits.

Code	Trait	Description	Tests where data was collected
HD	Heading date	Days from Jan 1st when 50% of heads have emerged	IL, IN, KS, KY, MO, NE, NY, OH, VA
HGT	Plant height	Height in inches from ground to top of spike at maturity	AR, IN, KY, MO, NE, VA, OH
SEV	Disease severity from field tests	% of infected spikelets in an infected head. Generally visually rated according to Stack & McMullen, 'A Visual scale to estimate severity of Fusarium Head Blight in Wheat', NDES. PP-1095	IL, IN, KY, MO, NE, NY, OH, ONT, SD, VA
INC	Disease incidence	% of heads with at least one infected spikelets	IL, IN, KY, MO, NE, NY, OH, ONT, SD†, VA
IND	Disease index	IND = (SEVxINC)/100	AR1, AR2, IL, IN, KS, KY, MO, NE, NY, OH, ONT, SD, VA
KR	Kernel rating	A visual assessment of the percent infected kernels	IL, KS, KY, NE
%SS	Percent scabby seed	Percent of scabby seed by weight	AR1, KY, NE, VA
DON	DON (vomitoxin)	PPM of vomitoxin in grain sample as assayed by Pat Hart, Michigan State University	IL, KY, NE, OH, VA
SEV-GH	Disease severity from greenhouse tests	Same as SEV except using greenhouse data	AR, IL, IN, KY, MI, MO

† SD data not used to calculate entry means over tests as all entries received an INC score of 100%.

Table 4. Entry means for 2002 NUWWSN (see Table 3 for information on traits and tests). Each entry was compared to the lowest (l) and highest (h) means in each column using $LSD_{(0.05)}$. "# low scores" is the number of disease traits for which an entry received a low score, "# high scores" is the times it received a high score.

	Trait:	HD	HGT	INC	SEV	IND	KR	%SS	DON	SEV-GH			
	# of tests:	9	7	9	10	13	4	4	5	5		# low	# high
	Units	Days	in	%	%	%	0-100	%	PPM	%		scores	scores
1	KY90C-054-6	139	37.3	55.0 h	34.1 h	23.2	21.4 h	22.0	18.4 h	54.2	h	0	5
2	KY93C-0876-66	140	35.3	64.9 h	40.0 h	30.1 h	30.9 h	21.5	14.7 h	44.8		0	5
3	KY92C-0010-17	140	37.0	67.2 h	38.5 h	29.5 h	31.1 h	26.7 h	22.9 h	31.2	l	1	6
4	KY92C-0158-63	142	36.3	68.3 h	31.8	27.0 h	21.6 h	23.6 h	19.9 h	42.8		0	5
5	VA01W447	135	35.6	61.4 h	41.8 h	31.9 h	27.3 h	27.3 h	10.4 l	48.8	h	1	6
6	VA01W461	137	36.6	53.8 h	28.8 l	18.8	24.9 h	14.3 l	11.8	40.2		2	2
7	VA01W462	135	34.6	61.8 h	38.4 h	29.4 h	27.5 h	17.5 l	13.3	34.9		1	4
8	VA01W465	139	32.6 l	66.9 h	36.0 h	28.4 h	20.1 h	22.5 h	18.8 h	40.6		0	6
9	VA01W469	137	35.1	62.9 h	36.8 h	30.2 h	29.2 h	24.1 h	12.2	55.5	h	0	6
10	P97397J1-4-1-4	135	34.0 l	52.9 h	37.0 h	24.2	25.3 h	17.1 l	13.5	36.5		1	3
11	P97395B1-4-5-9	133 l	34.1 l	48.0	41.4 h	31.3 h	18.0 lh	22.2 h	10.2 l	46.7		2	4
12	P97395B1-4-2-7	134 l	34.6	46.9	33.0	22.3	13.3 l	14.2 l	8.1 l	32.7	l	4	0
13	P981128A1-23-1	137	36.3	52.9 h	37.7 h	25.3 h	22.4 h	20.5	10.2 l	48.9	h	1	5
14	P981238A1-1-11	137	33.6 l	44.3	28.2 l	17.2	21.8 h	19.0 l	12.1	15.0	l	3	1
15	OH708	140	38.1	54.9 h	41.0 h	28.0 h	16.5 l	15.2 l	9.4 l	48.8	h	3	4
16	OH712	141	41.0 h	56.4 h	38.7 h	25.3 h	23.0 h	22.5 h	11.3	56.4	h	0	6
17	OH719	142	38.9 h	53.4 h	28.8 l	19.7	21.9 h	16.9 l	12.1	31.5	l	3	2
18	OH720	141	39.9 h	53.2 h	41.2 h	25.6 h	24.7 h	23.5 h	12.0	44.8		0	5
19	OH685	136	37.0	54.6 h	45.9 h	28.2 h	26.0 h	23.3 h	16.9 h	63.7	h	0	7
20	IL96-6472	135	36.1	41.9 l	30.9	19.0	12.5 l	7.8 l	5.7 l	34.1		4	0
21	IL97-1828	137	36.3	29.5 l	24.6 l	13.6 l	7.7 l	11.0 l	5.8 l	32.8	l	7	0
22	IL97-6755	138	40.6 h	26.0 l	26.4 l	14.6 l	8.6 l	8.7 l	1.7 l	19.6	l	7	0
23	IL97-7010	136	39.1 h	38.6 l	29.0 l	15.7 l	14.4 l	12.7 l	9.8 l	18.6	l	7	0
24	IL98-6718	135	37.7	43.6	35.2 h	22.3	10.2 l	14.0 l	5.7 l	44.9		3	1
25	MILLENNIUM	142	39.0 h	38.6 l	30.2	15.1 l	15.6 l	25.6 h	10.2 l	43.4		4	1
26	NE98632	141	39.0 h	48.2	31.7	18.8	23.3 h	29.2 h	18.7 h	42.4		0	3
27	NE99543	139	38.3	40.7 l	38.1 h	21.6	23.9 h	30.7 h	12.9	64.3	h	1	4
28	NY89052SP-9	143 h	38.6	42.6	38.3 h	19.2	11.6 l	17.6 l	14.3	53.6	h	2	2
29	NY89086-7120	142	38.9 h	48.9	39.6 h	23.6	19.8 h	20.4	21.3 h	40.5		0	3
30	NY89082-7159	144 h	35.9	48.9	35.5 h	19.7	15.1 l	19.3 l	9.9 l	50.3	h	3	2
31	NY89064SP-7139	143 h	37.6	41.6 l	36.1 h	15.6 l	11.7 l	14.5 l	5.9 l	31.9	l	6	1
32	NY89088-7401	143 h	38.9 h	48.4	32.8	18.0	18.4 h	20.5	12.9	39.8		0	1
33	MDV11-52	136	32.4 l	59.1 h	41.5 h	32.9 h	30.2 h	24.8 h	21.9 h	46.6		0	6
34	M94*1549-1	137	34.3 l	56.7 h	35.0 h	26.9 h	22.0 h	24.6 h	14.6 h	38.6		0	6
35	M95-2994-1	140	35.0	46.0	31.3	20.2	20.9 h	23.1 h	15.5 h	25.5	l	1	3
36	MO980829	141	39.3 h	25.9 l	17.1 l	8.4 l	5.7 l	12.8 l	5.5 l	16.3	l	7	0
37	MO981020	137	36.7	37.2 l	23.5 l	15.9 l	8.6 l	11.0 l	10.1 l	19.8	l	7	0
38	MO000925	138	36.1	43.6	28.6 l	20.3	21.8 h	15.2 l	12.4	34.0		2	1
39	MO000926	136	34.4 l	40.3 l	26.0 l	16.9 l	13.8 l	14.3 l	11.3	24.7	l	6	0
40	MO000969	137	36.1	46.9	42.8 h	23.1	24.8 h	27.0 h	17.6 h	30.3	l	1	4
41	PATTERSON	136	37.1	50.8	40.1 h	29.6 h	18.1 lh	21.4	9.7 l	60.3	h	2	4
42	FREEDOM	140	37.6	44.6	22.4 l	15.7 l	20.4 h	17.9 l	7.7 l	16.0	l	5	1
43	PIONEER 2545	140	36.6	59.1 h	38.3 h	28.4 h	28.4 h	34.2 h	23.8 h	52.1	h	0	7
44	ERNIE	134 l	34.1 l	42.6	23.6 l	20.0	17.0 l	16.9 l	11.1	24.9	l	4	0
45	D9046-1	136	35.7	41.3 l	31.5	22.9	26.7 h	18.2 l	17.0 h	67.3	h	2	3
46	D9070-1	141	37.7	52.0	36.7 h	19.7	18.3 lh	13.3 l	13.5	33.5	l	3	2
	Average	138.0	37.0	49.3	34.0	22.5	19.7	19.5	12.1	38.9			
	LSD (0.05)	1.8	2.2	16.1	12.7	8.7	13.2	12.2	9.3	19.0			

