Report on the 2019-2020 Northern Uniform Winter Wheat Scab Nurseries (NUWWSN and PNUWWSN)

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INTRODUCTION

The objective of the Northern Uniform Winter Wheat Scab Nursery (NUWWSN) and the Preliminary Northern Uniform Winter Wheat Scab Nursery (PNUWWSN) is to screen winter wheat genotypes adapted to the northern portion of the eastern US for scab resistance. Breeders submit entries each also conducts the trial in inoculated and misted FHB nurseries within their programs. Data is then sent to the coordinator for summation and distribution. Public and private breeders submit lines using their own criteria for inclusion though all must be adapted. Entries vary in the degree of pretesting and selection and their purpose (germplasm, cultivars). Most of the entries have only native resistance though some have undergone MAS for *Fhb1* and other QTL.

MATERIAL AND METHODS

The locations that reported data and the traits assessed are listed in Tables 1, 2 and 3. The NUWWSN had 50 entries (46 lines & four checks, Table 4) from 10 programs and we obtained phenotypic data on seven FHB-related traits from nine locations. The PNUWWSN had 37 entries (33 lines & four checks, Table 5) from 7 programs and we obtained phenotypic data from 7 locations. Cooperators collect replicated data and submit means to the coordinator. The means from individual locations are used in an analysis over locations. The genotype x environment interaction (GEI) term is the error and is used to calculate an LSD (0.05). The LSD value is used to determine if a particular entry mean is statistically equal to the lowest entry mean (such values are designated with an "l") or the highest entry mean (such values are designated with an "h") for each trait. Variance components were estimated using PROC MIXED from SAS considering entries and locations to be random.

Several cooperators scored FHB Index using a 0-9 scale (0=no disease, 9=severe disease). This created issues with combining IND data over locations. Data for IND is report in two ways: 0-9 (referred to as "F09" trait) and as a %, referred to as IND. The reported F09 values were multiplied by 10 to provide an IND value.

Genomic estimated breeding values for all entries in the 2019 test were generated by Dr. Brian Ward of the USDA Eastern Regional Small Grains Genotyping Laboratory at NCSU. Marker and phenotypic data from the 2014-2019 P+NUWWSN were used to build the genomic selection model (using rrBLUP) and that model was used to estimate the GEBVs for all 2020 entries.

The tables in this report are created from excel files that are available from Clay Sneller (sneller.5@osu.edu).

RESULTS

Disease Pressure (Table 3)

- Average IND > 18% in 6 of 9 NUWWSN tests and in 4 of 7 PNUWWSN tests
- Average DON > 3 ppm in 3 of 6 NUWWSN tests and in 1 of 4 PNUWWSN tests

Trait Correlations and heritability (Tables 6, 7)

- The correlation among all FHB traits, exceeded 0.62 in both tests
- "H" exceeded 0.65 for all traits in both tests: INC had the lowest H in both tests.

Level of Resistance (Tables 8, 13, Figures 1, 2, 3)

- In the NUWWSN, the % of lines with greater resistance than Truman was 15% for IND, 20% DON, and 13% for PC1
- In the NUWWSN, the % of lines with greater resistance than Freedom was 65% for IND, 76% DON, and 78% for PC1
- In the PNUWWSN, the % of lines with greater resistance than Truman was 15% for IND, 56% DON, and 12% for PC1
- In the PNUWWSN, the % of lines with greater resistance than Freedom was 66% for IND, 67% DON, and 73% for PC1
- Just one line (NE-15-624) in either test had greater DON and FDK than the susceptible check (Pioneer 2545) and none had greater IND or FDK Pioneer 2545.
- The frequency of the resistant allele at *Fhb1* was 0.343 among the 46 breeding lines in the NUWWSN and 0.379 among the 33 breeding lines in in the PNUWWSN: these are the highest frequencies noted in either test since genotyping of entries for *Fhb1*.
- The frequency of the resistant allele at *Fhb1* was 0.66 among the 16 best breeding lines in the NUWWSN and 0.88 among the 13 best breeding lines in in the PNUWWSN.

Genomic Predictions (Tables 11, 12, 16, 17)

- Phenotypic and genotypic data from the 2014-2019 P+NUWWSN tests were able to predict the FHB trait values of lines in the 2020 P+NUWWSN tests. The correlation of GEBV with trait means over all environments ranged from 0.30 (INC, NUWWSN) to 0.63 (FDK, PNUWWSN)
- The GEBV for any one FHB trait was generally well correlated to the phenotypes of any of the other 6 FHB traits that were measured. This is not surprising given the high correlation among the FHB traits in the 2020 trials.
- Accuracy was relatively low for HD and HGT, likely due to less genetic variation for these traits. Also, we did not include the genotype for major genes affecting HD and HGT as fixed effects in the GS model.

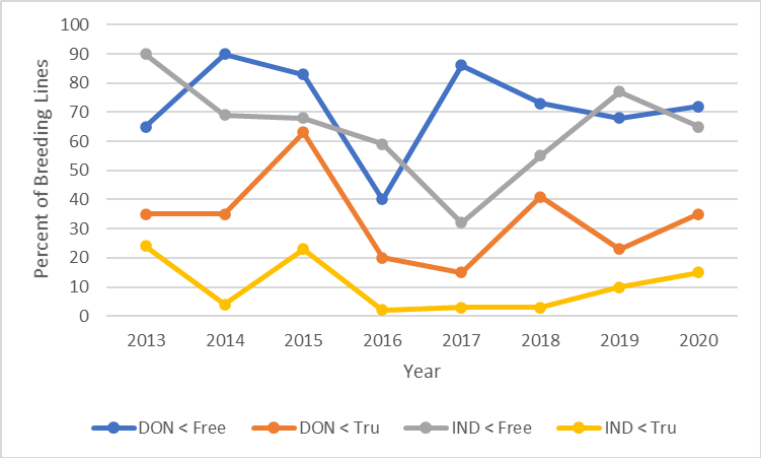

Figure 1. The percentage of P+NUWWSN breeding lines with IND or DON values that are less than that of Truman (TRU, the resistant check) or less than that of Freedom (FREE, the moderately resistant check)

Table 1. Fusarium Head Blight and other traits assessed in 2019-2020 P+NUWWSN

Code	Trait	Description
INC	Disease incidence	% of heads with at least one infected spikelets
SEV	Disease severity from field tests	% of infected spikelets in an infected head.
IND	Disease index	IND = (SEVxINC)/100
F09	FHB Index rated on a 0-9 scale	0= no disease, 9-very severe disease
FDK	Fusarium damaged kernels	Either a visual assessment of the percent infected kernels, or a percent of scabby seed by weight
ISK	Composite of head and kernel traits	ISK Index = .3 (Severity) + .3 (Incidence)+.4 (FDK)
DON	DON (vomitoxin)	PPM of vomitoxin in grain
GH	Greenhouse severity	Same as SEV except from greenhouse
HD	Heading Date	Julian date when 50% of spikes have emerged from the boot
HGT	Plant Height	Height in inches from soil to top of spike of a typical plant

Table 2A. Cooperators in the 2019-2020 P+NUWWSN

ENV CODE	LOCATION	NUWWSN	PNUWWSN	COOPERATORS	INSTITUTE	CODE
ILCHA	Champaign, IL	Yes	yes	Jana Murche	KWS Cereals	KWS
ILURB	Urbana, IL	yes	yes	Jessica Rutkoski	University of Illinois	UIL
INWLA	W. Lafayette, IN	no	no	Mohsen Mohammadi	Purdue University	PUR
INLAY	Lafayette, IN	yes	yes	Don Obert	Limagrain	LIM
KYLEX†	Lexington, KY	yes	yes	David Van Sanford	University of Kentucky	UKY
MIMAS	Mason, MI	yes	yes	Eric Olson, Lee Siler	Michigan State University	MSU
NEMEA	Mead, NE	yes	no	Stephen Baenziger, S Wegulo	University of Nebraska	UNE
NYITH	Ithaca, NY	yes	no	Mark Sorrells, Gary Bergstrom	Cornell University	COR
OHWOO	Wooster, Ohio	yes	yes	Clay Sneller, Pierce Paul	The Ohio State University	OSU
VAWAR	Warsaw, VA	yes	yes	Carl Griffey	Virginia Tech	VAT

†No data was collected from KYLEX due to frost damage in the spring of 2020.

Table 2B. Data obtained from each cooperator and location.

TEST	SOURCE	LOCATION	INC	SEV	IND	FDK	ISK	DON	GH	FHB (0-9)	HD	HGT	LDG	YLD	TW	PM	LR	SEP	FR
NUWWSN	COR	NYITH	y	Y	Y	Y	Y	Y	X	X	Y	X	X	X	X	X	X	X	X
NUWWSN	KWS	ILCHA	X	X	Y	Y	Y	Y	X	X	Y	Y	X	X	X	X	X	Y	X
NUWWSN	LIM	INLAF	X	X	X	Y	X	X	X	Y	Y	X	X	X	X	X	X	Y	X
NUWWSN	MSU	MIELA	Y	Y	Y	X	X	X	X	X	X	X	X	X	X	X	X	X	X
NUWWSN	OSU	OHWOO	X	X	Y	Y	Y	y	X	X	Y	X	X	X	X	X	X	X	Y
NUWWSN	PUR	INWLA	Y	Y	Y	X	X	X	X	X	Y	X	X	X	X	X	X	X	X
NUWWSN	UIL	UILURB	Y	Y	Y	Y	Y	Y	X	X	X	X	X	X	X	X	X	X	X
NUWWSN	UKY	KYLEX	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
NUWWSN	UNE	NEMEA	Y	Y	Y	Y	Y	Y	X	X	X	X	X	X	X	X	X	X	X
NUWWSN	VAT	VAWAR	Y	Y	Y	Y	Y	Y	X	X	Y	Y	Y	Y	Y	Y	Y	Y	X
			6	6	8	7	6	6	0	1	6	2	1	1	1	1	1	3	1

TEST	SOURCE	LOCATION	INC	SEV	IND	FDK	ISK	DON	GH	FHB (0-9)	HD	HGT	LDG	YLD	TW	PM	LR	SEP	FR
PNUWWSN	KWS	ILCHA	X	X	Y	Y	Y	Y	X	X	Y	Y	X	X	X	X	X	Y	X
PNUWWSN	LIM	INLAF	X	X	X	Y	X	X	X	Y	Y	X	X	X	X	X	X	Y	X
PNUWWSN	MSU	MIELA	Y	Y	Y	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PNUWWSN	OSU	OHWOO	X	X	Y	Y	Y	y	X	X	Y	X	X	X	X	X	X	X	Y
PNUWWSN	PUR	INWLA	Y	Y	Y	x	x	x	X	X	Y	X	X	X	X	X	X	X	X
PNUWWSN	UIL	UILURB	Y	Y	Y	Y	Y	Y	X	X	X	X	X	X	X	X	X	X	X
PNUWWSN	UKY	KYLEX	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PNUWWSN	VAT	VAWAR	Y	Y	Y	Y	Y	Y	X	X	Y	Y	Y	Y	Y	Y	Y	Y	X
			4	4	6	5	4	4	0	1	5	2	1	1	1	1	1	3	1

Table 3. Means for each trait and each location for the 2019-2020 P+NUWWSN.

A. NUWWSN

LOC	INC	SEV	IND	F09	FDK	ISK	DON	HD	HGT	LDG	YLD	TW	PM
ILCHA	.	.	31.0	.	9.8	22.4	2.2	141.5	35.3	.	.	.	.
ILURB	52.8	50.4	29.3	.	22.8	40.1	3.6	.	.	.	.	.	.
INLAF	.	.	.	5.3	25.8	.	.	142.1	.	.	.	.	.
INWLA	12.5	15.1	2.3	.	.	.	.	142.2	.	.	.	.	.
MIMAS	17.6	14.9	4.1	.	.	.	.	.	.	.	.	.	.
NEMEA	16.0	13.2	3.1	.	4.0	10.3	1.7	.	.	.	.	.	.
NYITH	70.3	23.3	18.5	.	53.8	49.6	18.5	150.2	.	.	.	.	.
OHWOO	.	.	18.2	.	25.3	21.0	9.2	145.8	.	.	.	.	.
VAWAR	49.0	40.9	24.5	4.0	22.9	27.3	1.9	114.9	39.8	0.6	94.2	58.4	0.4

B. PNUWWSN

LOC	INC	SEV	IND	F09	FDK	ISK	DON	HD	HGT	LDG	YLD	TW	PM	YR
ILCHA	.	.	33.7	.	10.1	24.3	2.2	142	34.3	.	.	.	.	.
ILURB	48.2	47.0	25.3	.	21.6	22.7	2.4	.	.	.	.	.	.	.
INLAF	.	.	55.0	5.5	23.8	42.5	.	142	.	.	.	.	.	.
INWLA	15.2	15.8	3.2	.	.	.	.	142	.	.	.	.	.	.
MIMAS	28.0	18.8	7.3	.	.	.	.	.	.	.	.	.	.	.
OHWOO	.	.	16.3	.	19.6	17.6	6.8	146	.	.	.	.	.	.
VAWAR	50.8	41.4	23.3	2.1	21.0	27.7	2.1	113	39.4	0.3	96.1	58.3	0.8	.