† Indicates a mean that is not different from the lowest (l) or highest (h) mean in the column based on $LSD_{(0.05)}$

Table 5. Entry means for the most tolerant (top) and susceptible (bottom) entries in the 2002 NUWWSN

	Trait:	HD	HGT	INC	SEV	IND	KR	%SS	DON	SEV-GH		
	# of tests:	9	7	9	10	13	4	4	5	5	# low	# high
	Units	Days	in	%	%	%	0-100	%	PPM	%	scores	scores
21	IL97-1828	137	36.3	29.5 l	24.6 l	13.6 l	7.7 l	11.0 l	5.8 l	32.8 l	7	0
22	IL97-6755	138	40.6 h	26.0 l	26.4 l	14.6 l	8.6 l	8.7 l	1.7 l	19.6 l	7	0
23	IL97-7010	136	39.1 h	38.6 l	29.0 l	15.7 l	14.4 l	12.7 l	9.8 l	18.6 l	7	0
36	MO980829	141	39.3 h	25.9 l	17.1 l	8.4 l	5.7 l	12.8 l	5.5 l	16.3 l	7	0
37	MO981020	137	36.7	37.2 l	23.5 l	15.9 l	8.6 l	11.0 l	10.1 l	19.8 l	7	0
31	NY89064SP-7139	143 h	37.6	41.6 l	36.1 h	15.6 l	11.7 l	14.5 l	5.9 l	31.9 l	6	1
39	MO000926	136	34.4 l	40.3 l	26.0 l	16.9 l	13.8 l	14.3 l	11.3	24.7 l	6	0
42	FREEDOM	140	37.6	44.6	22.4 l	15.7 l	20.4 h	17.9 l	7.7 l	16.0 l	5	1
7	VA01W462	135	34.6	61.8 h	38.4 h	29.4 h	27.5 h	17.5 l	13.3	34.9	1	4
11	P97395B1-4-5-9	133 l	34.1 l	48.0	41.4 h	31.3 h	18.0 lh	22.2 h	10.2 l	46.7	2	4
15	OH708	140	38.1	54.9 h	41.0 h	28.0 h	16.5 l	15.2 l	9.4 l	48.8 h	3	4
27	NE99543	139	38.3	40.7 l	38.1 h	21.6	23.9 h	30.7 h	12.9	64.3 h	1	4
40	MO000969	137	36.1	46.9	42.8 h	23.1	24.8 h	27.0 h	17.6 h	30.3 l	1	4
41	PATTERSON	136	37.1	50.8	40.1 h	29.6 h	18.1 lh	21.4	9.7 l	60.3 h	2	4
1	KY90C-054-6	139	37.3	55.0 h	34.1 h	23.2	21.4 h	22.0	18.4 h	54.2 h	0	5
2	KY93C-0876-66	140	35.3	64.9 h	40.0 h	30.1 h	30.9 h	21.5	14.7 h	44.8	0	5
4	KY92C-0158-63	142	36.3	68.3 h	31.8	27.0 h	21.6 h	23.6 h	19.9 h	42.8	0	5
13	P981128A1-23-1	137	36.3	52.9 h	37.7 h	25.3 h	22.4 h	20.5	10.2 l	48.9 h	1	5
18	OH720	141	39.9 h	53.2 h	41.2 h	25.6 h	24.7 h	23.5 h	12.0	44.8	0	5
3	KY92C-0010-17	140	37.0	67.2 h	38.5 h	29.5 h	31.1 h	26.7 h	22.9 h	31.2 l	1	6
5	VA01W447	135	35.6	61.4 h	41.8 h	31.9 h	27.3 h	27.3 h	10.4 l	48.8 h	1	6
8	VA01W465	139	32.6 l	66.9 h	36.0 h	28.4 h	20.1 h	22.5 h	18.8 h	40.6	0	6
9	VA01W469	137	35.1	62.9 h	36.8 h	30.2 h	29.2 h	24.1 h	12.2	55.5 h	0	6
16	OH712	141	41.0 h	56.4 h	38.7 h	25.3 h	23.0 h	22.5 h	11.3	56.4 h	0	6
33	MDV11-52	136	32.4 l	59.1 h	41.5 h	32.9 h	30.2 h	24.8 h	21.9 h	46.6	0	6
34	M94*1549-1	137	34.3 l	56.7 h	35.0 h	26.9 h	22.0 h	24.6 h	14.6 h	38.6	0	6
19	OH685	136	37.0	54.6 h	45.9 h	28.2 h	26.0 h	23.3 h	16.9 h	63.7 h	0	7
43	PIONEER 2545	140	36.6	59.1 h	38.3 h	28.4 h	28.4 h	34.2 h	23.8 h	52.1 h	0	7
	Average	138.0	37.0	49.3	34.0	22.5	19.7	19.5	12.1	38.9		
	LSD (0.05)	1.8	2.2	16.1	12.7	8.7	13.2	12.2	9.3	19.0		

† Indicates a mean that is not different from the lowest (l) or highest (h) mean in the corresponding column in Table 5 based on $LSD_{(0.05)}$

Table 6. Possible sources of resistance for the most resistant entries in Table 5.

Name	Pedigree	Possible source of resistance
IL97-1828	P818311-16-2-1-2-3-3/IL90-4813	
IL97-6755	IL90-4813//IL85-3132-1/NING7840	Ning 7840
IL97-7010	IL90-6363//IL90-9464/NING7840	Ning 7840
MO980829	MO11769/MADISON	MO11769 which is not a descendent of Ernie, Sumai 3, or Ning 7840
MO981020	MO11769/MADISON	MO11769 which is not a descendent of Ernie, Sumai 3, or Ning 7840
MO000926	ERNIE/AP HICKORY	Ernie
NY89064SP-7139	88029(84061(6120-15/F29-76)/AUGUSTA)/HARUS	Harus and 6120-15 (Geneva) are moderately resistant

Table 7. Heading date (julian days) for entries in 2002 NUWWSN

		LSMEAN		IL	IN	KS	KY	MO	NE	NY	VA	OH
1	KY90C-054-6	139		144	140	130	132	136	136	154	133	148
2	KY93C-0876-66	140		146	143	131	134	137	136	155	131	147
3	KY92C-0010-17	140		146	141	132	134	135	136	153	132	148
4	KY92C-0158-63	142		148	144	134	134	140	136	156	134	148
5	VA01W447	135		141	132	126	128	132	136	156	128	138
6	VA01W461	137		144	135	129	129	135	136	154	128	145
7	VA01W462	135		140	133	127	128	133	136	154	128	138
8	VA01W465	139		145	138	130	134	136	136	154	132	146
9	VA01W469	137		143	135	129	128	134	136	153	130	145
10	P97397J1-4-1-4	135		137	132	128	128	133	136	154	128	138
11	P97395B1-4-5-9	133	l†	135	133	125	124	130	136	155	126	137
12	P97395B1-4-2-7	134	l	136	132	127	126	132	136	153	129	138
13	P981128A1-23-1	137		141	134	130	128	133	136	153	130	144
14	P981238A1-1-11	137		142	135	130	129	134	136	156	131	141
15	OH708	140		147	142	130	132	136	136	155	132	146
16	OH712	141		148	141	133	134	137	136	156	133	148
17	OH719	142		148	143	137	134	139	136	156	135	147
18	OH720	141		147	144	133	134	137	136	156	134	148
19	OH685	136		143	135	127	128	133	136	153	130	143
20	IL96-6472	135		137	134	127	127	133	136	154	128	140
21	IL97-1828	137		144	135	129	130	136	136	154	129	144
22	IL97-6755	138		145	140	129	130	135	136	154	130	147
23	IL97-7010	136		139	136	127	128	133	136	153	128	142
24	IL98-6718	135		141	135	127	128	130	136	153	128	141
25	MILLENNIUM	142		149	145	134	136	137	136	158	135	150
26	NE98632	141		147	142	134	134	136	136	154	135	149
27	NE99543	139		145	140	129	134	135	136	153	132	148
28	NY89052SP-9	143	h	150	145	137	137	140	136	158	135	150
29	NY89086-7120	142		149	143	136	134	137	136	155	135	149
30	NY89082-7159	144	h	150	146	137	139	142	136	157	135	152
31	NY89064SP-7139	143	h	150	146	136	137	141	136	157	135	152
32	NY89088-7401	143	h	150	146	137	136	141	136	156	136	150
33	MDV11-52	136		141	134	127	129	134	136	154	129	142
34	M94*1549-1	137		142	134	132	129	133	136	154	130	145
35	M95-2994-1	140		146	141	129	130	137	136	156	134	148
36	MO980829	141		147	142	134	136	137	136	155	134	148
37	MO981020	137		141	135	130	129	135	136	153	130	143
38	MO000925	138		145	140	130	130	134	136	153	131	147
39	MO000926	136		139	136	128	128	134	136	154	129	143
40	MO000969	137		143	135	128	130	134	136	154	129	145
41	PATTERSON	136		142	136	126	127	133	136	152	130	141
42	FREEDOM	140		146	142	132	132	138	136	154	132	148
43	PIONEER 2545	140		145	140	130	132	137	136	155	133	148
44	ERNIE	134	l	136	133	126	127	131	136	154	127	138
45	D9046-1	136			135	126	127		136		129	142
46	D9070-1	141			134	136	138		136		135	151
	Average	138		144	138	130	131	135	136	155	131	145
	CV (%)			0.6		8.7	1.3	1.0			1.0	
	LSD (0.05)			1.3		1.3	5.5	2.0			1.8	4.1

† Indicates a mean that is not different from the lowest (l) or highest (h) mean in the column based on $LSD_{(0.05)}$

Table 8. Disease incidence (% heads with infected spikelets) for entries in 2002 NUWWSN

		ALL TESTS LSMEAN	IN+KY+MO +NY+OH	IN	KY	MO	NY	OH	IL+VA	IL	VA	NE	ONT	SD
1	KY90C-054-6	55.0 h†	49.2	23.8	65.3	90.0	8.7	58.3	53.4	45.0	61.7	70.0	72.5	100.0
2	KY93C-0876-66	64.9 h	52.8	23.8	76.8	83.0	10.2	70.0	73.6 h	67.2	80.0	93.3	80.0	100.0
3	KY92C-0010-17	67.2 h	55.6	30.0	52.1	90.0	9.1	96.7	77.2 h	64.3	90.0	90.0	82.5	100.0
4	KY92C-0158-63	68.3 h	59.9 h	8.8	88.4	99.0	11.8	91.7	71.0 h	55.3	86.7	93.3	80.0	100.0
5	VA01W447	61.4 h	64.9 h	77.5	72.4	85.0	11.5	78.3	28.7 l	32.3	25.0	93.3	77.5	100.0
6	VA01W461	53.8 h	56.6	47.5	80.8	76.0	25.4	53.3	37.8	30.5	45.0	53.3	72.5	100.0
7	VA01W462	61.8 h	68.3 h	77.5	76.3	90.0	10.9	86.7	33.7	35.6	31.7	70.0	77.5	100.0
8	VA01W465	66.9 h	60.3 h	47.5	80.7	89.0	10.9	73.3	61.6 h	46.5	76.7	90.0	87.5	100.0
9	VA01W469	62.9 h	65.7 h	70.0	87.4	80.0	12.6	78.3	56.6	54.9	58.3	70.0	55.0	100.0
10	P97397J1-4-1-4	52.9 h	62.5 h	42.5	83.7	83.0	16.6	86.7	25.2 l	23.7	26.7	40.0	73.3	100.0
11	P97395B1-4-5-9	48.0	53.1	52.5	85.5	65.0	4.4	58.3	18.3 l	21.5	15.0	43.3	86.7	100.0
12	P97395B1-4-2-7	46.9	55.7	52.5	75.1	78.0	9.7	63.3	18.2 l	13.1	23.3	26.7	80.0	100.0
13	P981128A1-23-1	52.9 h	55.6	22.5	92.4	80.0	8.3	75.0	37.1	35.9	38.3	43.3	80.0	100.0
14	P981238A1-1-11	44.3	44.3	27.5	51.4	77.0	7.1	58.3	29.9 l	21.5	38.3	60.0	57.5	100.0
15	OH708	54.9 h	44.3	15.0	87.5	72.0	5.2	41.7	61.4 h	59.5	63.3	60.0	90.0	100.0
16	OH712	56.4 h	47.6	15.0	84.2	70.0	8.6	60.0	66.8 h	63.6	70.0	63.3	72.5	100.0
17	OH719	53.4 h	42.3	7.5	68.0	75.0	6.1	55.0	57.2	49.3	65.0	80.0	75.0	100.0
18	OH720	53.2 h	47.2	20.0	68.1	83.0	10.1	55.0	73.0 h	61.0	85.0	6.7	90.0	100.0
19	OH685	54.6 h	65.6 h	78.8	72.7	90.0	15.0	71.7	41.6	34.9	48.3	3.3	76.7	100.0
20	IL96-6472	41.9 l	51.5	45.0	75.2	70.0	5.5	61.7	21.3 l	24.3	18.3	6.7	70.0	100.0
21	IL97-1828	29.5 l	29.3 l	5.0	34.9	73.0	3.7	30.0	22.6 l	18.5	26.7	3.3	70.0	100.0
22	IL97-6755	26.0 l	22.0 l	6.3	29.7	51.0	2.8	20.0	15.2 l	17.1	13.3	26.7	66.7	100.0
23	IL97-7010	38.6 l	47.4	33.8	72.8	79.0	8.2	43.3	21.2 l	17.4	25.0	3.3	65.0	100.0
24	IL98-6718	43.6	52.5	51.3	74.9	63.0	6.8	66.7	21.2 l	34.1	8.3	10.0	77.5	100.0
25	MILLENNIUM	38.6 l	35.0 l	6.3	56.3	65.0	5.6	41.7	52.7	40.4	65.0	10.0	57.5	100.0
26	NE98632	48.2	48.3	11.3	79.3	78.0	9.6	63.3	71.4 h	57.8	85.0	6.7	42.5	100.0
27	NE99543	40.7 l	38.3	15.0	62.3	73.0	14.3	26.7	47.4	56.4	38.3	10.0	70.0	100.0
28	NY89052SP-9	42.6	38.2	21.3	48.2	71.0	3.7	46.7	55.4	50.8	60.0	6.7	75.0	100.0
29	NY89086-7120	48.9	45.7	38.8	57.8	76.0	7.6	48.3	61.7 h	60.1	63.3	3.3	85.0	100.0
30	NY89082-7159	48.9	44.9	7.5	67.5	93.0	8.2	48.3	63.9 h	54.4	73.3	0.0	87.5	100.0
31	NY89064SP-7139	41.6 l	38.8	5.0	62.0	74.0	3.2	50.0	49.0	41.3	56.7	0.0	82.5	100.0
32	NY89088-7401	48.4	48.7	16.3	82.8	86.0	8.5	50.0	59.6 h	49.2	70.0	0.0	72.5	100.0
33	MDV11-52	59.1 h	73.4 h	87.5	80.6	94.0	15.1	90.0	43.4	40.1	46.7	3.3	75.0	100.0
34	M94*1549-1	56.7 h	71.8 h	87.5	85.8	86.0	11.2	88.3	42.0	33.9	50.0	0.0	67.5	100.0
35	M95-2994-1	46.0	49.3	25.0	76.9	79.0	3.7	61.7	48.3	43.2	53.3	3.3	67.5	100.0
36	MO980829	25.9 l	24.9 l	5.0	42.9	58.0	3.4	15.0	27.9 l	20.7	35.0	3.3	50.0	100.0
37	MO981020	37.2 l	40.4	13.8	80.1	76.0	3.6	28.3	23.3 l	18.2	28.3	10.0	76.7	100.0
38	MO000925	43.6	45.4	17.5	66.5	74.0	7.5	61.7	49.1	49.8	48.3	0.0	67.5	100.0
39	MO000926	40.3 l	48.2	20.0	83.9	68.0	5.9	63.3	25.3 l	15.5	35.0	3.3	67.5	100.0
40	MO000969	46.9	58.8 h	60.0	79.3	81.0	6.8	66.7	31.4 l	36.0	26.7	3.3	62.5	100.0
41	PATTERSON	50.8	59.6 h	77.5	62.3	89.0	11.0	58.3	46.9	48.8	45.0	0.0	65.0	100.0
42	FREEDOM	44.6	46.2	11.3	72.9	85.0	5.0	56.7	48.3	31.5	65.0	16.7	57.5	100.0
43	PIONEER 2545	59.1 h	59.3 h	45.0	77.3	91.0	8.0	75.0	71.3 h	60.9	81.7	3.3	90.0	100.0
44	ERNIE	42.6	47.4	21.3	73.2	74.0	10.4	58.3	22.7 l	17.1	28.3	13.3	87.5	100.0
45	D9046-1	41.3 l	46.1	23.8	71.3			56.7	26.9 l		31.7	0.0	85.0	100.0
46	D9070-1	52.0	52.6	38.8	72.4			60.0	65.2 h		70.0	6.7	85.0	100.0
	Average	49.2	50.3	33.4	71.3	78.7	8.7	59.7	44.7	39.8	49.5	28.3	73.8	100.0
	CV (%)	34.6	25.3	45.5	21.6	12.5	86.4		20.5	18.1	29.1			20.0
	LSD (0.05)	16.1	16.1	20.9	34.6	0.16	5.5	11.2	18.4	10.0	19.5		23.7	21.2