Table 4. Entries in the 2019-2020 NUWWSN

ENTRY	NAME	PEDIGREE
1	TRUMAN	
2	ERNIE	
3	FREEDOM	
4	PIONEER2545	
5	DH13SRW022-23NUE	[Yorktown (VA08W-294) / VA09W-52 (GF921221E16 / McCormick"S" // VA99W-200)]
6	VA17W-75	VA09W-45 [GF921221E16 (GA83519 / GA85240 // GA861278) / McCormick"S" (VA98W-590) // VA99W-200 (VA91-54-343 / ROANE"S" (VA91-54-222)] / YORKTOWN (VA08W-294), F9
7	15VDH-FHB-MAS33-13	MD08-26-H2-7-12-9 [SS8641//McCormick*2/ Ning7840] / USG 3118"S" (VA11W-278) // HILLIARD (VA11W-108)
8	15VTK-12-21	Featherstone 31 (VA12W-31) / IL07-19334
9	16VDH-SRW05-205	Pioneer 26R41 / Hilliard (VA11W-108) // Berkeley (VA12W-72)
10	MI17R0325	P25R30/MO080104
11	MI17R0415	Shirley/MO080589
12	MI16R0682	E5024/MO080103
13	MI17R0311	P25R30/IL02-18228
14	KWS246	SE05 1182-32 / Z10-40
15	KWS280	Starburst / KWS052
16	KWS283	11WIO1109 / LCS19701
17	KWS291	IL06-14262 / LCS19229 // OH08-180-48
18	KWS333	KWS072 / KWS074
19	NY12512-1-6-17	Va97w-375ws/NY7388//Pio2737w/Harus
20	NY12397-1-4-13	Pio25w41/Richland/NY7388//Madsen/Va97w-375ws
21	NY99056-161	NY85020-395/Pio25W33
22	NY12299-1-3-20	Erie/Cal-Res-L//03179-10/Va05w-251
23	NY12508-1-7-15	OH02-12686/Ava-6//Ava
24	IL15-27666	08-8844/KY02C-3005-25//07-21847
25	IL15-26131	07-19334/MO080104//07-19334/02-18228
26	IL15-4957	02-19463/07-16075
27	IL13-1960	M0050101 / 06-23571
28	IL15-2639	LA01-425/08-33373
29	OH14-112-34	02444A1-23-9/IL04-8445
30	OH14-222-49	VA03W-409/IL00-8061
31	OH15-191-52	OH05-164-76/OH07-176-46
32	OH15-42-1	OH05-164-76/OH07-176-46
33	KY07C-1145-94-12-5	IL99-15867/B990081//KY97C-0554-04-05
34	15VDH-FHB-MAS32-07-30-12-5	MD08-26-H2-7-12-9 [SS8641//McCormick*2/ Ning7840] / VA11W-278 (NC00-15389/GF951079-2E31 //USG3555(VA02W-555) // HILLIARD (VA11W-108)
35	X12-323-61-4-5	KY0C3-1237-39 // Syngenta W1104/USG 3555
36	X12-072-3-17-5	KY03C-1237-32 // KY02C-1121-11/KY02C-3004-07
37	X12-156-9-9-3	KY03C-1002-02 // KY03C-1237-39/KY03C-1237-32
38	NE-14-494	
39	NE-14-696	
40	NE-15-624	
41	NE-17-589	
42	NW-13-493	
43	LES18-0685	ES12-2619/VA10W-96
44	LES18-7031	08577-4/IL1021934
45	LES18-1653	LA07178C-44/VA11W-106
46	LES172093	IL05-4236/Branson
47	10534A1-17-17	10100RA/0537A1-3-12-1-6-7
48	10524A1-18-1	0537A1-3-12-1-6-7/104RA
49	04620A1-1-7-4-13	TRUMAN/0451A///TRUMAN/6/9017C1-1-2-X-4//92823A1-2-1-5/9218B4-4-1/3/P107/4/PATTERSON/5/INW9811/GOLDFIELD//96204A18
50	08344B-1-1	08128A/08125A///02AAA1-23-6/6/011007A1-14-6/5/0128A1-36/3/Chinese Spr.ph1b/KS24-2(275-4//Chinese Spr./4/0128A1-36/7/02444A1-23-1/6/97395C1-1-4/RSI5//INW0304-1/3/981281A1-4-3-7/4/INW0315/99794RA4-14-1/5/INW0411/3/Chinese Spr ph1b/KS24-2-2(275-4)//Chinese Spr/4/0128A1-36/INW0411

Table 5. Entries in the 2019-2020 PNUWWSN

ENTRY	NAME	PEDIGREE
1	TRUMAN	
2	ERNIE	
3	FREEDOM	
4	PIONEER2545	
5	15VDH-FHB-MAS10-25	MD08-26-H2-7-12-9 [SS8641//McCormick*2/ Ning7840] / 12V51 (VA05W-251) // Hilliard "S" (VA11W-95)
6	15VDH-FHB-MAS31-30	MD08-26-H2-7-12-9 [SS8641//McCormick*2/ Ning7840] / USG 3118"S" (VA11W-278) // Hilliard (VA11W-108)
7	16VDH-SRW03-023	USG 3118"S" (VA12W-54) / HILLIARD (VA11W-108)
8	DH15SRW67-151	LCS19229 / Shirley (VA03W-409)
9	12VTK20-102	MD03W61-09-7 / SH 7200 (VA10W-119) // Featherstone 73 (VA09W-73)
10	VA18W-54†	Yorktown (VA08W-294) / Pioneer 26R10, F8
11	MI16W0102	Crystal//P25R47/IL02-18228
12	MI17W0121	Ambassador//E5024/Truman
13	MI16R0830	Aubrey//P25R47/WA-1-93
14	MI17R0386	Shirley/Ava
15	KWS263	SY Harrison / VA08W-176
16	KWS305	E5024 / E5011 // KWS018
17	KWS316	DH09FG6_3-6 / MO100647
18	KWS317	DH09FG6_3-6 / MO100647
19	KWS319	LCS19229 / VA12FHB-8
20	IL16-36048	02-18228/MO081320
21	IL16-8048	07-12948/07-4415
22	IL16-23972	00-8641/07-20728//07-4415
23	IL16-36206	07-4415//07-4415/06-14262
24	IL16-4364	00-8530/07-4415
25	OH15-131-31	OH07-176-46*2/OH05-164-76
26	OH16-182-26	OH08-180-48/0762A1-2-8
27	OH16-167-76	OH08-256-47/OH08-206-69
28	OH16-168-48	OH08-256-47/OH08-206-69
29	15VDH-FHB-MAS02-10-2-6-3	MD08-26-H2-7-12-9 [SS8641//McCormick*2/ Ning7840] / USG3555 (VA02W-555) // VA12W-150 [IL99-15867 (IL93-2879/P881705A-1-X-60)/ JAMESTOWN(VA02W-370)
30	X12-862-16-13-5	KY03C-1237-32/KAS 5003 // KY03C-1237-32/VA08W-294
31	X12-461-32-3-1	Pembroke // KY02C-1121-11/KY02C-2215-02
32	X12-3049-57-4-3	KY03C-1237-07/0762A1-2-8
33	X12-839-11-18-5	KY02C-1121-11/KY02C-2215-02 // KY02C-1121-11/KY02C-3004-07
34	0527A1-9-9-2-4	04617A1/04688A1///99751D8-2-3/96169RE2-3-6-4-1/3/7D(E)//97462A1-21-1-5-1-15/INW0412
35	984RE1-57-5	VA93-54-429/92145A2-4-6
36	09186A1-10-2	INW0731/08343D1///INW0731/8/02444A1-23-1/6/97395C1-1-4/RSI5//INW0304-1/3/981281A1-4-3-7/4/INW0315/99794RA4-14-1/5/INW0411/3/Chinese Spr ph1b/KS24-2-2(275-4)//Chinese Spr/4/0128A1-36/INW0411/7/02444A1-23-8/3/INW0304/INW0315//981358C1-4-2-13/97462A1-21-1-5-1-15
37	10518RA1-1-6	INW0412/99751RA1-6-3-94

Table 6. Correlation of traits in the 2019-2020 P+NUWWSN. Coefficients of |r| > 0.23 are significant at P<0.05.

A. NUWWSN

	INC	SEV	IND	FHB(0-9)	FDK	ISK	DON	HD	HGT
INC	1.000	0.899	0.925	0.787	0.779	0.922	0.709	0.136	-0.208
SEV	0.899	1.000	0.953	0.887	0.795	0.928	0.763	0.302	0.005
IND	0.925	0.953	1.000	0.857	0.851	0.975	0.807	0.242	0.005
FHB(0-9)	0.787	0.887	0.857	1.000	0.785	0.860	0.746	0.460	0.043
FDK	0.779	0.795	0.851	0.785	1.000	0.929	0.901	0.391	0.010
ISK	0.922	0.928	0.975	0.860	0.929	1.000	0.852	0.296	-0.032
DON	0.709	0.763	0.807	0.746	0.901	0.852	1.000	0.486	0.093
HD	0.136	0.302	0.242	0.460	0.391	0.296	0.486	1.000	0.348
HGT	-0.208	0.005	0.005	0.043	0.010	-0.032	0.093	0.348	1.000

B. PNUWWSN

	INC	SEV	IND	FHB(0-9)	FDK	ISK	DON	HD	HGT
INC	1.000	0.875	0.828	0.786	0.789	0.807	0.624	0.207	-0.102
SEV	0.875	1.000	0.947	0.902	0.793	0.920	0.661	0.221	0.089
IND	0.828	0.947	1.000	0.943	0.834	0.984	0.737	0.236	0.101
FHB(0-9)	0.786	0.902	0.943	1.000	0.812	0.958	0.719	0.405	0.182
FDK	0.789	0.793	0.834	0.812	1.000	0.894	0.850	0.281	0.021
ISK	0.807	0.920	0.984	0.958	0.894	1.000	0.791	0.292	0.123
DON	0.624	0.661	0.737	0.719	0.850	0.791	1.000	0.441	0.170
HD	0.207	0.221	0.236	0.405	0.281	0.292	0.441	1.000	0.262
HGT	-0.102	0.089	0.101	0.182	0.021	0.123	0.170	0.262	1.000

Table 7. Summary of variance components and their ratios from the 2019-2020 P+NUWWSN. Entry mean H was calculated as $V_g/(V_g+(V_{error}/e))$ where e is the number of environments.

A. NUWWSN

	Venv	Vgen	Verror	# Envs	H
INC	579	61	192	6	0.66
SEV	237	60	99	6	0.78
IND	269	81	105	9	0.87
FDK	248	136	109	7	0.90
ISK	200	109	80	6	0.89
DON	44	8.2	11.6	6	0.81
HD	155	5.60	4.10	6	0.89
HGT	10.4	7.60	2.10	2	0.88

B. PNUWWSN

	Venv	Vgen	Verror	# Envs	H
INC	283	84	164	4	0.67
SEV	243	103	130	4	0.76
IND	301	101	108	7	0.87
FDK	27	81	57	5	0.88
ISK	87	103	45	5	0.92
DON	5.1	5.8	2.6	4	0.90
HD	174.00	3.40	3.50	5	0.83
HGT	13.00	5.50	1.00	2	0.92

Table 8. Summary of all FHB traits from the 2019-2020 NUWWSN: " h" and "l" indicate means that are not significantly different from the highest (h) or lowest (l) mean in that column. Lower PC1 scores indicate more resistance. A principal component analysis was performed using the eight FHB traits. "FHB1" indicates the presence of the resistance allele at QTL *Fhb1*.

ENTRY	NAME	INC AVG	SEV AVG	IND AVG	FHB(0-9) AVG	FDK AVG	ISK AVG	DON AVG	PC1	FHB1
1	TRUMAN	22.5 l	18.9 l	10.1 l	3.5	8.4 l	15.3 l	3.7 l	-2.72	no
2	ERNIE	40.5	29.3	25.8	7.0	25.5	33.6	5.0 l	0.80	no
3	FREEDOM	39.9	31.7	23.3	6.0	35.4	33.5	7.1	1.54	no
4	PIONEER2545	62.5 h	53.1 h	48.2 h	8.0	55.7 h	59.1 h	15.0 h	7.17	no
5	DH13SRW022-23NUE	35.4	25.4	19.4	7.5	21.1	25.6	4.4 l	-0.24	no
6	VA17W-75	42.6	30.2	25.9	8.0	24.2	32.0	6.4	1.07	no
7	15VDH-FHB-MAS33-13	28.1 l	15.9 l	9.7 l	3.0	15.5 l	17.8 l	3.8 l	-2.51	Fhb1
8	15VTK-12-21	45.9	32.8	25.5	5.5	25.1	33.6	6.9	1.57	no
9	16VDH-SRW05-205	40.5	24.8	20.6	5.0	35.8	34.0	7.4	0.71	no
10	MI17R0325	28.7 l	18.3 l	11.1 l	3.0	9.0 l	17.9 l	1.7 l	-2.69	no
11	MI17R0415	34.7	24.5	18.4	4.0	20.8	28.5	6.2	-0.53	no
12	MI16R0682	33.6 l	24.7	18.2	4.0	20.4	24.8	4.2 l	-0.76	no
13	MI17R0311	46.7	28.3	24.7	5.5	22.4	32.3	5.5	0.82	no
14	KWS246	40.3	30.0	28.5	8.0	39.7	37.6	10.0	2.10	no
15	KWS280	48.5 h	36.7	31.3	7.0	36.7	41.5	10.1	3.10	no
16	KWS283	34.6	25.0	19.5	4.5	23.0	28.0	6.3	-0.18	no
17	KWS291	49.4 h	37.4	30.9	6.0	29.8	41.6	6.3	2.47	no
18	KWS333	34.8	25.9	16.9	6.0	26.4	25.4	5.5	-0.50	no
19	NY12512-1-6-17	34.9	23.9	17.8	5.5	17.4	22.7	10.4	-0.07	Fhb1
20	NY12397-1-4-13	36.1	27.1	20.6	5.0	15.9 l	26.9	6.1	-0.18	Fhb1
21	NY99056-161	28.6 l	25.0	16.3	6.0	22.1	23.1	9.3	-0.35	no
22	NY12299-1-3-20	36.4	24.9	16.1	5.5	28.6	28.0	5.9	-0.18	Fhb1
23	NY12508-1-7-15	33 l	27.7	15.9	5.0	17.4	22.8	6.3	-0.63	Fhb1?
24	IL15-27666	25.1 l	11.6 l	9.3 l	2.5	10.5 l	15.9 l	3.6 l	-3.23	Fhb1
25	IL15-26131	21.9 l	17.0 l	7.4 l	2.5	5.6 l	12.1 l	2.0 l	-3.49	no
26	IL15-4957	26 l	21.1 l	11.7 l	3.5	5.8 l	15.7 l	2.0 l	-2.80	no
27	IL13-1960	27.8 l	21.3 l	16.8	6.0	15.4 l	19.8	4.3 l	-1.67	no
28	IL15-2639	29.9 l	15.8 l	9.0 l	3.5	6.2 l	14.3 l	3.5 l	-2.91	Fhb1
29	OH14-112-34	29.1 l	19.0 l	13.2 l	5.0	22.3	23.6	6.1	-1.35	Fhb1
30	OH14-222-49	36.5	34.3	21.9	5.5	20.5	29.2	5.2 l	0.28	no
31	OH15-191-52	40.8	31.4	24.2	7.0	27.9	33.9	6.3	1.04	Fhb1
32	OH15-42-1	40.9	32.4	25.1	6.5	31.5	36.4	7.2	1.48	Fhb1
33	KY07C-1145-94-12-5	45.8	35.6	25.0	4.0	17.0	33.3	6.7	1.13	no
34	15VDH-FHB-MAS32-07-30-12-5	29.6 l	17.0 l	11.0 l	4.0	14.0 l	18.8 l	3.8 l	-2.21	Fhb1
35	X12-323-61-4-5	32.2 l	22.1 l	12.2 l	3.5	16.4 l	21.0	5.4 l	-1.70	Fhb1
36	X12-072-3-17-5	25.2 l	18.0 l	10.4 l	4.0	15.5 l	17.4 l	4.0 l	-2.49	Fhb1
37	X12-156-9-9-3	32.5 l	13.0 l	8.3 l	3.0	17.2	18.7 l	3.5 l	-2.61	Fhb1
38	NE-14-494	40.2	29.5	27.8	6.0	42.5	41.8	12.7 h	2.54	no
39	NE-14-696	50.2 h	41.8 h	40.2 h	8.0	47.5	51.4 h	12.7 h	4.92	no
40	NE-15-624	49.9 h	40.4	40.6 h	8.0	63.6 h	55.3 h	16.4 h	6.00	no
41	NE-17-589	40	37.0	29.9	8.0	28.6	36.4	6.9	1.95	no
42	NW-13-493	36.8	32.3	28.2	8.0	33.4	35.9	7.9	1.96	no
43	LES18-0685	64.2 h	43.1 h	39.9 h	8.0	33.2	47.0	8.0	4.35	no
44	LES18-7031	38.9	25.1	20.2	5.5	24.2	28.9	5.5	0.25	no
45	LES18-1653	35.8	26.0	27.4	8.0	21.5	32.8	5.1 l	0.27	no
46	LES172093	40.5	24.2	20.3	5.0	19.5	30.0	4.2 l	-0.36	no
47	10534A1-17-17	17.6 l	11.2 l	5.7 l	2.5	5.7 l	9.3 l	1.5 l	-4.33	Fhb1
48	10524A1-18-1	21.4 l	14.2 l	9.5 l	4.0	13.7 l	16.0 l	2.9 l	-2.93	Fhb1_het
49	04620A1-1-7-4-13	24.1 l	20.8 l	10.5 l	3.0	11.7 l	16.7 l	3.1 l	-2.50	Fhb1
50	08344B-1-1	35.5	18.7 l	10.5 l	2.0	23.2	23.8	5.1 l	-1.41	Fhb1
100	AVERAGE	36.3	26.3	20.2	5.3	23.4	28.4	6.2		
101	MINUMUM	17.6	11.2	5.7	2.0	5.6	9.3	1.5		
102	MAXIMUM	64.2	53.1	48.2	8.0	63.6	59.1	16.4		
103	LSD(0.05)	16.0	11.5	9.7	NA	11.2	10.3	3.9		
	NUMBER OF ENVIRONMENTS	6	6	9	1	7	6	6		

Table 9. Best (top) and worst (bottom) entries in the 2019-2020 NUWWSN. Summary statistics are over all entries.

ENTRY	NAME	INC AVG	SEV AVG	IND AVG	FHB(0-9) AVG	FDK AVG	ISK AVG	DON AVG	PC1	FHB1
47	10534A1-17-17	17.6 l	11.2 l	5.7 l	2.5	5.7 l	9.3 l	1.5 l	-4.33	Fhb1
25	IL15-26131	21.9 l	17.0 l	7.4 l	2.5	5.6 l	12.1 l	2.0 l	-3.49	no
24	IL15-27666	25.1 l	11.6 l	9.3 l	2.5	10.5 l	15.9 l	3.6 l	-3.23	Fhb1
48	10524A1-18-1	21.4 l	14.2 l	9.5 l	4.0	13.7 l	16.0 l	2.9 l	-2.93	Fhb1_het
28	IL15-2639	29.9 l	15.8 l	9.0 l	3.5	6.2 l	14.3 l	3.5 l	-2.91	Fhb1
26	IL15-4957	26 l	21.1 l	11.7 l	3.5	5.8 l	15.7 l	2.0 l	-2.80	no
1	TRUMAN	22.5 l	18.9 l	10.1 l	3.5	8.4 l	15.3 l	3.7 l	-2.72	no
10	MI17R0325	28.7 l	18.3 l	11.1 l	3.0	9.0 l	17.9 l	1.7 l	-2.69	no
37	X12-156-9-9-3	32.5 l	13.0 l	8.3 l	3.0	17.2	18.7 l	3.5 l	-2.61	Fhb1
7	15VDH-FHB-MAS33-13	28.1 l	15.9 l	9.7 l	3.0	15.5 l	17.8 l	3.8 l	-2.51	Fhb1
49	04620A1-1-7-4-13	24.1 l	20.8 l	10.5 l	3.0	11.7 l	16.7 l	3.1 l	-2.50	Fhb1
36	X12-072-3-17-5	25.2 l	18.0 l	10.4 l	4.0	15.5 l	17.4 l	4.0 l	-2.49	Fhb1
34	15VDH-FHB-MAS32-07-30-12-5	29.6 l	17.0 l	11.0 l	4.0	14.0 l	18.8 l	3.8 l	-2.21	Fhb1
35	X12-323-61-4-5	32.2 l	22.1 l	12.2 l	3.5	16.4 l	21.0	5.4 l	-1.70	Fhb1
27	IL13-1960	27.8 l	21.3 l	16.8	6.0	15.4 l	19.8	4.3 l	-1.67	no
50	08344B-1-1	35.5	18.7 l	10.5 l	2.0	23.2	23.8	5.1 l	-1.41	Fhb1
17	KWS291	49.4 h	37.4	30.9	6.0	29.8	41.6	6.3	2.47	no
38	NE-14-494	40.2	29.5	27.8	6.0	42.5	41.8	12.7 h	2.54	no
15	KWS280	48.5 h	36.7	31.3	7.0	36.7	41.5	10.1	3.10	no
43	LES18-0685	64.2 h	43.1 h	39.9 h	8.0	33.2	47.0	8.0	4.35	no
39	NE-14-696	50.2 h	41.8 h	40.2 h	8.0	47.5	51.4 h	12.7 h	4.92	no
40	NE-15-624	49.9 h	40.4	40.6 h	8.0	63.6 h	55.3 h	16.4 h	6.00	no
4	PIONEER2545	62.5 h	53.1 h	48.2 h	8.0	55.7 h	59.1 h	15.0 h	7.17	no
100	AVERAGE	36.3	26.3	20.2	4.5	23.4	28.4	6.2		
101	MINUMUM	17.6	11.2	5.7	2.0	5.6	9.3	1.5		
102	MAXIMUM	64.2	53.1	48.2	8.0	63.6	59.1	16.4		
103	LSD(0.05)	16.0	11.5	9.7	NA	11.2	10.3	3.9		
	NUMBER OF ENVIRONMENTS	6	6.0	9.0	1	7.0	6.0	6.0		

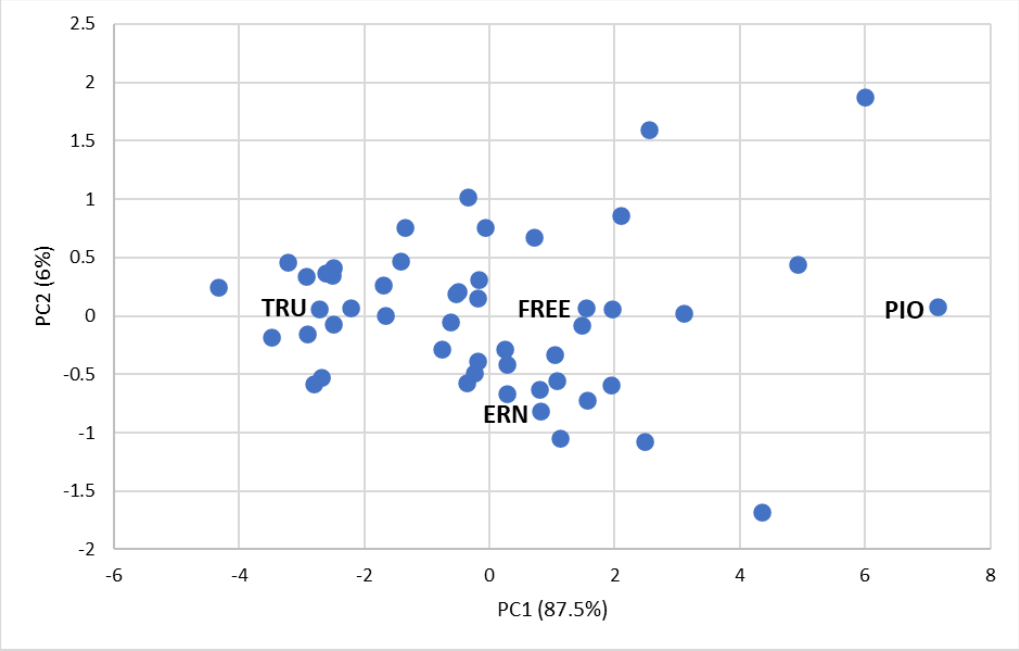

Figure 2. Graph of first two PC from the analysis of the seven FHB traits from the NUWWSN entries (Table 8). Checks are identified: TRU=Truman (R), FREE=Freedom (MR), ERN=Ernie (MR), PIO=Pioneer 2545 (S).

Table 10. Genomic estimated breeding values (GEBV) of lines in the 2019-2020 NUWWSN. Phenotypic and genotypic data from 2014 through 2019 was used to train the model that was then used to predict the values of the 2020 entries.

ENTRY	NAME	INC	SEV	IND	FDK	ISK	DON	HD	HGT
1	TRUMAN	24.5	11.5	9.0	9.9	13.0	3.0	92.7	38.3
2	ERNIE	31.8	19.6	15.5	16.6	19.5	4.3	88.6	36.1
3	FREEDOM	35.8	18.1	16.0	21.5	22.0	5.2	91.3	35.8
4	PIONEER2545	37.6	25.7	24.2	22.6	24.8	7.1	93.8	35.8
5	DH13SRW022-23NUE	33.0	18.8	15.0	13.3	17.2	3.8	93.8	34.5
6	VA17W-75								
7	15VDH-FHB-MAS33-13								
8	15VTK-12-21	31.5	16.4	16.6	14.1	18.7	2.4	96.8	35.4
9	16VDH-SRW05-205								
10	MI17R0325	29.0	14.4	11.6	13.0	15.2	2.7	90.8	36.2
11	MI17R0415	28.2	16.9	13.3	13.3	15.8	4.2	94.0	36.9
12	MI16R0682	34.7	17.0	13.8	12.6	17.0	3.8	94.2	35.5
13	MI17R0311	27.9	13.8	12.3	12.6	15.2	3.8	90.0	36.4
14	KWS246								
15	KWS280	33.1	21.2	16.5	16.4	18.7	4.5	94.7	34.7
16	KWS283	34.4	20.4	16.7	18.0	19.0	5.2	92.8	36.6
17	KWS291	26.3	11.0	7.3	10.6	13.3	3.7	92.8	34.0
18	KWS333								
19	NY12512-1-6-17	35.1	21.4	17.0	17.6	21.4	6.0	94.3	34.1
20	NY12397-1-4-13	36.2	19.8	17.6	15.8	20.3	4.9	91.1	34.1
21	NY99056-161	33.8	22.3	18.5	19.5	21.5	6.1	96.2	36.8
22	NY12299-1-3-20	32.9	16.9	14.2	14.5	17.3	4.5	94.1	36.0
23	NY12508-1-7-15	36.1	20.0	15.8	17.5	21.4	5.8	95.4	34.8
24	IL15-27666	24.4	8.7	7.4	9.8	12.2	1.2	98.5	35.1
25	IL15-26131	31.3	14.6	11.2	8.1	14.1	1.1	92.8	35.5
26	IL15-4957	29.0	15.8	13.4	10.7	15.3	2.2	92.9	35.3
27	IL13-1960	28.4	14.3	11.2	12.0	15.1	2.7	93.7	35.7
28	IL15-2639	28.0	12.0	8.1	7.0	13.1	1.2	94.4	36.6
29	OH14-112-34	27.4	13.9	12.0	14.8	16.6	3.3	94.9	34.3
30	OH14-222-49	29.9	17.6	15.1	10.9	16.8	2.6	94.6	35.3
31	OH15-191-52	31.1	20.7	19.6	18.3	21.2	4.2	97.9	35.0
32	OH15-42-1	32.1	20.1	19.5	18.0	21.2	4.1	96.6	34.9
33	KY07C-1145-94-12-5	34.8	17.1	14.1	13.4	17.2	2.9	88.5	34.5
34	DH-FHB-MAS32-07-30-12-5	33.5	18.1	13.3	18.1	18.7	4.5	92.6	35.0
35	X12-323-61-4-5	30.2	13.0	14.3	15.9	19.1	4.4	101.8	33.5
36	X12-072-3-17-5	31.9	12.2	12.5	13.8	17.4	3.7	96.6	33.2
37	X12-156-9-9-3	31.9	13.1	16.2	17.9	20.2	5.3	99.6	33.6
38	NE-14-494	35.4	22.4	19.6	18.6	20.0	5.3	89.6	38.3
39	NE-14-696	36.1	21.0	17.7	17.6	20.1	5.5	91.3	36.4
40	NE-15-624	34.8	22.4	19.1	23.7	22.8	8.1	86.8	36.2
41	NE-17-589	34.8	23.1	18.7	18.2	20.6	5.3	90.9	37.2
42	NW-13-493	34.6	24.6	18.8	18.2	19.7	5.2	89.5	37.7
43	LES18-0685	35.7	22.8	19.6	15.8	20.3	3.4	91.2	33.4
44	LES18-7031	31.9	16.5	14.4	14.2	17.9	3.6	90.3	35.0
45	LES18-1653	34.5	19.9	15.6	18.1	20.0	4.6	92.9	35.5
46	LES172093								
47	10534A1-17-17	33.2	13.6	12.2	15.7	16.5	4.2	93.2	35.5
48	10524A1-18-1	30.4	13.1	12.0	16.2	16.9	3.5	94.2	33.2
49	04620A1-1-7-4-13	30.5	10.9	12.4	12.9	14.9	4.1	94.1	35.1
50	08344B-1-1	29.6	12.2	12.2	14.0	16.1	3.3	94.7	34.1

Table 11. Correlation of Genomic estimated breeding values and observed phenotypes of lines in the 2019-2020 NUWWSN. The correlation was obtained using phenotypes from each environment as well as the average over all environments. Phenotypic data from 2014 through 2019 was used to train the model that was then used to predict the values of the 2020 entries.