† Indicates a mean that is not different from the lowest (l) or highest (h) mean in the column based on $LSD_{(0.05)}$

Table 9. Field disease severity (% infected spikelets) for entries in 2002 NUWWSN

		ALL TESTS LSMEAN	IL+KY+ MO+VA	IL	KY	MO	VA	IN+OH	IN	OH	NE	NY	ONT	SD
1	KY90C-054-6	34.1 h†	43.3 h	94.3	47.7	15.0	16.3	27.8 l	40.4	15.2	22.7	2.8	16.2	70.5
2	KY93C-0876-66	40.0 h	47.8 h	96.5	66.1	16.0	12.7	35.0 h	53.7	16.2	33.2	3.4	28.0	74.3
3	KY92C-0010-17	38.5 h	53.2 h	99.3	74.3	20.0	19.3	34.2 h	43.3	25.1	23.6	1.6	21.5	57.4
4	KY92C-0158-63	31.8	48.5 h	93.8	55.3	29.0	15.7	18.3 l	16.2	20.3	17.8	1.2	17.3	51.7
5	VA01W447	41.8 h	44.5 h	94.0	52.1	19.0	13.0	37.2 h	51.6	22.8	84.0	1.7	16.8	62.8
6	VA01W461	28.8 l	35.5	81.3	36.5	13.0	11.0	24.6 l	37.3	11.9	14.5	8.3	22.1	52.5
7	VA01W462	38.4 h	42.1 h	96.5	34.7	18.0	19.0	40.3 h	52.9	27.7	52.5	1.6	25.9	55.4
8	VA01W465	36.0 h	44.9 h	90.5	54.5	18.0	16.7	24.4 l	39.7	9.1	21.8	2.6	24.3	82.8
9	VA01W469	36.8 h	44.3 h	93.0	49.0	16.0	19.3	45.5 h	72.6	18.3	22.0	2.4	11.7	63.4
10	P97397J1-4-1-4	37.0 h	35.1	89.5	29.0	13.0	8.7	26.3 l	35.8	16.8	92.9	1.6	20.1	62.8
11	P97395B1-4-5-9	41.4 h	34.7	62.5	57.9	10.0	8.3	36.5 h	51.4	21.6	92.7	1.0	37.3	71.3
12	P97395B1-4-2-7	33.0	25.0 l	41.3	35.8	12.0	11.0	32.1 h	54.9	9.2	76.0	0.9	24.5	64.2
13	P981128A1-23-1	37.7 h	32.4	62.5	44.1	12.0	11.0	30.1	41.5	18.6	85.7	2.3	31.1	68.2
14	P981238A1-1-11	28.2 l	32.4	66.3	39.6	14.0	9.7	13.7 l	18.0	9.3	66.8	1.8	11.4	44.6
15	OH708	41.0 h	47.2 h	85.5	69.4	15.0	19.0	23.0 l	29.0	16.9	61.9	1.5	41.7	69.6
16	OH712	38.7 h	47.0 h	88.0	66.1	17.0	16.7	36.5 h	55.9	17.1	19.3	3.9	30.9	72.3
17	OH719	28.8 l	37.0 h	84.3	32.9	17.0	13.7	9.8 l	11.3	8.3	33.3	0.9	34.7	51.2
18	OH720	41.2 h	53.3 h	96.5	78.3	22.0	16.3	23.8 l	37.7	9.8	55.3	3.1	40.3	52.3
19	OH685	45.9 h	44.3 h	81.3	53.2	21.0	21.7	41.5 h	63.4	19.5	100.0	6.2	31.8	61.0
20	IL96-6472	30.9	30.4	82.5	19.9	9.0	10.0	34.0 h	50.8	17.1	48.6	0.5	18.8	51.8
21	IL97-1828	24.6 l	13.6 l	19.3	14.1	10.0	11.0	14.8 l	24.5	5.1	64.1	0.6	17.8	79.2
22	IL97-6755	26.4 l	11.6 l	11.8	18.5	5.0	11.0	15.5 l	27.6	3.4	94.1	0.4	18.7	73.3
23	IL97-7010	29.0 l	22.5 l	51.7	21.4	10.0	7.0	25.6 l	44.4	6.8	84.6	0.9	24.0	39.1
24	IL98-6718	35.2 h	25.7 l	65.0	25.1	7.0	5.7	43.5 h	71.7	15.3	57.9	1.8	25.8	77.0
25	MILLENNIUM	30.2	38.5 h	98.3	29.5	10.0	16.3	13.1 l	19.0	7.2	39.4	1.1	12.9	68.1
26	NE98632	31.7	39.3 h	96.8	33.7	14.0	12.7	26.7 l	44.9	8.5	29.0	2.2	7.5	67.3
27	NE99543	38.1 h	42.2 h	94.8	45.1	16.0	13.0	40.9 h	74.6	7.2	51.9	5.3	12.5	60.3
28	NY89052SP-9	38.3 h	42.4 h	94.8	37.5	18.0	19.3	42.1 h	61.1	23.0	29.0	0.7	30.9	68.9
29	NY89086-7120	39.6 h	45.4 h	96.3	59.3	13.0	13.0	37.1 h	59.1	15.0	38.3	1.3	30.3	70.8
30	NY89082-7159	35.5 h	41.0 h	92.8	28.8	29.0	13.3	29.0 l	47.5	10.4	33.1	1.9	36.9	61.2
31	NY89064SP-7139	36.1 h	35.7	78.8	26.4	20.0	17.7	22.8 l	40.9	4.6	76.3	0.7	33.3	62.2
32	NY89088-7401	32.8	37.0 h	90.0	29.1	19.0	9.7	33.4 h	47.1	19.6	19.2	1.1	28.7	64.7
33	MDV11-52	41.5 h	48.2 h	98.5	46.7	26.0	21.7	43.4 h	62.6	24.2	36.1	5.9	29.7	63.8
34	M94*1549-1	35.0 h	41.3 h	90.5	45.9	15.0	13.7	47.6 h	80.9	14.3	27.8	2.3	11.2	47.9
35	M95-2994-1	31.3	38.4 h	81.3	35.3	16.0	21.0	25.4 l	28.7	22.0	27.9	0.7	27.2	53.0
36	MO980829	17.1 l	13.6 l	25.8	15.9	5.0	7.7	6.7 l	11.0	2.4	37.5	0.4	12.1	53.1
37	MO981020	23.5 l	21.8 l	42.5	27.2	8.0	9.3	19.6 l	31.3	7.8	10.0	0.8	32.5	65.3
38	MO000925	28.6 l	33.8	89.5	17.8	13.0	14.7	23.4 l	30.6	16.1	10.0	2.3	22.2	69.5
39	MO000926	26.0 l	26.7 l	53.8	27.6	11.0	14.3	18.8 l	28.1	9.5	25.0	0.8	19.7	70.0
40	MO000969	42.8 h	41.3 h	92.3	43.3	13.0	16.7	43.6 h	55.9	31.2	100.0	1.1	14.6	59.7
41	PATTERSON	40.1 h	40.0 h	88.8	28.6	21.0	21.7	54.9 h	80.7	29.1	26.3	4.8	27.1	72.9
42	FREEDOM	22.4 l	35.9	72.5	45.3	16.0	9.7	8.9 l	10.9	6.9	10.0	0.6	9.7	42.0
43	PIONEER 2545	38.3 h	45.3 h	96.5	48.3	21.0	15.3	40.0 h	64.2	15.8	10.0	2.1	33.4	76.7
44	ERNIE	23.6 l	21.8 l	53.8	23.5	0.1	9.7	16.6 l	18.6	14.5	10.0	2.3	21.4	81.8
45	D9046-1	31.5	34.1		37.7	11.0	12.0	41.8 h	56.8	26.8	10.0		34.6	50.4
46	D9070-1	36.7 h	32.6		32.5		13.0	47.6 h	70.3	24.9	10.0		43.7	69.0
	Average	34.0	36.5	79	40	15	14	29.9	45	15	43	2	24	63
	CV (%)	42.3	31.8	8.6	25.5	29.5	32.8	39.3	45.3			51.0		0.0
	LSD (0.05)	12.7	16.4	9.5	23.7	.07	6.2	23.5	28.2	18.2		13.5	18.2	0.0

† Indicates a mean that is not different from the lowest (l) or highest (h) mean in the column based on $LSD_{(0.05)}$

Table 10. Disease index ([severity% x incidence%]/100) for entries in 2002 NUWWSN

		AL TESTS LSMEAN	IL+KY+ MO+VA	IL	KY	MO	VA	AR(2)+IN+ KS+OH	ARFAY	ARKIB	IN	KS	OH	NE	NY	ONT	SD
1	KY90C-054-6	23.2	24.4	42.3	31.3	14.0	10.0	20.9	2.3	55.0	8.8	29.5	8.7	16.0	0.2	12.4	70.5
2	KY93C-0876-66	30.1 h	34.6 h†	65.0	50.3	13.0	10.0	24.9	1.5	62.5	12.1	36.5	11.7	31.0	0.3	22.7	74.3
3	KY92C-0010-17	29.5 h	34.7 h	63.9	38.4	18.0	18.3	29.5	7.5	65.0	11.3	39.3	24.6	21.0	0.1	18.1	57.4
4	KY92C-0158-63	27.0 h	35.9 h	51.8	48.7	29.0	14.0	24.9	3.5	77.5	1.2	23.5	19.0	17.0	0.1	14.1	51.7
5	VA01W447	31.9 h	21.8	30.4	37.4	16.0	3.3	34.5 h	7.5	72.5	40.0	35.4	17.2	78.0	0.2	13.6	62.8
6	VA01W461	18.8	17.3	24.9	29.7	10.0	4.7	19.1	1.8	42.5	19.1	25.5	6.5	8.0	2.1	17.5	52.5
7	VA01W462	29.4 h	20.7	34.2	26.5	16.0	6.0	37.2 h	16.3	62.5	46.2	36.5	24.5	37.0	0.2	20.4	55.4
8	VA01W465	28.4 h	28.9 h	42.5	44.4	16.0	12.7	25.6	1.5	70.0	21.9	27.7	6.9	20.0	0.3	22.9	82.8
9	VA01W469	30.2 h	29.6 h	51.2	42.8	13.0	11.3	37.8 h	7.5	85.0	51.3	30.9	14.5	15.0	0.3	6.1	63.4
10	P97397J1-4-1-4	24.2	14.8 l	21.3	24.5	11.0	2.3	28.1	2.8	65.0	20.6	36.7	15.2	37.0	0.3	15.1	62.8
11	P97395B1-4-5-9	31.3 h	17.7	13.5	49.0	7.0	1.3	38.5 h	25.0	75.0	35.0	44.6	12.9	40.0	0.0	32.2	71.3
12	P97395B1-4-2-7	22.3	11.0 l	5.4	26.8	9.0	2.7	28.0	8.8	55.0	32.0	38.9	5.3	20.0	0.1	22.0	64.2
13	P981128A1-23-1	25.3 h	19.3	22.4	40.7	10.0	4.0	23.9	3.5	55.0	9.7	38.4	12.9	37.0	0.2	26.4	68.2
14	P981238A1-1-11	17.2	12.5 l	14.2	20.7	11.0	4.0	16.2 l	1.3	42.5	6.1	25.8	5.4	40.0	0.1	7.4	44.6
15	OH708	28.0 h	33.7 h	50.9	60.9	11.0	12.0	17.1 l	2.5	37.5	5.6	32.7	7.0	37.0	0.1	37.5	69.6
16	OH712	25.3 h	33.8 h	56.3	55.0	12.0	12.0	17.0 l	2.5	35.0	9.2	27.7	10.6	12.0	0.3	24.4	72.3
17	OH719	19.7	21.9	41.9	23.9	13.0	8.7	12.8 l	0.4	42.5	1.0	15.0	5.1	27.0	0.1	25.7	51.2
18	OH720	25.6 h	36.2 h	58.9	53.7	18.0	14.3	19.0	0.8	55.0	7.4	26.7	4.9	4.0	0.3	36.3	52.3
19	OH685	28.2 h	23.8	28.2	38.7	19.0	9.3	36.6 h	13.8	67.5	50.6	37.2	14.1	3.0	0.9	23.8	61.0
20	IL96-6472	19.0	10.7 l	20.0	15.0	6.0	1.7	26.8	5.1	57.5	24.4	37.2	9.9	3.0	0.0	14.9	51.8
21	IL97-1828	13.6 l	4.7 l	3.8	4.8	7.0	3.0	12.5 l	0.2	32.5	1.2	27.0	1.4	2.0	0.0	14.4	79.2
22	IL97-6755	14.6 l	3.1 l	1.9	5.6	3.0	2.0	13.0 l	0.2	30.0	2.4	31.7	0.7	25.0	0.0	13.6	73.3
23	IL97-7010	15.7 l	8.6 l	8.7	15.8	8.0	1.7	21.7	2.8	45.0	16.6	41.2	2.9	3.0	0.1	19.0	39.1
24	IL98-6718	22.3	11.4 l	22.3	19.1	4.0	0.3	28.3	1.8	52.5	36.7	39.8	10.8	6.0	0.1	19.7	77.0
25	MILLENNIUM	15.1 l	18.3	39.7	16.2	7.0	10.3	8.4 l	0.2	16.3	1.8	20.8	3.1	4.0	0.1	9.0	68.1
26	NE98632	18.8	26.1 h	56.1	26.4	11.0	11.0	13.1 l	0.5	32.5	6.3	20.6	5.7	2.0	0.2	4.2	67.3
27	NE99543	21.6	24.7	53.3	27.9	12.0	5.7	21.2	2.3	60.0	11.3	30.5	1.8	5.0	0.8	9.8	60.3
28	NY89052SP-9	19.2	22.8	48.2	18.1	13.0	11.7	13.0 l	0.5	18.8	12.8	22.6	10.2	2.0	0.0	22.9	68.9
29	NY89086-7120	23.6	27.7 h	58.1	34.4	10.0	8.3	19.8	0.3	40.0	25.7	25.5	7.5	1.0	0.1	25.5	70.8
30	NY89082-7159	19.7	26.9 h	50.3	20.2	27.0	10.0	10.9 l	0.0	20.0	4.2	26.1	4.4	0.0	0.2	32.9	61.2
31	NY89064SP-7139	15.6 l	18.8	32.4	17.8	15.0	10.0	7.2 l	0.2	16.3	2.1	15.2	2.3	0.0	0.0	28.7	62.2
32	NY89088-7401	18.0	22.9	44.7	24.0	16.0	6.7	10.9 l	0.4	16.3	7.8	20.5	9.5	0.0	0.1	23.5	64.7
33	MDV11-52	32.9 h	27.7 h	39.5	37.6	24.0	9.7	45.4 h	32.5	77.5	54.7	40.2	22.0	1.0	0.9	24.7	63.8
34	M94*1549-1	26.9 h	22.4	31.0	38.7	13.0	6.7	40.7 h	16.3	70.0	70.6	34.0	12.6	0.0	0.3	9.1	47.9
35	M95-2994-1	20.2	21.7	35.4	27.1	13.0	11.3	20.2	2.5	52.5	7.3	26.9	11.7	1.0	0.0	20.6	53.0
36	MO980829	8.4 l	4.4 l	5.4	6.4	3.0	2.7	5.9 l	0.4	10.0	0.6	18.3	0.4	1.0	0.0	7.6	53.1
37	MO981020	15.9 l	9.8 l	8.2	21.8	6.0	3.0	14.6 l	1.3	32.5	4.6	32.6	2.0	1.0	0.0	27.9	65.3
38	MO000925	20.3	18.8	44.6	12.7	10.0	8.0	20.8	1.1	57.5	5.1	30.6	9.6	0.0	0.2	15.3	69.5
39	MO000926	16.9 l	10.7 l	8.6	22.3	7.0	5.0	18.2 l	0.4	45.0	5.3	34.0	6.1	1.0	0.0	15.0	70.0
40	MO000969	23.1	20.8	33.4	34.5	11.0	4.3	28.6	1.6	55.0	33.4	32.0	20.8	3.0	0.1	11.1	59.7
41	PATTERSON	29.6 h	23.2	43.4	21.0	19.0	9.3	39.7 h	4.0	65.0	62.8	50.4	16.2	0.0	0.5	20.0	72.9
42	FREEDOM	15.7 l	19.3	23.6	33.5	14.0	6.0	15.2 l	3.5	40.0	1.3	27.4	3.9	2.0	0.0	6.7	42.0
43	PIONEER 2545	28.4 h	32.6 h	58.8	40.4	19.0	12.3	26.3	6.0	50.0	28.4	34.7	12.3	0.0	0.2	29.9	76.7
44	ERNIE	20.0	9.3 l	9.3	17.2	8.0	2.7	24.1	5.0	60.0	4.3	42.0	9.2	1.0	0.2	19.4	81.8
45	D9046-1	22.9	17.9		27.0		4.0	27.7	4.8	56.7	13.0	46.9	17.2	0.0		29.5	50.4
46	D9070-1	19.7	18.3		22.5		9.3	15.7 l	0.0	10.0	27.0	26.1	15.5	1.0		37.0	69.0
	Average	22.5	20.8	34.1	29.4	12.5	7.3	22.6	4.5	48.7	18.7	31.4	9.9	12.3	0.2	19.8	
	CV (%)	49.1	44.6	21.9	43.4	36.5	50.5	43.9			70.0	10.2					20.0
	LSD (0.05)	8.7	13.1	10.4	30.5	0.7	5.0	12.6	5.1	9.2	18.0	4.5	9.3			17.8	21.2