	CORRELATION OF GEBVS WITH PHENOTYPIC VALUES									
		KWS	UIL	LIM	PUR					
	AVG	ILCHA	ILURB	INLAF	INWLA	MIMAS	NEMEA	NYITH	OHWOO	VAWAR
INC	0.30		0.11	0.09		0.62	0.46	0.08		0.44
SEV	0.51		0.62	0.24		0.70	0.34	0.54		0.60
IND	0.53	0.65	0.43	0.68	0.37	0.67	0.52	0.53	0.54	0.51
FDK	0.60	0.61	0.55	0.71			0.61	0.53	0.58	0.62
ISK	0.50	0.59	0.47				0.59	0.50	0.54	0.40
DON	0.59	0.60	0.58				0.49	0.55	0.65	0.68
HD	-0.01	-0.02		-0.05	0.03			0.02	-0.02	-0.02
HGT	0.30	0.21								0.30

Table 12. Correlation of Genomic estimated breeding values and the average phenotypes of lines in the 2019-2020 NUWWSN. Phenotypic data from 2014 through 2019 was used to train the model that was then used to predict the values of the 2020 entries.

	INC	SEV	IND	FDK	ISK	DON	HD	HGT	AVG CORR OF GEBV WITH FHB PHENOTYPES
GEBV INC	0.43523	0.51451	0.49401	0.50793	0.49138	0.54371	0.21947	0.09272	0.51
GEBV SEV	0.58537	0.70825	0.67684	0.66316	0.68739	0.71044	0.32634	0.14257	0.66
GEBV IND	0.59598	0.67882	0.64811	0.68972	0.67756	0.70424	0.3067	0.0688	0.67
GEBV FDK	0.42027	0.46962	0.49962	0.69298	0.5747	0.67246	0.33996	0.13647	0.53
GEBV ISK	0.52161	0.58309	0.55616	0.66156	0.60504	0.68578	0.29926	0.05301	0.60
GEBV DON	0.39553	0.47904	0.49561	0.68195	0.56107	0.72195	0.46254	0.13748	0.52
GEBV HD	-0.31157	-0.36891	-0.4335	-0.33165	-0.39619	-0.28301	-0.17911	-0.25496	-0.35
GEBV HGT	-0.01189	0.14315	0.16546	0.20263	0.16835	0.23328	0.27424	0.57328	0.15

Table 13. Summary of all FHB traits from the 2019-2020 PNUWWSN: “h” and “l” indicate means that are not significantly different from the highest (h) or lowest (l) mean in that column. Lower PC1 scores indicate more resistance. A principal component analysis was performed using the eight FHB traits. “FHB1” indicates the presence of the resistance allele at QTL *Fhb1*.

ENTRY	NAME	INC AVG		SEV AVG		IND AVG		FDK AVG		ISK AVG		DON AVG		PC1	FHB1
1	TRUMAN	18.9	l	17.4	l	10.6	l	7.7	l	14.6	l	3.5		-2.738	no
2	ERNIE	32.1	l	35.2		32.0		19.8		34.8		3.9		0.960	no
3	FREEDOM	36.9		35.4		27.7		27.0		34.3		3.7		1.367	no
4	PIONEER2545	60.0	h	53.6	h	51.4	h	55.5	h	58.4	h	15.8	h	7.651	no
5	15VDH-FHB-MAS10-25	21.1	l	23.9	l	21.5		19.0		27.7		3.6		-0.584	Fhb1_het
6	15VDH-FHB-MAS31-30	33.8	l	23.0	l	14.4	l	12.9	l	17.2	l	2.7	l	-1.738	Fhb1
7	16VDH-SRW03-023	56.3	h	46.7	h	40.2	h	31.0		42.6		4.3		3.571	no
8	DH15SRW67-151	28.0	l	26.7	l	21.9		17.8		27.2		2.4	l	-0.622	no
9	12VTK20-102	35.2		36.7		25.6		21.5		28.6		3.8		0.431	no
10	VA18W-54	49.1	h	42.8	h	36.9		27.8		39.0		5.3		2.770	no
11	MI16W0102	26.6	l	29.6		28.5		18.7		28.2		2.8	l	-0.339	no
12	MI17W0121	36.1		34.1		27.3		20.3		30.1		4.7		0.732	no
13	MI16R0830	36.2		29.1		19.5		26.7		25.1		4.1		0.097	no
14	MI17R0386	34.4	l	37.8	h	30.2		17.2		33.9		2.7	l	0.711	no
15	KWS263	42.2	h	41.5	h	35.9		30.2		40.7		5.0		2.749	no
16	KWS305	37.1		41.2	h	28.9		22.2		33.1		6.8		1.889	no
17	KWS316	47.1	h	30.4		28.2		21.3		31.6		4.7		1.310	no
18	KWS317	42.3	h	35.2		26.6		14.2		28.5		3.7		0.553	no
19	KWS319	46.5	h	42.6	h	36.0		19.3		34.2		3.9		1.750	no
20	IL16-36048	17.0	l	15.8	l	9.2	l	4.8	l	11.7	l	0.8	l	-3.683	Fhb1
21	IL16-8048	24.8	l	15.7	l	8.6	l	4.9	l	11.4	l	0.5	l	-3.438	Fhb1
22	IL16-23972	27.5	l	15.4	l	10.8	l	6.1	l	14.2	l	0.5	l	-2.978	Fhb1
23	IL16-36206	18.3	l	11.4	l	7.2	l	4.6	l	9.7	l	0.5	l	-4.065	Fhb1
24	IL16-4364	26.6	l	23.4	l	16.1	l	13.5	l	20.8		1.7	l	-1.785	Fhb1_het
25	OH15-131-31	27.8	l	27.3	l	17.1	l	13.3	l	21.6		2.3	l	-1.356	Fhb1
26	OH16-182-26	20.7	l	13.1	l	10.7	l	14.1		16.9	l	1.9	l	-2.581	Fhb1
27	OH16-167-76	52.3	h	48.8	h	34.1		31.3		37.7		3.2		2.845	no
28	OH16-168-48	49.1	h	43.2	h	31.2		27.8		33.9		3.5		1.952	no
29	15VDH-FHB-MAS02-10-2-6-3	26.9	l	19.4	l	9.7	l	13.9	l	15.0	l	1.4	l	-2.670	Fhb1
30	X12-862-16-13-5	36.1		32.0		20.9		16.7		24.5		2.8		-0.247	Fhb1?
31	X12-461-32-3-1	32.5	l	17.1	l	9.8	l	22.7		16.5	l	2.8		-1.992	Fhb1
32	X12-3049-57-4-3	27.4	l	15.4	l	12.7	l	15.5		18.0	l	1.3	l	-2.188	Fhb1
33	X12-839-11-18-5	39.5		20.9	l	12.4	l	13.8	l	15.2	l	2.0	l	-1.876	Fhb1
34	0527A1-9-9-2-4	49.1	h	42.0	h	35.9		26.5		39.1		3.5		2.444	no
35	984RE1-57-5	52.8	h	51.1	h	32.3		24.3		32.1		3.9		2.256	Fhb1_het
36	09186A1-10-2	38.0		30.1		20.8		13.0	l	22.9		2.3	l	-0.656	no
37	10518RA1-1-6	30.9	l	31.2		24.9		14.0	l	26.8		1.9	l	-0.502	no
100	AVERAGE	35.6		30.7		23.4		19.2		27.0		3.4			
101	MINUMUM	17.0		11.4		7.2		4.6		9.7		0.5			
102	MAXIMUM	60.0		53.6		51.4		55.5		58.4		15.8			
103	LSD(0.05)	18.1		16.1		12.0		9.5		8.5		2.3			

Table 14. Best and worst entries in the 2019-2020 PNUWWSN. Summary statistics are over all entries.

ENTRY	NAME	INC AVG		SEV AVG		IND AVG		FDK AVG		ISK AVG		DON AVG		PC1	FHB1
23	IL16-36206	18.3	l	11.4	l	7.2	l	4.6	l	9.7	l	0.5	l	-4.065	Fhb1
20	IL16-36048	17.0	l	15.8	l	9.2	l	4.8	l	11.7	l	0.8	l	-3.683	Fhb1
21	IL16-8048	24.8	l	15.7	l	8.6	l	4.9	l	11.4	l	0.5	l	-3.438	Fhb1
22	IL16-23972	27.5	l	15.4	l	10.8	l	6.1	l	14.2	l	0.5	l	-2.978	Fhb1
1	TRUMAN	18.9	l	17.4	l	10.6	l	7.7	l	14.6	l	3.5		-2.738	no
29	15VDH-FHB-MAS02-10-2-6-3	26.9	l	19.4	l	9.7	l	13.9	l	15.0	l	1.4	l	-2.670	Fhb1
26	OH16-182-26	20.7	l	13.1	l	10.7	l	14.1		16.9	l	1.9	l	-2.581	Fhb1
32	X12-3049-57-4-3	27.4	l	15.4	l	12.7	l	15.5		18.0	l	1.3	l	-2.188	Fhb1
31	X12-461-32-3-1	32.5	l	17.1	l	9.8	l	22.7		16.5	l	2.8		-1.992	Fhb1
33	X12-839-11-18-5	39.5		20.9	l	12.4	l	13.8	l	15.2	l	2.0	l	-1.876	Fhb1
24	IL16-4364	26.6	l	23.4	l	16.1	l	13.5	l	20.8		1.7	l	-1.785	Fhb1_het
6	15VDH-FHB-MAS31-30	33.8	l	23.0	l	14.4	l	12.9	l	17.2	l	2.7	l	-1.738	Fhb1
25	OH15-131-31	27.8	l	27.3	l	17.1	l	13.3	l	21.6		2.3	l	-1.356	Fhb1
19	KWS319	46.5	h	42.6	h	36.0		19.3		34.2		3.9		1.750	no
16	KWS305	37.1		41.2	h	28.9		22.2		33.1		6.8		1.889	no
28	OH16-168-48	49.1	h	43.2	h	31.2		27.8		33.9		3.5		1.952	no
35	984RE1-57-5	52.8	h	51.1	h	32.3		24.3		32.1		3.9		2.256	Fhb1_het
34	0527A1-9-9-2-4	49.1	h	42.0	h	35.9		26.5		39.1		3.5		2.444	no
15	KWS263	42.2	h	41.5	h	35.9		30.2		40.7		5.0		2.749	no
10	VA18W-54	49.1	h	42.8	h	36.9		27.8		39.0		5.3		2.770	no
27	OH16-167-76	52.3	h	48.8	h	34.1		31.3		37.7		3.2		2.845	no
7	16VDH-SRW03-023	56.3	h	46.7	h	40.2	h	31.0		42.6		4.3		3.571	no
4	PIONEER2545	60.0	h	53.6	h	51.4	h	55.5	h	58.4	h	15.8	h	7.651	no
100	AVERAGE	35.6		30.7		23.4		19.2		27.0		3.4			
101	MINUMUM	17.0		11.4		7.2		4.6		9.7		0.5			
102	MAXIMUM	60.0		53.6		51.4		55.5		58.4		15.8			
103	LSD(0.05)	18.1		16.1		12.0		9.5		8.5		2.3			

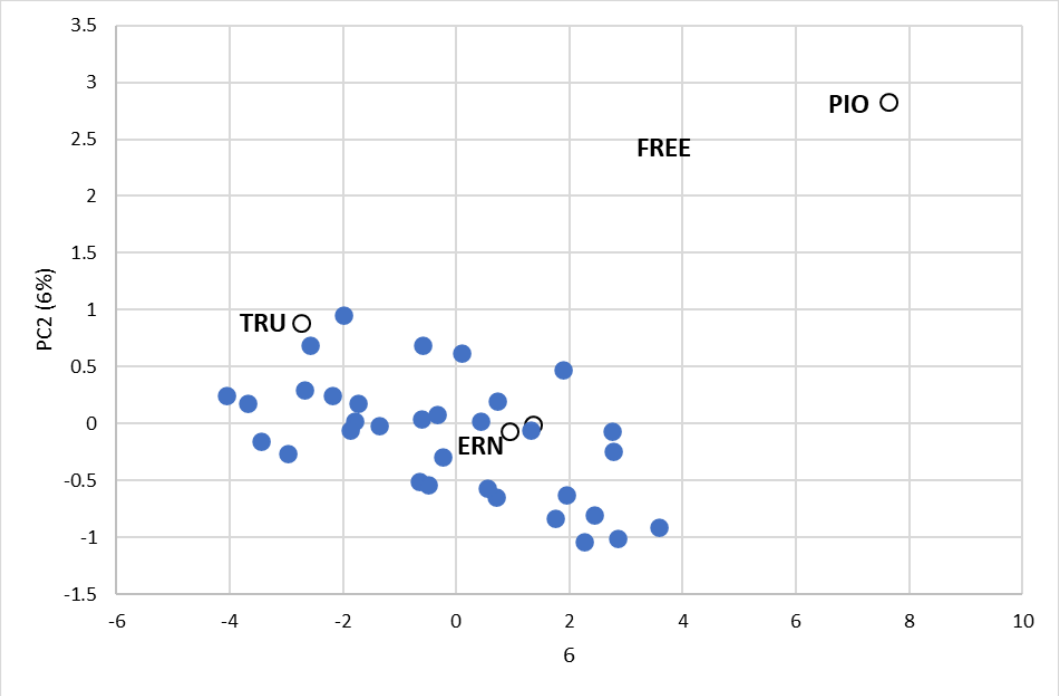

Figure 3. Graph of first two PC from the analysis of the seven FHB traits from the 2019-2020 PNUWWSN. Checks are identified: TRU=Truman (R), FREE=Freedom (MR), ERN=Ernie (MR), PIO=Pioneer 2545 (S).

Table 15. Genomic estimated breeding values (GEBV) of lines in the 2019-2020 NUWWSN. Phenotypic and genotypic data from 2014 through 2019 was used to train the model that was then used to predict the values of the 2020 entries.