† Indicates a mean that is not different from the lowest (l) or highest (h) mean in the column based on $LSD_{(0.05)}$

Table 11. Kernel rating (visual rating of % infected seeds) for entries in 2002 NUWWSN

		ALL TESTS LSMEAN		IL	KS	KY	NE
1	KY90C-054-6	21.4	h†	58	3.5	24.0	0.0
2	KY93C-0876-66	30.9	h	60	9.3	53.1	1.0
3	KY92C-0010-17	31.1	h	65	9.8	47.5	2.0
4	KY92C-0158-63	21.6	h	50	6.0	29.4	1.0
5	VA01W447	27.3	h	48	5.0	54.0	2.0
6	VA01W461	24.9	h	40	10.8	46.7	2.0
7	VA01W462	27.5	h	55	6.5	45.6	3.0
8	VA01W465	20.1	h	28	9.8	40.7	2.0
9	VA01W469	29.2	h	65	6.5	43.2	2.0
10	P97397J1-4-1-4	25.3	h	55	4.5	41.6	0.0
11	P97395B1-4-5-9	18.0	lh	23	9.5	38.4	1.0
12	P97395B1-4-2-7	13.3	l	18	2.8	31.2	1.0
13	P981128A1-23-1	22.4	h	55	3.0	30.6	1.0
14	P981238A1-1-11	21.8	h	33	11.5	41.6	1.0
15	OH708	16.5	l	30	3.8	30.0	2.0
16	OH712	23.0	h	38	2.3	47.7	4.0
17	OH719	21.9	h	38	7.0	42.7	0.0
18	OH720	24.7	h	55	9.3	33.4	1.0
19	OH685	26.0	h	43	5.8	55.1	0.0
20	IL96-6472	12.5	l	28	2.3	19.5	0.0
21	IL97-1828	7.7	l	10	4.0	16.8	0.0
22	IL97-6755	8.6	l	8	1.3	25.0	0.0
23	IL97-7010	14.4	l	25	4.0	28.6	0.0
24	IL98-6718	10.2	l	18	1.5	20.2	1.0
25	MILLENNIUM	15.6	l	40	3.3	18.9	0.0
26	NE98632	23.3	h	65	4.5	23.7	0.0
27	NE99543	23.9	h	48	6.8	40.7	0.0
28	NY89052SP-9	11.6	l	23	3.8	16.6	3.0
29	NY89086-7120	19.8	h	28	7.0	44.2	0.0
30	NY89082-7159	15.1	l	23	17.3	19.1	1.0
31	NY89064SP-7139	11.7	l	18	4.0	18.9	6.0
32	NY89088-7401	18.4	h	25	8.3	37.4	3.0
33	MDV11-52	30.2	h	65	13.8	37.9	4.0
34	M94*1549-1	22.0	h	53	8.5	24.3	2.0
35	M95-2994-1	20.9	h	38	12.8	30.7	2.0
36	MO980829	5.7	l	10	2.3	10.6	0.0
37	MO981020	8.6	l	15	1.5	17.8	0.0
38	MO000925	21.8	h	40	4.0	42.1	1.0
39	MO000926	13.8	l	20	5.5	29.6	0.0
40	MO000969	24.8	h	43	6.0	48.3	2.0
41	PATTERSON	18.1	lh	38	2.3	27.9	4.0
42	FREEDOM	20.4	h	40	4.5	36.9	0.0
43	PIONEER 2545	28.4	h	65	13.8	34.9	0.0
44	ERNIE	17.0	l	25	2.5	40.4	0.0
45	D9046-1	26.7	h		8.8	53.2	0.0
46	D9070-1	18.3	lh		5.5	27.2	4.0
	Average	20		38	6	34	1
	CV (%)			23.9		48.0	
	LSD (0.05)			1.2		54.0	

† Indicates a mean that is not different from the lowest (l) or highest (h) mean in the column based on $LSD_{(0.05)}$

Table 12. % scabby seed (% scabby seed based on weight) for entries in 2002 NUWWSN

		ALL TESTS LSMEAN		ARFAY	KY	NE	VA
1	KY90C-054-6	22.0		49.0	28.8	0.0	10.3
2	KY93C-0876-66	21.5		49.0	27.8	2.0	7.0
3	KY92C-0010-17	26.7	h†	53.0	36.6	2.0	15.0
4	KY92C-0158-63	23.6	h	51.0	32.1	2.0	9.3
5	VA01W447	27.3	h	55.0	46.9	2.0	5.3
6	VA01W461	14.3	l	26.0	19.8	2.0	9.3
7	VA01W462	17.5	l	38.0	21.0	2.0	9.0
8	VA01W465	22.5	h	46.0	29.1	2.0	13.0
9	VA01W469	24.1	h	65.0	18.6	2.0	10.7
10	P97397J1-4-1-4	17.1	l	33.0	28.0	0.0	7.3
11	P97395B1-4-5-9	22.2	h	53.0	32.0	0.0	3.7
12	P97395B1-4-2-7	14.2	l	30.0	20.6	2.0	4.3
13	P981128A1-23-1	20.5		51.0	21.1	2.0	8.0
14	P981238A1-1-11	19.0	l	39.0	28.6	0.0	8.3
15	OH708	15.2	l	41.0	15.6	0.0	4.3
16	OH712	22.5	h	45.0	35.0	1.1	9.0
17	OH719	16.9	l	38.0	20.4	0.0	9.3
18	OH720	23.5	h	54.0	26.4	1.6	12.0
19	OH685	23.3	h	56.0	.	0.0	8.3
20	IL96-6472	7.8	l	20.0	5.0	1.9	4.3
21	IL97-1828	11.0	l	12.0	25.8	0.0	6.0
22	IL97-6755	8.7	l	12.0	20.2	0.0	2.7
23	IL97-7010	12.7	l	36.0	10.5	0.0	4.3
24	IL98-6718	14.0	l	34.0	19.4	0.0	2.7
25	MILLENNIUM	25.6	h	63.0	19.3	2.9	17.0
26	NE98632	29.2	h	70.0	29.4	2.6	14.7
27	NE99543	30.7	h	70.0	40.9	0.0	12.0
28	NY89052SP-9	17.6	l	34.0	29.1	0.0	7.3
29	NY89086-7120	20.4		44.0	28.6	0.0	9.0
30	NY89082-7159	19.3	l	50.0	19.1	0.0	8.0
31	NY89064SP-7139	14.5	l	44.0	7.4	0.0	6.7
32	NY89088-7401	20.5		43.0	32.7	0.0	6.3
33	MDV11-52	24.8	h	73.0	15.0	2.3	9.0
34	M94*1549-1	24.6	h	54.0	36.1	0.0	8.3
35	M95-2994-1	23.1	h	58.0	25.6	0.0	8.7
36	MO980829	12.8	l	15.0	30.6	2.4	3.3
37	MO981020	11.0	l	10.0	26.1	2.6	5.3
38	MO000925	15.2	l	29.0	17.8	0.0	14.0
39	MO000926	14.3	l	33.0	15.5	0.0	8.7
40	MO000969	27.0	h	68.0	29.9	0.0	10.0
41	PATTERSON	21.4		46.0	30.2	2.2	7.0
42	FREEDOM	17.9	l	34.0	30.7	0.0	6.7
43	PIONEER 2545	34.2	h	78.0	45.1	0.0	13.7
44	ERNIE	16.9	l	39.0	23.9	0.0	4.7
45	D9046-1	18.2	l	43.0	23.9	0.0	5.7
46	D9070-1	13.3	l	40.0	6.2	2.3	4.7
	Average	19.6		44.0	25.2	0.9	8.1
	CV (%)				40.2		36.0
	LSD (0.05)			9.0	40.2		4.0

† Indicates a mean that is not different from the lowest (l) or highest (h) mean in the column based on $LSD_{(0.05)}$

Table 13. DON (vomitoxin in ppm) for entries in 2002 NUWWSN. The scores of "<0.5" from NE were assumed to be 0.25 when calculating the mean.

		LSMEAN		KY	OH	VA	IL	NE
1	KY90C-054-6	18.4	h	29.0	4.2	7.7	51.0	<0.5
2	KY93C-0876-66	14.7	h	33.0	9.0	6.0	25.2	<0.5
3	KY92C-0010-17	22.9	h	40.0	12.5	10.0	51.0	1
4	KY92C-0158-63	19.9	h	31.0	8.5	5.3	54.0	0.6
5	VA01W447	10.4	l	20.0	4.0	2.6	25.2	<0.5
6	VA01W461	11.8		24.0	7.5	5.6	18.0	3.7
7	VA01W462	13.3		18.0	8.0	4.3	36.0	<0.5
8	VA01W465	18.8	h	44.0	13.5	7.3	28.8	<0.5
9	VA01W469	12.2		23.0	5.5	4.3	27.6	0.5
10	P97397J1-4-1-4	13.5		34.0	6.5	2.7	24.0	<0.5
11	P97395B1-4-5-9	10.2	l	28.0	8.0	2.6	12.0	<0.5
12	P97395B1-4-2-7	8.1	l	23.0	5.0	2.5	9.6	<0.5
13	P981128A1-23-1	10.2	l	25.0	5.0	4.1	16.8	<0.5
14	P981238A1-1-11	12.1		28.0	8.5	4.5	19.2	<0.5
15	OH708	9.4	l	25.0	5.0	4.7	12.0	<0.5
16	OH712	11.3		21.0	9.5	7.2	16.8	1.8
17	OH719	12.1		20.0	9.0	8.0	22.8	0.5
18	OH720	12.0		14.0	8.0	7.0	30.0	1.1
19	OH685	16.9	h	40.5	9.0	5.3	28.8	0.7
20	IL96-6472	5.7	l	13.0	3.0	2.6	9.6	<0.5
21	IL97-1828	5.8	l	20.0	2.8	2.5	3.6	<0.5
22	IL97-6755	1.7	l	5.0	0.9	1.2	1.2	<0.5
23	IL97-7010	9.8	l	29.0	3.5	1.7	14.4	<0.5
24	IL98-6718	5.7	l	15.0	4.0	1.0	8.4	<0.5
25	MILLENNIUM	10.2	l	10.0	5.0	6.7	28.8	<0.5
26	NE98632	18.7	h	24.0	10.5	10.0	48.0	1
27	NE99543	12.9		25.0	3.5	5.9	30.0	<0.5
28	NY89052SP-9	14.3		35.0	9.5	6.3	19.2	1.4
29	NY89086-7120	21.3	h	64.5	10.5	7.0	24.0	0.5
30	NY89082-7159	9.9	l	14.0	10.5	7.4	16.8	0.6
31	NY89064SP-7139	5.9	l	12.0	7.0	4.1	6.0	<0.5
32	NY89088-7401	12.9		35.0	8.0	6.3	14.4	0.9
33	MDV11-52	21.9	h	47.0	9.0	4.0	48.0	1.5
34	M94*1549-1	14.6	h	25.0	4.0	4.3	39.0	0.6
35	M95-2994-1	15.5	h	32.0	8.5	6.9	30.0	<0.5
36	MO980829	5.5	l	11.0	2.8	2.9	9.6	1.2
37	MO981020	10.1	l	33.0	3.5	3.5	9.6	0.9
38	MO000925	12.4		30.0	3.6	6.3	21.6	<0.5
39	MO000926	11.3		29.0	6.5	4.9	15.6	<0.5
40	MO000969	17.6	h	40.5	7.0	4.1	36.0	<0.5
41	PATTERSON	9.7	l	17.0	6.0	3.7	18.0	3.6
42	FREEDOM	7.7	l	22.0	4.5	3.5	8.4	<0.5
43	PIONEER 2545	23.8	h	52.5	14.0	7.0	45.0	<0.5
44	ERNIE	11.1		24.0	3.5	3.5	24.0	<0.5
45	D9046-1	17.0	h	45.5	6.0	5.1		<0.5
46	D9070-1	13.5		22.0	13.0	7.7		<0.5
	Average	12.7		27.2	6.9	5.0	23.6	0.6
	CV (%)	53.7						
	LSD (0.05)	9.3						

† Indicates a mean that is not different from the lowest (l) or highest (h) mean in the column based on $LSD_{(0.05)}$

Table 14. Greenhouse disease severity (% infected spikelets) for entries in 2002 NUWWSN.

		ALL TESTS LSMEAN	AR+IL +MO	AR	IL	MO	IN	KY
1	KY90C-054-6	54.2 h†	61.4	48.8	68.5	67.0	61.6	25.0
2	KY93C-0876-66	44.8	51.0	52.4	69.5	31.0	64.7	6.4
3	KY92C-0010-17	31.2 l	35.0 l	24.6	55.4	25.0	43.1	7.8
4	KY92C-0158-63	42.8	58.7	37.9	79.1	59.0	14.6	23.3
5	VA01W447	48.8 h	63.1 h	21.5	74.9	93.0	26.3	28.3
6	VA01W461	40.2	45.7	28.6	71.5	37.0	44.0	19.9
7	VA01W462	34.9	51.2	30.9	77.7	45.0	11.4	9.4
8	VA01W465	40.6	51.2	45.1	73.5	35.0	33.9	15.3
9	VA01W469	55.5 h	56.5	53.3	82.3	34.0	80.4	27.6
10	P97397J1-4-1-4	36.5	49.3	25.4	76.4	46.0	12.2	22.4
11	P97395B1-4-5-9	46.7	62.6 h	52.3	74.6	61.0	30.4	15.1
12	P97395B1-4-2-7	32.7 l	41.2	16.6	68.1	39.0	19.5	20.4
13	P981128A1-23-1	48.9 h	56.1	38.1	69.1	61.0	45.9	30.3
14	P981238A1-1-11	15.0 l	18.3 l	21.7	18.1	15.0	12.0	8.3
15	OH708	48.8 h	59.6	19.1	79.8	80.0	40.8	24.5
16	OH712	56.4 h	70.8 h	63.1	91.2	58.0	63.7	5.9
17	OH719	31.5 l	37.8 l	11.1	86.4	16.0	25.1	18.9
18	OH720	44.8	57.4	52.4	85.7	34.0	40.9	10.8
19	OH685	63.7 h	82.3 h	69.3	89.5	88.0	43.5	28.2
20	IL96-6472	34.1	40.9	21.1	71.6	30.0	33.1	14.7
21	IL97-1828	32.8 l	32.5 l	9.2	63.4	25.0	57.9	8.5
22	IL97-6755	19.6 l	24.3 l	7.2	40.6	25.0	15.5	9.6
23	IL97-7010	18.6 l	19.4 l	12.5	31.8	14.0	27.7	6.8
24	IL98-6718	44.9	32.9 l	7.9	69.9	21.0	86.9	38.6
25	MILLENNIUM	43.4	49.5	30.6	77.0	41.0	61.1	7.3
26	NE98632	42.4	42.6	21.5	61.2	45.0	74.7	9.5
27	NE99543	64.3 h	70.5 h	51.9	85.5	74.0	83.3	26.9
28	NY89052SP-9	53.6 h	62.3	36.7	88.3	62.0	64.5	16.3
29	NY89086-7120	40.5	44.1	33.6	49.8	49.0	56.4	13.8
30	NY89082-7159	50.3 h	49.9	41.9	71.8	36.0	85.0	17.0
31	NY89064SP-7139	31.9 l	36.6 l	12.1	77.8	20.0	43.6	5.9
32	NY89088-7401	39.8	42.1	16.1	82.2	28.0	68.5	4.2
33	MDV11-52	46.6	61.8	23.6		77.0	45.4	10.8
34	M94*1549-1	38.6	27.3 l	13.5		18.0	73.6	19.8
35	M95-2994-1	25.5 l	27.4 l	12.8		19.0	24.7	15.9
36	MO980829	16.3 l	18.5 l	8.9		5.0	13.9	7.8
37	MO981020	19.8 l	24.0 l	12.1	54.8	5.0	15.0	12.2
38	MO000925	34.0	39.1 l	15.4	65.8	36.0	27.5	25.3
39	MO000926	24.7 l	30.4 l	9.9	53.3	28.0	27.5	5.0
40	MO000969	30.3 l	37.3 l	27.1	66.9	18.0	33.4	6.3
41	PATTERSON	60.3 h	61.2	27.5	92.0	64.0	82.8	35.2
42	FREEDOM	16.0 l	20.3 l	12.0	41.8	7.0	13.4	5.8
43	PIONEER 2545	52.1 h	59.5	28.4	93.0	57.0	46.8	35.3
44	ERNIE	24.9 l	26.7 l	13.6	46.5	20.0	9.5	34.8
45	D9046-1	67.3 h	83.9 h			88.0	67.2	27.7
46	D9070-1	33.5 l	30.1 l			11.0	51.0	16.3
	Average	39.6	44.9	27.7	69.4	40.2	43.6	17.1
	CV (%)	38.5	29.2		25.7	36.5		140.7
	LSD (0.05)	19.0	21.4	27.5	28.5	.29		23.6