ENTRY	NAME	INC	SEV	IND	FDK	ISK	DON	HD	HGT
1	TRUMAN	24.5	11.5	9.0	9.9	13.0	3.0	92.7	38.3
2	ERNIE	31.8	19.6	15.5	16.6	19.5	4.3	88.6	36.1
3	FREEDOM	35.8	18.1	16.0	21.5	22.0	5.2	91.3	35.8
4	PIONEER2545	37.6	25.7	24.2	22.6	24.8	7.1	93.8	35.8
5	15VDH-FHB-MAS10-25	37.7	20.1	17.3	19.6	21.8	5.1	94.0	34.5
6	15VDH-FHB-MAS31-30	35.3	19.7	14.5	17.5	18.9	3.9	93.1	34.3
7	16VDH-SRW03-023								
8	DH15SRW67-151	34.9	19.2	15.1	15.3	18.9	4.8	91.6	32.9
9	12VTK20-102	35.3	23.1	19.0	18.1	20.7	4.2	90.6	34.4
10	VA18W-54	37.4	23.4	20.1	18.5	21.2	5.0	91.7	34.3
11	MI16W0102	30.1	18.7	14.7	17.4	19.1	4.0	91.5	35.5
12	MI17W0121	32.2	22.5	19.7	22.9	24.2	7.4	96.2	37.6
13	MI16R0830	33.6	19.3	17.1	19.1	20.8	6.4	91.1	35.8
14	MI17R0386	27.6	14.1	12.2	10.2	13.9	3.1	93.2	35.3
15	KWS263								
16	KWS305								
17	KWS316	36.3	20.2	17.8	16.0	20.2	4.3	87.2	35.0
18	KWS317	33.3	19.1	17.4	16.4	19.3	4.3	88.4	35.6
19	KWS319	33.7	15.8	14.7	14.5	18.3	3.0	95.3	32.2
20	IL16-36048	24.5	10.4	8.9	8.7	12.6	0.2	95.0	35.4
21	IL16-8048	28.2	15.4	14.6	10.2	15.1	2.2	95.0	34.4
22	IL16-23972	23.2	8.2	7.2	5.5	10.5	0.4	93.8	35.0
23	IL16-36206	24.4	10.0	7.4	9.4	12.1	1.5	96.8	34.1
24	IL16-4364	26.4	11.7	9.0	11.4	13.8	2.4	93.6	35.3
25	OH15-131-31	30.4	19.6	19.0	16.5	20.0	3.7	96.0	35.6
26	OH16-182-26	28.7	14.2	13.1	16.2	17.6	4.0	94.1	34.2
27	OH16-167-76	28.8	12.5	12.1	13.3	15.7	3.0	95.9	34.8
28	OH16-168-48								
29	15VDH-FHB-MAS02-10-2-6-	34.1	17.8	16.0	21.7	21.7	5.6	94.0	34.7
30	X12-862-16-13-5	30.8	17.4	18.2	18.5	20.9	5.2	98.9	34.5
31	X12-461-32-3-1	31.0	13.0	13.7	14.8	18.1	3.3	98.1	33.5
32	X12-3049-57-4-3	29.3	11.6	14.6	16.6	19.8	4.8	103.1	34.7
33	X12-839-11-18-5	29.6	12.7	15.4	18.6	20.7	5.8	102.1	34.3
34	0527A1-9-9-2-4	33.9	10.6	13.6	14.7	14.9	4.3	94.8	33.8
35	984RE1-57-5								
36	09186A1-10-2	29.8	11.1	9.4	14.7	15.6	3.6	93.5	35.5
37	10518RA1-1-6	31.6	16.4	15.1	18.0	18.4	4.3	91.0	35.8

Table 16. Correlation of Genomic estimated breeding values and observed phenotypes of lines in the 2019-2020 PNUWWSN. The correlation was obtained using phenotypes from each environment as well as the average over all environments. Phenotypic data from 2014 through 2019 was used to train the model that was then used to predict the values of the 2020 entries.

	WITH TRAIT	KWS	UIL	LIM	PUR	MSU	OSU	VAT
	AVG	ILCHA	ILURB	INLAF	INWLA	MIMAS	OHWOO	VAWAR
INC	0.56		0.33		0.30	0.53		0.35
SEV	0.51		0.41		0.41	0.46		0.34
IND	0.56	0.57	0.33	0.59	0.45	0.41	0.47	0.38
FDK	0.63	0.54	0.43	0.35			0.48	0.68
ISK	0.44	0.46	0.41	0.48			0.48	0.25
DON	0.54	0.55	0.44				0.55	0.60
HD	-0.40	-0.37		-0.22	-0.17		-0.40	-0.42
HGT	0.71	0.69						0.69

Table 17. Correlation of Genomic estimated breeding values and the average phenotypes of lines in the 2019-2020 PNUWWSN. Phenotypic data from 2014 through 2019 was used to train the model that was then used to predict the values of the 2020 entries.

	INC	SEV	IND	FDK	ISK	DON	HD	HGT	AVG CORR OF GEBV WITH FHB PHENOTYPES
GEBV INC	0.56	0.56	0.59	0.65	0.63	0.57	0.44	-0.07	0.60
GEBV SEV	0.38	0.51	0.54	0.56	0.57	0.63	0.38	0.04	0.54
GEBV IND	0.53	0.55	0.56	0.65	0.60	0.66	0.35	-0.01	0.60
GEBV FDK	0.39	0.41	0.41	0.58	0.46	0.51	0.28	0.06	0.44
GEBV ISK	0.41	0.41	0.43	0.59	0.48	0.56	0.31	-0.01	0.48
GEBV DON	0.45	0.43	0.44	0.62	0.50	0.57	0.36	0.11	0.49
GEBV HD	-0.13	-0.32	-0.36	-0.14	-0.35	-0.22	-0.42	-0.28	-0.26
GEBV HGT	-0.13	0.03	0.03	0.00	0.05	0.19	0.24	0.71	0.00

Table 18. Summary of incidence (INC, %) from 2019-2020 NUWWSN.

ENTRY	NAME	AVG		ILURB	INWLA*	MIMAS	NEMEA	NYITH	VAWAR	GEBV
1	TRUMAN	22.5	l	10.0	7.5	10.4	7.0	50.0	50.0	24.5
2	ERNIE	40.5		72.0	21.3	10.2	43.0	56.3	40.0	31.8
3	FREEDOM	39.9		45.0	11.3	25.2	8.0	75.0	75.0	35.8
4	PIONEER2545	62.5	h	83.0	27.5	45.9	56.0	92.5	70.0	37.6
5	DH13SRW022-23NUE	35.4		48.0	6.3	10.0	8.0	75.0	65.0	33.0
6	VA17W-75	42.6		73.0	10.0	23.3	18.0	81.3	50.0	.
7	15VDH-FHB-MAS33-13	28.1	l	22.0	10.0	10.0	3.0	88.8	35.0	.
8	15VTK-12-21	45.9		72.0	15.0	6.7	7.0	100.0	75.0	31.5
9	16VDH-SRW05-205	40.5		72.0	6.3	16.7	7.0	96.3	45.0	.
10	MI17R0325	28.7	l	47.0	15.0	5.0	10.0	50.0	45.0	29.0
11	MI17R0415	34.7		60.0	15.0	5.0	13.0	80.0	35.0	28.2
12	MI16R0682	33.6	l	65.0	16.3	20.0	0.0	45.0	55.0	34.7
13	MI17R0311	46.7		73.0	20.0	25.0	12.0	85.0	65.0	27.9
14	KWS246	40.3		67.0	15.0	23.3	3.0	88.8	45.0	.
15	KWS280	48.5	h	63.0	17.5	34.5	12.0	98.8	65.0	33.1
16	KWS283	34.6		45.0	8.8	21.4	20.0	57.5	55.0	34.4
17	KWS291	49.4	h	67.0	16.3	19.1	24.0	100.0	70.0	26.3
18	KWS333	34.8		80.0	12.5	22.9	7.0	61.3	25.0	.
19	NY12512-1-6-17	34.9		15.0	10.0	35.0	12.0	77.5	60.0	35.1
20	NY12397-1-4-13	36.1		53.0	13.8	13.3	33.0	48.8	55.0	36.2
21	NY99056-161	28.6	l	15.0	6.3	25.0	12.0	58.3	55.0	33.8
22	NY12299-1-3-20	36.4		42.0	11.3	21.7	31.0	62.5	50.0	32.9
23	NY12508-1-7-15	33	l	23.0	13.8	30.0	13.0	58.3	60.0	36.1
24	IL15-27666	25.1	l	45.0	12.5	4.3	0.0	73.8	15.0	24.4
25	IL15-26131	21.9	l	28.0	12.5	3.7	7.0	25.0	55.0	31.3
26	IL15-4957	26	l	67.0	10.0	3.0	0.0	46.3	30.0	29.0
27	IL13-1960	27.8	l	65.0	12.5	8.3	0.0	61.3	20.0	28.4
28	IL15-2639	29.9	l	47.0	13.8	12.0	8.0	63.8	35.0	28.0
29	OH14-112-34	29.1	l	23.0	2.5	14.9	17.0	82.5	35.0	27.4
30	OH14-222-49	36.5		62.0	26.3	14.0	19.0	52.5	45.0	29.9
31	OH15-191-52	40.8		58.0	10.0	24.0	13.0	95.0	45.0	31.1
32	OH15-42-1	40.9		60.0	12.5	22.4	18.0	82.5	50.0	32.1
33	KY07C-1145-94-12-5	45.8		62.0	10.0	35.9	22.0	75.0	70.0	34.8
34	15VDH-FHB-MAS32-07-30-12-5	29.6	l	57.0	7.5	5.0	7.0	56.3	45.0	33.5
35	X12-323-61-4-5	32.2	l	70.0	8.8	6.7	3.0	90.0	15.0	30.2
36	X12-072-3-17-5	25.2	l	43.0	5.0	18.3	0.0	70.0	15.0	31.9
37	X12-156-9-9-3	32.5	l	63.0	8.8	21.7	10.0	81.3	10.0	31.9
38	NE-14-494	40.2		30.0	6.3	23.3	23.0	93.8	65.0	35.4
39	NE-14-696	50.2	h	72.0	12.5	35.0	24.0	87.5	70.0	36.1
40	NE-15-624	49.9	h	58.0	5.0	31.7	26.0	98.8	80.0	34.8
41	NE-17-589	40		48.0	18.8	23.3	18.0	66.7	65.0	34.8
42	NW-13-493	36.8		33.0	2.5	33.3	13.0	58.8	80.0	34.6
43	LES18-0685	64.2	h	83.0	38.8	31.7	67.0	95.0	70.0	35.7
44	LES18-7031	38.9		45.0	5.0	16.7	17.0	75.0	75.0	31.9
45	LES18-1653	35.8		78.0	10.0	6.7	40.0	65.0	15.0	34.5
46	LES172093	40.5		62.0	13.8	5.0	47.0	70.0	45.0	.
47	10534A1-17-17	17.6	l	38.0	13.8	10.0	7.0	21.7	15.0	33.2
48	10524A1-18-1	21.4	l	23.0	3.8	5.0	13.0	33.8	50.0	30.4
49	04620A1-1-7-4-13	24.1	l	23.0	12.5	10.0	8.0	36.3	55.0	30.5
50	08344B-1-1	35.5		60.0	21.3	6.0	3.0	72.5	50.0	29.6
100	AVERAGE	36.3		52.3	12.5	17.8	15.8	70.3	49.3	.
101	MINUMUM	17.6		10.0	2.5	3.0	0.0	21.7	10.0	.
102	MAXIMUM	64.2		83.0	38.8	45.9	67.0	100.0	80.0	.
103	LSD(0.05)	16.0		.	.	.	.	.	.	.

Table 19. Summary of severity (SEV, %) data from the 2019-2020 NUWWSN

ENTRY	NAME	AVG		ILURB	INWLA	MIMAS	NEMEA	NYITH	VAWAR	GEBV
1	TRUMAN	18.9	l	13.0	12.5	6.8	23.0	13.3	45.0	11.5
2	ERNIE	29.3		74.0	12.5	16.0	20.0	18.3	35.0	19.6
3	FREEDOM	31.7		46.0	15.0	18.9	23.0	22.5	65.0	18.1
4	PIONEER2545	53.1	h	79.0	47.5	44.6	27.0	50.8	70.0	25.7
5	DH13SRW022-23NUE	25.4		47.0	7.5	16.7	13.0	23.0	45.0	18.8
6	VA17W-75	30.2		72.0	17.5	16.7	13.0	22.3	40.0	.
7	15VDH-FHB-MAS33-13	15.9	l	21.0	10.0	11.7	7.0	16.0	30.0	.
8	15VTK-12-21	32.8		61.0	15.0	10.0	10.0	36.0	65.0	16.4
9	16VDH-SRW05-205	24.8		53.0	6.3	11.7	7.0	36.0	35.0	.
10	MI17R0325	18.3	l	33.0	12.5	6.7	10.0	12.8	35.0	14.4
11	MI17R0415	24.5		71.0	12.5	6.7	3.0	18.7	35.0	16.9
12	MI16R0682	24.7		61.0	15.0	10.0	0.0	12.0	50.0	17.0
13	MI17R0311	28.3		47.0	21.3	16.7	13.0	26.8	45.0	13.8
14	KWS246	30.0		72.0	21.3	15.0	3.0	33.5	35.0	.
15	KWS280	36.7		62.0	30.0	18.9	10.0	39.3	60.0	21.2
16	KWS283	25.0		53.0	6.3	21.0	3.0	16.5	50.0	20.4
17	KWS291	37.4		65.0	13.8	16.3	30.0	39.3	60.0	11.0
18	KWS333	25.9		60.0	23.8	23.9	10.0	17.5	20.0	.
19	NY12512-1-6-17	23.9		21.0	15.0	11.7	17.0	23.5	55.0	21.4
20	NY12397-1-4-13	27.1		57.0	8.8	13.3	17.0	16.5	50.0	19.8
21	NY99056-161	25.0		47.0	6.3	16.7	17.0	18.3	45.0	22.3
22	NY12299-1-3-20	24.9		51.0	8.8	13.3	17.0	19.3	40.0	16.9
23	NY12508-1-7-15	27.7		37.0	12.5	26.7	30.0	15.0	45.0	20.0
24	IL15-27666	11.6	l	21.0	11.3	3.7	0.0	18.5	15.0	8.7
25	IL15-26131	17.0	l	26.0	18.8	7.2	7.0	12.8	30.0	14.6
26	IL15-4957	21.1	l	54.0	15.0	7.9	0.0	14.5	35.0	15.8
27	IL13-1960	21.3	l	72.0	13.8	15.0	0.0	12.0	15.0	14.3
28	IL15-2639	15.8	l	22.0	16.3	12.2	7.0	12.5	25.0	12.0
29	OH14-112-34	19.0	l	38.0	2.5	12.2	7.0	24.5	30.0	13.9
30	OH14-222-49	34.3		76.0	26.3	13.7	20.0	19.5	50.0	17.6
31	OH15-191-52	31.4		57.0	20.0	16.3	17.0	33.3	45.0	20.7
32	OH15-42-1	32.4		52.0	10.0	19.5	17.0	41.0	55.0	20.1
33	KY07C-1145-94-12-5	35.6		57.0	23.8	25.6	33.0	19.5	55.0	17.1
34	15VDH-FHB-MAS32-07-30-12-5	17.0	l	24.0	10.0	5.0	13.0	14.8	35.0	18.1
35	X12-323-61-4-5	22.1	l	47.0	33.8	5.0	10.0	22.0	15.0	13.0
36	X12-072-3-17-5	18.0	l	30.0	20.0	13.3	0.0	19.5	25.0	12.2
37	X12-156-9-9-3	13.0	l	21.0	6.3	10.0	17.0	14.0	10.0	13.1
38	NE-14-494	29.5		59.0	3.8	23.3	13.0	37.8	40.0	22.4
39	NE-14-696	41.8	h	77.0	17.5	31.7	23.0	46.9	55.0	21.0
40	NE-15-624	40.4		68.0	8.8	23.3	27.0	55.3	60.0	22.4
41	NE-17-589	37.0		71.0	27.5	23.3	17.0	33.3	50.0	23.1
42	NW-13-493	32.3		74.0	2.5	18.3	13.0	25.8	60.0	24.6
43	LES18-0685	43.1	h	77.0	37.5	36.7	17.0	35.5	55.0	22.8
44	LES18-7031	25.1		37.0	17.5	18.3	3.0	19.5	55.0	16.5
45	LES18-1653	26.0		72.0	20.0	13.3	10.0	15.5	25.0	19.9
46	LES172093	24.2		56.0	11.3	11.7	17.0	19.3	30.0	.
47	10534A1-17-17	11.2	l	15.0	8.8	8.3	10.0	10.3	15.0	13.6
48	10524A1-18-1	14.2	l	24.0	3.8	6.7	10.0	11.0	30.0	13.1
49	04620A1-1-7-4-13	20.8	l	37.0	7.5	8.3	20.0	11.8	40.0	10.9
50	08344B-1-1	18.7	l	25.0	10.0	10.0	7.0	20.0	40.0	12.2
100	AVERAGE	26.3		49.8	15.1	15.4	13.2	23.3	41.0	.
101	MINUMUM	11.2		13.0	2.5	3.7	0.0	10.3	10.0	.
102	MAXIMUM	53.1		79.0	47.5	44.6	33.0	55.3	70.0	.
103	LSD(0.05)	11.5		.	.	.	.	.	.	.