† Indicates a mean that is not different from the lowest (l) or highest (h) mean in the column based on $LSD_{(0.05)}$

Table 15. Correlations among entry means for traits, as averaged over appropriate 2002 NUWWSN tests

	HD	HGT	INC	SEV	IND	KR	%SS	DON	SEV-GH
HD		0.56*	0.05	-0.02	-0.27	-0.07	0.19	0.10	0.05
HGT	0.56*		-0.34*	-0.10	-0.41*	-0.30*	-0.09	-0.25	0.05
INC	0.05	-0.34*		0.63*	0.84*	0.77*	0.56*	0.63*	0.42*
SEV	-0.02	-0.10	0.63*		0.80*	0.56*	0.55*	0.44*	0.68*
IND	-0.27	-0.41*	0.84*	0.80*		0.72*	0.57*	0.53*	0.59*
KR	-0.07	-0.30*	0.77*	0.56*	0.72*		0.70*	0.70*	0.42*
%SS	0.19	-0.09	0.56*	0.55*	0.57*	0.70*		0.69*	0.51*
DON	0.10	-0.25	0.63*	0.44*	0.53*	0.70*	0.69*		0.33*
SEV-GH	0.05	0.05	0.42*	0.68*	0.59*	0.42*	0.51*	0.33*	

* indicates significance at 0.05 probability level

Table 16. Height and other traits for entries in 2002 NUWWSN

		# Infected florets from GH SPI			GH Leaf Rust	Height (inches)							
		LSMEAN	IN	MI	AR	LSMEAN		ARFAY	IN	KY	MO	NE	VA	OH
1	KY90C-054-6	7.6	7.3	8.0	4.4	37		42	41	26	33	43	33	43
2	KY93C-0876-66	2.0	0.9	3.1	5.3	35		40	38	26	31	43	31	38
3	KY92C-0010-17	2.9	4.5	1.3	5.8	37		41	39	32	32	43	33	39
4	KY92C-0158-63	6.3	2.7	9.8	5.1	36		41	37	31	31	43	32	39
5	VA01W447	4.9	4.0	5.8	4.7	36		39	35	32	32	43	30	38
6	VA01W461	5.4	4.7	6.2	1.0	37		41	38	33	30	43	33	38
7	VA01W462	2.7	1.7	3.8	2.1	35		39	35	32	29	43	29	35
8	VA01W465	5.9	3.4	8.4	1.2	33	l†	36	32	28	28	43	27	34
9	VA01W469	2.2	0.6	3.7	4.8	35		37	37	31	31	43	30	37
10	P97397J1-4-1-4	3.9	1.0	6.8	1.0	34	l	38	34	31	29	43	28	35
11	P97395B1-4-5-9	3.7	1.0	6.4	2.2	34	l	37	34	31	31	43	27	36
12	P97395B1-4-2-7	1.5	0.9	2.1	0.8	35		38	34	32	31	43	28	36
13	P981128A1-23-1	5.9	2.4	9.5	1.0	36		40	38	32	33	43	31	37
14	P981238A1-1-11	2.1	1.1	3.1	5.7	34	l	37	34	29	30	43	27	35
15	OH708	5.8	5.7	5.9	2.7	38		44	39	33	34	43	33	41
16	OH712	6.3	5.4	7.1	5.8	41	h	48	44	34	37	43	39	42
17	OH719	3.5	1.4	5.6	4.2	39	h	46	44	29	34	43	33	43
18	OH720	5.6	1.9	9.3	4.3	40	h	46	45	29	34	43	37	45
19	OH685	5.7	4.2	7.1	3.4	37		41	40	31	33	43	31	40
20	IL96-6472	2.7	2.1	3.2	2.7	36		41	37	30	32	43	32	38
21	IL97-1828	6.4	3.0	9.7	3.5	36		41	38	29	31	43	33	39
22	IL97-6755	2.2	0.5	3.9	5.0	41	h	46	45	29	36	43	38	47
23	IL97-7010	1.7	2.5	0.8	2.5	39	h	44	43	31	36	43	35	42
24	IL98-6718	2.7	1.8	3.6	5.0	38		41	40	33	35	43	33	39
25	MILLENNIUM	4.8	4.0	5.5	1.4	39	h	43	44	30	37	43	35	41
26	NE98632	5.7		7.1	2.9	39	h	43	42	33	35	43	34	43
27	NE99543	9.5	9.5	9.6	5.5	38		43	42	31	34	43	32	43
28	NY89052SP-9	6.3	3.0	9.6	4.3	39		44	43	27	34	43	36	43
29	NY89086-7120	6.7	4.2	9.3	4.3	39	h	46	42	30	34	43	34	43
30	NY89082-7159	7.0	8.8	5.3	4.6	36		42	37	24	33	43	32	40
31	NY89064SP-7139	2.2	0.2	4.2	4.5	38		43	38	28	34	43	35	42
32	NY89088-7401	4.0	4.4	3.6	4.3	39	h	45	40	27	35	43	38	44
33	MDV11-52	4.7	1.8	7.7	1.2	32	l	35	33	29	30	43	26	31
34	M94*1549-1	5.7	2.6	8.7	1.1	34	l	38	35	28	30	43	28	38
35	M95-2994-1	3.3	3.2	3.3	2.5	35		41	36	27	31	43	30	37
36	MO980829	0.0		1.4	4.6	39	h	42	42	30	37	43	37	44
37	MO981020	2.0	2.0	2.1	5.8	37		41	38	28	34	43	32	41
38	MO000925	3.0	2.8	3.3	2.9	36		39	38	32	33	43	31	37
39	MO000926	1.3	0.8	1.9	6.0	34	l	37	34	34	30	43	28	35
40	MO000969	2.9	1.2	4.6	4.8	36		42	38	29	31	43	31	39
41	PATTERSON	9.1	6.8	11.4	2.6	37		42	41	28	34	43	32	40
42	FREEDOM	3.1	1.0	5.2	1.8	38		42	41	30	33	43	34	40
43	PIONEER 2545	4.2	1.4	6.9	3.9	37		41	39	32	33	43	30	38
44	ERNIE	1.2	1.0	1.5	3.3	34	l	38	36	29	30	43	28	35
45	D9046-1	2.9	1.5		3.3	36		41	41	25		43	28	40
46	D9070-1				2.2	38		44	38	25		43	38	42
	Average	4.2	2.9	5.6	3.5	37		41	38	29	33	43	32	39
	CV (%)													
	LSD (0.05)													

† Indicates a mean that is not different from the lowest (l) or highest (h) mean in the column based on $LSD_{(0.05)}$