Table 20. Summary of index (IND, %) data from the 2019-2020 NUWWSN.

ENTRY	NAME	AVG		ILCHA	ILURB	INLAF*	INWLA	MIMAS	NEMEA	NYITH	OHWOO	VAWAR	GEBV
1	TRUMAN	10.1	l	8.0	1.0	35.0	0.9	1.0	3.0	6.5	12.2	23.0	9.0
2	ERNIE	25.8		43.0	53.0	70.0	2.7	1.0	6.0	10.8	23.3	22.0	15.5
3	FREEDOM	23.3		28.0	21.0	60.0	1.7	5.0	3.0	17.2	25.5	48.0	16.0
4	PIONEER2545	48.2	h	85.0	68.0	80.0	13.1	21.0	12.0	47.7	58.0	49.0	24.2
5	DH13SRW022-23NUE	19.4		18.0	23.0	75.0	0.5	2.0	2.0	17.2	7.2	30.0	15.0
6	VA17W-75	25.9		40.0	53.0	80.0	1.8	4.0	2.0	19.1	11.1	22.0	
7	15VDH-FHB-MAS33-13	9.7	l	13.0	5.0	30.0	1.0	1.0	1.0	14.3	10.6	11.0	
8	15VTK-12-21	25.5		30.0	43.0	55.0	2.3	1.0	1.0	36.0	12.2	49.0	16.6
9	16VDH-SRW05-205	20.6		20.0	38.0	50.0	0.4	2.0	1.0	34.6	23.3	16.0	
10	MI17R0325	11.1	l	23.0	15.0	30.0	1.9	0.0	2.0	6.2	6.1	16.0	11.6
11	MI17R0415	18.4		35.0	43.0	40.0	1.9	0.0	1.0	15.3	16.1	13.0	13.3
12	MI16R0682	18.2		30.0	42.0	40.0	2.4	2.0	0.0	5.7	12.8	29.0	13.8
13	MI17R0311	24.7		50.0	35.0	55.0	4.3	5.0	2.0	23.9	18.3	29.0	12.3
14	KWS246	28.5		58.0	48.0	80.0	3.2	4.0	0.0	30.2	17.3	16.0	
15	KWS280	31.3		55.0	40.0	70.0	5.3	8.0	2.0	38.8	23.9	39.0	16.5
16	KWS283	19.5		38.0	25.0	45.0	0.5	6.0	2.0	9.7	21.7	28.0	16.7
17	KWS291	30.9		43.0	43.0	60.0	2.2	4.0	6.0	39.3	38.3	42.0	7.3
18	KWS333	16.9		10.0	47.0	60.0	3.0	7.0	1.0	11.0	8.4	5.0	
19	NY12512-1-6-17	17.8		38.0	3.0	55.0	1.5	4.0	2.0	18.3	4.4	34.0	17.0
20	NY12397-1-4-13	20.6		35.0	31.0	50.0	1.2	2.0	6.0	7.9	21.1	31.0	17.6
21	NY99056-161	16.3		18.0	8.0	60.0	0.4	5.0	2.0	11.3	16.7	25.0	18.5
22	NY12299-1-3-20	16.1		18.0	22.0	55.0	1.0	3.0	7.0	13.0	5.5	20.0	14.2
23	NY12508-1-7-15	15.9		23.0	9.0	50.0	1.7	8.0	4.0	9.0	10.5	28.0	15.8
24	IL15-27666	9.3	l	8.0	11.0	25.0	1.4	0.0	0.0	13.9	21.1	3.0	7.4
25	IL15-26131	7.4	l	5.0	7.0	25.0	2.3	1.0	1.0	3.1	4.4	18.0	11.2
26	IL15-4957	11.7	l	10.0	36.0	35.0	1.5	0.0	0.0	7.0	6.1	10.0	13.4
27	IL13-1960	16.8		18.0	47.0	60.0	1.7	1.0	0.0	7.4	11.7	4.0	11.2
28	IL15-2639	9.0	l	5.0	10.0	35.0	2.2	2.0	2.0	8.2	7.2	9.0	8.1
29	OH14-112-34	13.2	l	18.0	9.0	50.0	0.1	2.0	2.0	22.4	5.5	10.0	12.0
30	OH14-222-49	21.9		30.0	48.0	55.0	6.9	3.0	4.0	10.1	16.7	23.0	15.1
31	OH15-191-52	24.2		35.0	34.0	70.0	2.0	5.0	2.0	31.9	16.7	21.0	19.6
32	OH15-42-1	25.1		38.0	32.0	65.0	1.3	5.0	4.0	33.9	18.9	28.0	19.5
33	KY07C-1145-94-12-5	25.0		50.0	36.0	40.0	2.4	10.0	7.0	14.3	26.5	39.0	14.1
34	15VDH-FHB-MAS32-07-30-12-5	11.0	l	8.0	13.0	40.0	0.8	0.0	1.0	10.0	10.6	16.0	13.3
35	X12-323-61-4-5	12.2	l	5.0	32.0	35.0	3.0	0.0	1.0	20.0	12.2	2.0	14.3
36	X12-072-3-17-5	10.4	l	5.0	14.0	40.0	1.0	3.0	0.0	14.4	12.2	4.0	12.5
37	X12-156-9-9-3	8.3	l	5.0	12.0	30.0	0.5	2.0	2.0	11.4	10.6	1.0	16.2
38	NE-14-494	27.8		50.0	18.0	60.0	0.2	6.0	5.0	35.7	48.9	26.0	19.6
39	NE-14-696	40.2	h	83.0	55.0	80.0	2.2	11.0	7.0	42.5	38.9	42.0	17.7
40	NE-15-624	40.6	h	88.0	41.0	80.0	0.4	8.0	7.0	54.7	38.3	48.0	19.1
41	NE-17-589	29.9		53.0	34.0	80.0	5.2	7.0	3.0	24.2	30.0	33.0	18.7
42	NW-13-493	28.2		50.0	25.0	80.0	0.1	7.0	3.0	16.7	24.4	48.0	18.8
43	LES18-0685	39.9	h	65.0	65.0	80.0	14.5	14.0	11.0	33.8	37.1	39.0	19.6
44	LES18-7031	20.2		33.0	16.0	55.0	0.9	3.0	2.0	15.0	14.8	42.0	14.4
45	LES18-1653	27.4		60.0	56.0	80.0	2.0	1.0	4.0	10.1	29.8	4.0	15.6
46	LES172093	20.3		35.0	34.0	50.0	1.5	1.0	8.0	14.7	24.4	14.0	.
47	10534A1-17-17	5.7	l	5.0	6.0	25.0	1.2	1.0	1.0	2.0	7.2	3.0	12.2
48	10524A1-18-1	9.5	l	10.0	5.0	40.0	0.1	0.0	1.0	4.0	9.5	16.0	12.0
49	04620A1-1-7-4-13	10.5	l	13.0	9.0	30.0	0.9	1.0	3.0	4.7	8.9	24.0	12.4
50	08344B-1-1	10.5	l	5.0	15.0	20.0	2.1	1.0	1.0	15.4	13.3	22.0	12.2
100	AVERAGE	20.2		31.0	28.7	53.0	2.3	3.8	3.0	18.5	18.2	23.5	.
101	MINUMUM	5.7		5.0	1.0	20.0	0.1	0.0	0.0	2.0	4.4	1.0	.
102	MAXIMUM	48.2		88.0	68.0	80.0	14.5	21.0	12.0	54.7	58.0	49.0	.
103	LSD(0.05)	9.7		.	.	.	.	.	.	.	.	.	.
				* indicates a value converted to % from a 0-9 scoring									

Table 21. Summary of Fusarium Damaged Kernel (FDK, %) data from the 2019-2020 NUWWSN.

ENTRY	NAME	AVG		ILCHA	ILURB	INLAF	NEMEA	NYITH	OHWOO	VAWAR	GEBV
1	TRUMAN	8.4	l	2.0	5.3	5.0	1.0	20.0	14.0	11.5	9.9
2	ERNIE	25.5		12.5	38.3	30.0	2.0	60.0	22.5	13.5	16.6
3	FREEDOM	35.4		10.0	35.0	60.0	3.0	60.0	45.0	35.0	21.5
4	PIONEER2545	55.7	h	40.0	66.7	70.0	11.0	90.0	67.5	45.0	22.6
5	DH13SRW022-23NUE	21.1		2.5	23.3	20.0	2.0	50.0	25.0	25.0	13.3
6	VA17W-75	24.2		10.0	28.3	30.0	7.0	50.0	30.0	14.0	.
7	15VDH-FHB-MAS33-13	15.5	l	3.5	10.0	35.0	4.0	30.0	17.5	8.5	.
8	15VTK-12-21	25.1		10.0	25.0	25.0	1.0	60.0	25.0	30.0	14.1
9	16VDH-SRW05-205	35.8		10.0	45.0	30.0	3.0	90.0	32.5	40.0	.
10	MI17R0325	9.0	l	2.0	1.0	10.0	0.0	20.0	20.0	10.0	13.0
11	MI17R0415	20.8		2.5	8.3	20.0	1.0	70.0	32.5	11.5	13.3
12	MI16R0682	20.4		12.5	20.0	30.0	4.0	40.0	15.0	21.5	12.6
13	MI17R0311	22.4		7.5	15.0	30.0	2.0	60.0	22.5	20.0	12.6
14	KWS246	39.7		20.0	30.0	40.0	3.0	70.0	67.5	47.5	.
15	KWS280	36.7		15.0	53.3	30.0	1.0	90.0	37.5	30.0	16.4
16	KWS283	23.0		7.5	16.7	30.0	0.0	60.0	22.5	24.0	18.0
17	KWS291	29.8		15.0	31.7	20.0	2.0	80.0	32.5	27.5	10.6
18	KWS333	26.4		5.0	31.7	30.0	1.0	80.0	25.0	12.0	.
19	NY12512-1-6-17	17.4		10.0	15.0	25.0	7.0	20.0	15.0	30.0	17.6
20	NY12397-1-4-13	15.9	l	5.0	7.0	25.0	2.0	40.0	17.5	15.0	15.8
21	NY99056-161	22.1		7.5	5.0	25.0	10.0	50.0	22.5	35.0	19.5
22	NY12299-1-3-20	28.6		5.0	35.0	25.0	8.0	60.0	42.5	25.0	14.5
23	NY12508-1-7-15	17.4		5.0	18.3	25.0	1.0	50.0	7.5	15.0	17.5
24	IL15-27666	10.5	l	0.0	11.7	15.0	0.0	30.0	12.5	4.0	9.8
25	IL15-26131	5.6	l	1.0	8.7	10.0	0.0	10.0	5.0	4.5	8.1
26	IL15-4957	5.8	l	3.5	5.3	10.0	0.0	10.0	7.5	4.0	10.7
27	IL13-1960	15.4	l	3.5	13.3	25.0	0.0	40.0	12.5	13.5	12.0
28	IL15-2639	6.2	l	0.0	3.7	5.0	0.0	20.0	6.5	8.0	7.0
29	OH14-112-34	22.3		1.0	41.7	15.0	1.0	70.0	12.5	15.0	14.8
30	OH14-222-49	20.5		7.5	26.7	20.0	2.0	50.0	22.5	15.0	10.9
31	OH15-191-52	27.9		15.0	38.3	20.0	2.0	70.0	32.5	17.5	18.3
32	OH15-42-1	31.5		15.0	40.0	30.0	4.0	80.0	40.0	11.5	18.0
33	KY07C-1145-94-12-5	17.0		10.0	18.3	15.0	2.0	40.0	20.0	13.5	13.4
34	15VDH-FHB-MAS32-07-30-12-	14.0	l	6.0	11.7	20.0	0.0	40.0	7.5	12.5	18.1
35	X12-323-61-4-5	16.4	l	2.5	15.0	20.0	3.0	50.0	15.0	9.0	15.9
36	X12-072-3-17-5	15.5	l	3.5	15.0	15.0	0.0	50.0	15.0	10.0	13.8
37	X12-156-9-9-3	17.2		3.5	13.3	25.0	5.0	50.0	15.0	8.5	17.9
38	NE-14-494	42.5		30.0	26.7	30.0	6.0	90.0	55.0	60.0	18.6
39	NE-14-696	47.5		42.5	56.7	30.0	11.0	70.0	67.5	55.0	17.6
40	NE-15-624	63.6	h	42.5	70.0	95.0	23.0	90.0	60.0	65.0	23.7
41	NE-17-589	28.6		15.0	33.3	20.0	7.0	50.0	40.0	35.0	18.2
42	NW-13-493	33.4		10.0	25.0	30.0	4.0	70.0	50.0	45.0	18.2
43	LES18-0685	33.2		17.5	60.0	30.0	6.0	70.0	22.5	26.5	15.8
44	LES18-7031	24.2		10.0	15.0	20.0	7.0	70.0	15.0	32.5	14.2
45	LES18-1653	21.5		10.0	21.7	20.0	5.0	70.0	10.0	13.5	18.1
46	LES172093	19.5		6.0	8.7	15.0	11.0	60.0	15.0	21.0	.
47	10534A1-17-17	5.7	l	2.0	1.0	10.0	4.0	10.0	5.0	8.0	15.7
48	10524A1-18-1	13.7	l	7.5	15.0	20.0	11.0	20.0	10.0	12.5	16.2
49	04620A1-1-7-4-13	11.7	l	3.5	3.7	25.0	5.0	20.0	12.5	12.5	12.9
50	08344B-1-1	23.2		1.0	10.0	30.0	3.0	90.0	17.5	11.0	14.0
100	AVERAGE	23.4		9.8	23.5	25.8	4.0	53.8	25.3	21.8	.
101	MINUMUM	5.6		0.0	1.0	5.0	0.0	10.0	5.0	4.0	.
102	MAXIMUM	63.6		42.5	70.0	95.0	23.0	90.0	67.5	65.0	.
103	LSD(0.05)	11.2		.	.	.	.	.	.	.	.

Table 22. Summary of INC/SEV/FDK (ISK, %) data from the 2019-2020 NUWWSN

ENTRY	NAME	AVG		ILCHA	ILURB	NEMEA	NYITH	OHWOO	VAWAR	GEBV
1	TRUMAN	15.3	l	5.3	8.9	9.4	27.0	12.9	28.5	13.0
2	ERNIE	33.6		30.5	59.2	19.7	46.4	23.0	22.6	19.5
3	FREEDOM	33.5		20.5	41.4	10.5	53.3	33.3	42.1	22.0
4	PIONEER2545	59.1	h	67.0	75.3	29.3	79.0	61.8	42.2	24.8
5	DH13SRW022-23NUE	25.6		11.5	37.9	7.1	49.4	14.3	33.1	17.2
6	VA17W-75	32.0		28.0	54.9	12.1	51.1	18.7	27.1	.
7	15VDH-FHB-MAS33-13	17.8	l	8.9	16.9	4.6	43.4	13.4	19.5	.
8	15VTK-12-21	33.6		22.0	49.8	5.5	64.8	17.3	42.1	18.7
9	16VDH-SRW05-205	34.0		16.0	55.4	5.4	75.7	27.0	24.2	.
10	MI17R0325	17.9	l	14.3	24.4	6.0	26.8	11.7	24.0	15.2
11	MI17R0415	28.5		22.0	42.5	5.2	57.6	22.7	21.0	15.8
12	MI16R0682	24.8		23.0	45.9	1.6	33.1	13.7	31.6	17.0
13	MI17R0311	32.3		33.0	41.9	8.3	57.5	20.0	33.1	15.2
14	KWS246	37.6		42.5	53.6	3.0	64.7	37.4	24.2	.
15	KWS280	41.5		39.0	58.8	7.0	77.4	29.3	37.6	18.7
16	KWS283	28.0		25.5	36.0	6.9	46.2	22.0	31.6	19.0
17	KWS291	41.6		31.5	52.2	17.0	73.8	36.0	39.1	13.3
18	KWS333	25.4		8.0	54.5	5.5	55.6	15.0	13.5	.
19	NY12512-1-6-17	22.7		26.5	16.9	11.5	38.3	8.6	34.6	21.4
20	NY12397-1-4-13	26.9		23.0	35.7	15.8	35.6	19.7	31.6	20.3
21	NY99056-161	23.1		13.5	20.5	12.7	43.0	19.0	30.1	21.5
22	NY12299-1-3-20	28.0		12.5	41.9	17.6	48.5	20.3	27.1	17.3
23	NY12508-1-7-15	22.8		15.5	25.2	13.3	42.0	9.3	31.6	21.4
24	IL15-27666	15.9	l	4.5	24.6	0.0	39.7	17.7	9.0	12.2
25	IL15-26131	12.1	l	3.4	19.7	4.2	15.3	4.6	25.5	14.1
26	IL15-4957	15.7	l	7.4	38.6	0.0	22.2	6.7	19.5	15.3
27	IL13-1960	19.8		11.9	46.4	0.0	38.0	12.0	10.6	15.1
28	IL15-2639	14.3	l	3.0	22.2	4.5	30.9	6.9	18.0	13.1
29	OH14-112-34	23.6		10.9	34.8	7.6	60.1	8.3	19.6	16.6
30	OH14-222-49	29.2		21.0	52.2	12.5	41.6	19.0	28.6	16.8
31	OH15-191-52	33.9		27.0	49.9	9.8	66.5	23.0	27.1	21.2
32	OH15-42-1	36.4		28.5	49.7	12.1	69.1	27.3	31.5	21.2
33	KY07C-1145-94-12-5	33.3		34.0	42.9	17.3	44.4	23.9	37.6	17.2
34	15VDH-FHB-MAS32-07-30-12-	18.8	l	6.9	29.0	6.0	37.3	9.4	24.1	18.7
35	X12-323-61-4-5	21.0		4.0	41.0	5.1	53.6	13.3	9.0	19.1
36	X12-072-3-17-5	17.4	l	4.4	28.0	0.0	46.9	13.3	12.0	17.4
37	X12-156-9-9-3	18.7	l	4.4	30.5	10.1	48.6	12.4	6.0	20.2
38	NE-14-494	41.8		42.0	37.2	13.2	75.5	51.3	31.7	20.0
39	NE-14-696	51.4	h	66.5	67.3	18.5	68.3	50.3	37.7	20.1
40	NE-15-624	55.3	h	69.5	65.9	25.1	82.2	47.0	42.3	22.8
41	NE-17-589	36.4		37.5	49.1	13.3	50.0	34.0	34.6	20.6
42	NW-13-493	35.9		34.0	42.0	9.4	53.4	34.6	42.2	19.7
43	LES18-0685	47.0		46.0	72.1	27.6	67.2	31.3	37.6	20.3
44	LES18-7031	28.9		23.5	30.5	8.8	56.4	14.9	39.1	17.9
45	LES18-1653	32.8		40.0	53.7	17.0	52.2	21.9	12.1	20.0
46	LES172093	30.0		23.4	38.7	23.6	50.8	20.6	22.6	.
47	10534A1-17-17	9.3	l	3.8	16.2	6.7	13.6	6.3	9.0	16.5
48	10524A1-18-1	16.0	l	9.0	20.2	11.3	21.4	9.7	24.1	16.9
49	04620A1-1-7-4-13	16.7	l	8.9	19.4	10.4	22.4	10.3	28.6	14.9
50	08344B-1-1	23.8		3.4	29.5	4.2	63.8	15.0	27.0	16.1
100	AVERAGE	28.4		22.4	40.0	10.3	49.6	21.0	27.2	.
101	MINUMUM	9.3		3.0	8.9	0.0	13.6	4.6	6.0	.
102	MAXIMUM	59.1		69.5	75.3	29.3	82.2	61.8	42.3	.
103	LSD(0.05)	10.3		.	.	.	.	.	.	.

Table 23. Summary of deoxynivalenol (DON, ppm) data from the 2019-2020 NUWWSN.

ENTRY	NAME	AVG		ILCHA	ILURB	NEMEA	NYITH	OHWOO	VAWAR	GEBV
1	TRUMAN	3.7	l	0.5	0.6	0.5	10.5	8.7	1.4	3.0
2	ERNIE	5.0	l	1.9	3.2	1.3	15.2	7.4	1.1	4.3
3	FREEDOM	7.1		1.5	3.0	1.6	19.1	15.4	2.1	5.2
4	PIONEER2545	15.0	h	10.1	18.5	2.1	37.9	16.6	4.7	7.1
5	DH13SRW022-23NUE	4.4	l	0.4	2.3	1.4	15.4	5.4	1.6	3.8
6	VA17W-75	6.4		1.6	2.9	1.2	25.2	6.9	0.9	.
7	15VDH-FHB-MAS33-13	3.8	l	1.0	3.0	0.4	13.4	4.7	0.6	.
8	15VTK-12-21	6.9		2.2	5.8	0.2	19.5	10.3	3.3	2.4
9	16VDH-SRW05-205	7.4		3.2	7.4	0.6	21.1	8.2	4.0	.
10	MI17R0325	1.7	l	0.4	1.0	0.1	5.0	3.2	0.5	2.7
11	MI17R0415	6.2		0.3	2.8	0.3	21.2	11.3	1.3	4.2
12	MI16R0682	4.2	l	1.2	2.8	0.1	13.1	6.5	1.5	3.8
13	MI17R0311	5.5		0.9	3.0	0.2	22.3	5.1	1.6	3.8
14	KWS246	10.0		1.7	6.1	2.1	31.0	16.9	2.2	.
15	KWS280	10.1		3.2	5.6	0.6	31.8	16.4	3.1	4.5
16	KWS283	6.3		1.3	2.5	0.8	21.9	10.4	1.2	5.2
17	KWS291	6.3		2.7	2.7	1.5	19.3	9.3	2.1	3.7
18	KWS333	5.5		0.4	2.6	0.2	23.0	5.9	0.9	.
19	NY12512-1-6-17	10.4		3.3	3.0	10.6	15.6	25.7	4.0	6.0
20	NY12397-1-4-13	6.1		2.5	2.3	0.9	16.7	12.0	2.0	4.9
21	NY99056-161	9.3		3.1	1.6	8.3	20.9	15.3	6.8	6.1
22	NY12299-1-3-20	5.9		0.7	2.2	5.7	14.8	10.5	1.5	4.5
23	NY12508-1-7-15	6.3		0.7	2.2	0.2	18.8	14.1	1.6	5.8
24	IL15-27666	3.6	l	0.2	1.6	0.3	14.6	4.5	0.4	1.2
25	IL15-26131	2.0	l	0.3	1.0	0.1	7.7	1.9	0.8	1.1
26	IL15-4957	2.0	l	0.5	0.8	0.1	7.3	3.0	0.6	2.2
27	IL13-1960	4.3	l	1.3	3.0	0.1	13.0	7.0	1.3	2.7
28	IL15-2639	3.5	l	0.3	1.3	0.2	12.7	6.1	0.5	1.2
29	OH14-112-34	6.1		0.6	2.0	0.3	27.4	5.3	0.9	3.3
30	OH14-222-49	5.2	l	1.8	3.6	0.3	16.6	7.0	1.9	2.6
31	OH15-191-52	6.3		2.7	3.4	0.3	17.3	13.0	1.0	4.2
32	OH15-42-1	7.2		3.9	3.1	0.4	17.8	16.4	1.6	4.1
33	KY07C-1145-94-12-5	6.7		1.4	3.4	9.3	16.7	8.2	1.1	2.9
34	)H-FHB-MAS32-07-30-12-	3.8	l	1.2	2.2	0.1	16.3	1.9	1.0	4.5
35	X12-323-61-4-5	5.4	l	1.2	2.7	0.5	22.5	4.8	0.7	4.4
36	X12-072-3-17-5	4.0	l	1.3	2.2	0.3	15.5	4.1	0.8	3.7
37	X12-156-9-9-3	3.5	l	0.6	3.7	0.7	12.0	3.4	0.4	5.3
38	NE-14-494	12.7	h	6.9	5.0	1.7	38.9	19.5	4.3	5.3
39	NE-14-696	12.7	h	13.7	11.9	4.8	20.1	19.9	5.7	5.5
40	NE-15-624	16.4	h	11.1	15.2	10.8	35.8	18.5	7.3	8.1
41	NE-17-589	6.9		2.0	3.6	2.5	17.9	11.1	4.4	5.3
42	NW-13-493	7.9		2.6	5.5	2.3	22.6	10.0	4.5	5.2
43	LES18-0685	8.0		4.2	6.9	3.8	22.9	9.1	1.2	3.4
44	LES18-7031	5.5		1.7	1.6	1.4	19.5	7.2	1.8	3.6
45	LES18-1653	5.1	l	1.5	2.4	0.3	20.2	5.6	0.9	4.6
46	LES172093	4.2	l	1.1	1.9	0.1	16.7	4.5	1.1	.
47	10534A1-17-17	1.5	l	0.5	0.6	0.3	5.0	2.0	0.4	4.2
48	10524A1-18-1	2.9	l	1.3	1.3	1.8	3.7	8.1	1.0	3.5
49	04620A1-1-7-4-13	3.1	l	0.7	0.8	1.6	7.7	6.5	1.3	4.1
50	08344B-1-1	5.1	l	0.8	1.5	0.1	23.0	4.6	0.7	3.3
100	AVERAGE	6.2		2.2	3.6	1.7	18.5	9.2	1.9	.
101	MINUMUM	1.5		0.2	0.6	0.1	3.7	1.9	0.4	.
102	MAXIMUM	16.4		13.7	18.5	10.8	38.9	25.7	7.3	.
103	LSD(0.05)	3.9		.	.	.	.	.	.	.

Table 24. Summary of heading date (HD, Julian days) height (HGT, inches), and lodging (LDG) data from the 2019-2020 NUWWSN

		HEADING DATE (JULIAN DAYS)									HEIGHT (INCHES)				
ENTRY	NAME	AVG		ILCHA	INLAF	INWLA	NYITH	OHWO	VAWAR	GEBV	AVG		ILCHA	VAWAR	GEBV
1	TRUMAN	143.7	h	145.0	145.0	146.0	152.3	148.0	126.0	92.7	42.5	h	39.0	46.0	38.3
2	ERNIE	139.4		141.0	142.0	143.0	149.3	146.3	115.0	88.6	40.0		37.0	43.0	36.1
3	FREEDOM	141.2		143.0	145.0	145.0	150.8	146.3	117.0	91.3	41.5	h	39.0	44.0	35.8
4	PIONEER2545	140.6		141.0	143.5	143.0	151.0	146.0	119.0	93.8	38.5		37.0	40.0	35.8
5	DH13SRW022-23NUE	140.7		144.0	145.0	144.0	151.5	146.7	113.0	93.8	33.0	l	33.0	33.0	34.5
6	VA17W-75	138.3		142.0	143.5	141.0	148.5	145.0	110.0	.	36.0		33.0	39.0	.
7	15VDH-FHB-MAS33-13	139.0		142.0	142.0	143.0	152.0	145.0	110.0	.	36.0		34.0	38.0	.
8	15VTK-12-21	139.2		140.0	140.5	143.0	150.0	144.7	117.0	96.8	36.5		35.0	38.0	35.4
9	16VDH-SRW05-205	140.0		144.0	143.5	143.0	151.8	145.7	112.0	.	34.5	l	33.0	36.0	.
10	MI17R0325	135.2	l	138.0	138.0	139.0	148.3	141.0	107.0	90.8	40.5		39.0	42.0	36.2
11	MI17R0415	136.2	l	140.0	140.5	139.0	149.5	144.0	104.0	94.0	38.5		36.0	41.0	36.9
12	MI16R0682	136.5	l	139.0	138.0	139.0	149.0	143.7	110.0	94.2	40.0		39.0	41.0	35.5
13	MI17R0311	138.4		139.0	139.0	143.0	150.3	145.3	114.0	90.0	35.0	l	34.0	36.0	36.4
14	KWS246	139.0		141.0	142.0	141.0	150.8	147.0	112.0	.	36.0		34.0	38.0	.
15	KWS280	140.7		143.0	143.5	143.0	151.8	147.0	116.0	94.7	33.0	l	31.0	35.0	34.7
16	KWS283	139.2		141.0	142.0	143.0	150.3	146.7	112.0	92.8	35.0	l	33.0	37.0	36.6
17	KWS291	142.2	h	145.0	145.0	145.0	152.5	147.7	118.0	92.8	34.0	l	32.0	36.0	34.0
18	KWS333	136.4	l	138.0	139.0	139.0	147.3	143.3	112.0	.	36.0		33.0	39.0	.
19	NY12512-1-6-17	144.3	h	145.0	145.5	146.0	153.3	149.0	127.0	94.3	40.5		38.0	43.0	34.1
20	NY12397-1-4-13	139.5		142.0	142.0	145.0	150.0	146.0	112.0	91.1	34.0	l	31.0	37.0	34.1
21	NY99056-161	144.1	h	146.0	145.0	146.0	153.8	149.7	124.0	96.2	41.0		40.0	42.0	36.8
22	NY12299-1-3-20	143.0	h	146.0	145.5	144.0	152.0	148.3	122.0	94.1	35.5	l	33.0	38.0	36.0
23	NY12508-1-7-15	139.5		141.0	142.0	142.0	150.0	146.0	116.0	95.4	35.5	l	34.0	37.0	34.8
24	IL15-27666	136.4	l	137.0	137.0	139.0	147.3	142.3	116.0	98.5	36.0		33.0	39.0	35.1
25	IL15-26131	138.1		140.0	139.0	139.0	149.8	144.0	117.0	92.8	35.5	l	33.0	38.0	35.5
26	IL15-4957	135.7	l	138.0	138.0	138.0	147.5	142.7	110.0	92.9	36.5		34.0	39.0	35.3
27	IL13-1960	136.3	l	140.0	142.0	139.0	149.0	143.0	105.0	93.7	39.5		37.0	42.0	35.7
28	IL15-2639	138.8		140.0	140.5	141.0	149.0	144.3	118.0	94.4	39.5		37.0	42.0	36.6
29	OH14-112-34	139.8		142.0	145.0	141.0	150.8	145.3	115.0	94.9	37.0		36.0	38.0	34.3
30	OH14-222-49	139.4		142.0	142.0	142.0	150.3	146.3	114.0	94.6	39.5		37.0	42.0	35.3
31	OH15-191-52	141.2		144.0	145.0	143.0	152.0	147.0	116.0	97.9	36.5		35.0	38.0	35.0
32	OH15-42-1	141.5		143.0	145.0	145.0	152.3	148.0	116.0	96.6	38.0		37.0	39.0	34.9
33	KY07C-1145-94-12-5	137.5		139.0	139.0	142.0	149.3	144.0	112.0	88.5	36.0		34.0	38.0	34.5
34	15VDH-FHB-MAS32-07-30-12-5	136.2	l	139.0	138.0	139.0	149.0	145.3	107.0	92.6	37.5		36.0	39.0	35.0
35	X12-323-61-4-5	136.8	l	140.0	139.0	139.0	149.0	145.5	108.0	101.8	34.5	l	33.0	36.0	33.5
36	X12-072-3-17-5	137.1	l	139.0	139.0	141.0	149.3	144.3	110.0	96.6	37.0		34.0	40.0	33.2
37	X12-156-9-9-3	136.7	l	139.0	139.0	142.0	149.0	144.0	107.0	99.6	33.0	l	30.0	36.0	33.6
38	NE-14-494	143.3	h	144.0	145.0	146.0	150.0	150.5	124.0	89.6	42.5	h	40.0	45.0	38.3
39	NE-14-696	142.3	h	143.0	145.0	145.0	150.8	148.0	122.0	91.3	44.0	h	38.0	50.0	36.4
40	NE-15-624	142.7	h	143.0	145.0	146.0	150.0	148.3	124.0	86.8	37.0		33.0	41.0	36.2
41	NE-17-589	141.3		143.0	142.0	144.0	150.0	146.7	122.0	90.9	42.0	h	38.0	46.0	37.2
42	NW-13-493	141.8		144.0	143.5	143.0	150.0	147.3	123.0	89.5	41.0		37.0	45.0	37.7
43	LES18-0685	137.6		139.0	140.5	139.0	149.0	145.0	113.0	91.2	35.0	l	33.0	37.0	33.4
44	LES18-7031	139.8		141.0	144.5	144.0	150.5	145.0	114.0	90.3	33.5	l	32.0	35.0	35.0
45	LES18-1653	135.1	l	139.0	137.0	139.0	149.0	142.5	104.0	92.9	35.5	l	33.0	38.0	35.5
46	LES172093	137.5		139.0	140.5	139.0	149.0	144.7	113.0	.	39.5		36.0	43.0	.
47	10534A1-17-17	140.4		142.0	143.5	143.0	151.5	146.3	116.0	93.2	44.0	h	43.0	45.0	35.5
48	10524A1-18-1	142.4	h	145.0	145.0	145.0	152.3	148.0	119.0	94.2	39.5		37.0	42.0	33.2
49	04620A1-1-7-4-13	142.5	h	145.0	145.0	143.0	151.5	148.3	122.0	94.1	39.5		37.0	42.0	35.1
50	08344B-1-1	137.6		139.0	142.0	139.0	148.8	144.7	112.0	94.7	36.0		34.0	38.0	34.1
100	AVERAGE	139.4		141.5	142.1	142.2	150.2	145.8	114.9	.	37.6		35.3	39.8	.
101	MINUMUM	135.1		137.0	137.0	138.0	147.3	141.0	104.0	.	33.0		30.0	33.0	.
102	MAXIMUM	144.3		146.0	145.5	146.0	153.8	150.5	127.0	.	44.0		43.0	50.0	.
103	LSD(0.05)	2.3		.	.	.	.	.	.	.	2.9		.	.	.

Table 25. Summary of other traits collected on the 2019-2020 NUWWSN.

		YIELD	TW	LDG(0-5)	SEPTORIA(0-9)				PM(0-9)	LR(0-9)	FOLIAR HEALTH (0-9)
		VAWAR	VAWAR	VAWAR	AVG	ILCHA	VAWAR	INLAF	VAWAR	VAWAR	OHWOO
1	TRUMAN	86.7	57.7	0.0	3.5	2.5	3.0	5.0	2.0	6.0	5.7
2	ERNIE	79.2	57.9	3.0	5.0	4.5	3.0	7.5	2.0	7.0	5.7
3	FREEDOM	80.5	56.0	0.0	6.0	7.0	3.0	8.0	1.0	7.0	5.0
4	PIONEER2545	79.5	54.7	0.0	5.0	6.0	2.0	7.0	0.0	8.0	7.5
5	DH13SRW022-23NUE	99.0	57.6	0.0	4.2	2.0	5.0	5.5	0.0	5.0	4.3
6	VA17W-75	111.5	59.7	1.0	3.8	1.0	6.0	4.5	0.0	0.0	5.3
7	15VDH-FHB-MAS33-13	106.3	58.4	0.0	4.0	2.0	5.0	5.0	0.0	0.5	5.0
8	15VTK-12-21	103.4	59.4	0.0	4.7	3.0	5.0	6.0	0.0	6.0	4.3
9	16VDH-SRW05-205	103.1	58.4	0.0	3.7	1.0	6.0	4.0	0.0	1.0	6.0
10	MI17R0325	88.6	61.0	1.0	6.5	7.5	3.0	9.0	0.0	6.0	6.3
11	MI17R0415	99.1	60.0	3.0	4.8	5.0	3.0	6.5	0.0	6.0	6.3
12	MI16R0682	93.8	59.0	0.0	4.7	3.5	4.0	6.5	0.0	7.0	4.7
13	MI17R0311	107.6	59.5	0.0	5.7	4.5	4.0	8.5	0.0	6.0	5.3
14	KWS246	105.7	58.2	1.0	4.0	1.0	5.0	6.0	0.0	6.0	6.0
15	KWS280	102.8	60.4	0.0	3.5	2.0	4.0	4.5	0.0	0.5	4.7
16	KWS283	102.1	58.1	0.0	4.3	4.0	4.0	5.0	0.0	7.0	4.3
17	KWS291	116.1	58.6	0.0	2.7	1.5	4.0	2.5	0.0	0.0	5.3
18	KWS333	106.6	58.6	1.0	5.7	6.5	3.0	7.5	0.0	6.0	5.0
19	NY12512-1-6-17	64.6	54.7	0.0	5.2	5.0	3.0	7.5	0.0	7.0	4.7
20	NY12397-1-4-13	101.4	58.6	0.0	4.7	4.0	4.0	6.0	0.0	6.0	4.0
21	NY99056-161	70.9	55.9	0.0	2.7	1.5	3.0	3.5	0.0	6.0	6.0
22	NY12299-1-3-20	91.8	56.9	0.0	3.5	2.0	4.0	4.5	0.0	1.0	4.7
23	NY12508-1-7-15	78.9	57.1	0.0	5.5	6.5	3.0	7.0	1.0	7.0	4.3
24	IL15-27666	103.3	59.6	0.0	5.3	6.5	5.0	4.5	1.0	5.0	4.7
25	IL15-26131	96.4	59.2	0.0	5.2	4.5	2.0	9.0	0.0	7.0	3.7
26	IL15-4957	98.1	60.6	0.0	5.8	6.0	5.0	6.5	0.0	6.0	4.0
27	IL13-1960	94.7	59.4	3.0	4.0	3.0	4.0	5.0	0.0	8.0	4.7
28	IL15-2639	109.3	61.1	0.0	3.3	3.5	3.0	3.5	0.0	6.0	3.7
29	OH14-112-34	78.2	55.7	0.0	4.3	3.5	3.0	6.5	0.0	9.0	3.7
30	OH14-222-49	101.1	57.6	0.0	3.7	1.5	6.0	3.5	0.0	3.0	5.3
31	OH15-191-52	100.6	57.1	0.0	3.0	1.0	4.0	4.0	0.0	4.0	2.3
32	OH15-42-1	102.3	57.3	0.0	3.5	1.0	5.0	4.5	1.0	5.0	3.0
33	KY07C-1145-94-12-5	98.3	59.0	0.0	6.3	6.0	5.0	8.0	0.0	5.0	5.0
34	15VDH-FHB-MAS32-07-30-12-5	90.4	58.7	0.0	4.2	3.0	6.0	3.5	0.0	0.0	5.7
35	X12-323-61-4-5	90.2	58.4	0.0	5.2	5.0	4.0	6.5	2.0	8.0	5.0
36	X12-072-3-17-5	87.6	58.9	1.0	4.2	4.5	2.0	6.0	0.0	8.0	6.0
37	X12-156-9-9-3	91.8	57.9	1.0	4.5	4.5	2.0	7.0	0.0	8.0	6.0
38	NE-14-494	87.6	59.5	0.0	4.5	4.5	5.0	4.0	4.0	6.0	7.0
39	NE-14-696	85.2	58.5	4.0	3.2	2.5	4.0	3.0	1.0	4.0	6.7
40	NE-15-624	84.6	59.5	0.0	5.3	4.0	5.0	7.0	2.0	1.0	6.3
41	NE-17-589	80.8	58.8	2.0	3.3	2.0	5.0	3.0	0.0	4.0	6.7
42	NW-13-493	80.7	60.6	0.0	6.7	5.5	6.0	8.5	3.0	1.0	6.3
43	LES18-0685	107.0	59.2	0.0	5.3	3.5	4.0	8.5	0.0	2.0	4.5
44	LES18-7031	102.7	57.1	0.0	6.7	5.5	6.0	8.5	0.0	5.0	4.5
45	LES18-1653	93.2	57.8	1.0	5.5	5.5	4.0	7.0	0.0	6.0	6.0
46	LES172093	104.6	57.8	2.0	4.3	3.0	5.0	5.0	0.0	7.0	4.7
47	10534A1-17-17	96.7	59.5	2.0	4.7	4.0	5.0	5.0	0.0	6.0	5.0
48	10524A1-18-1	81.5	57.8	0.0	5.0	3.5	6.0	5.5	0.0	5.0	4.7
49	04620A1-1-7-4-13	89.7	57.4	0.0	4.3	4.0	5.0	4.0	0.0	4.0	6.0
50	08344B-1-1	92.0	57.3	4.0	6.0	5.5	7.0	5.5	0.0	2.0	3.7

Table 26. Summary of incidence (INC, %) from 2019-2020 PNUWWSN.

ENTRY	NAME	AVG		ILURB	INWLA	MIMAS	VAWAR	GEBV
1	TRUMAN	18.9	l	15.0	3.8	11.6	45.0	24.5
2	ERNIE	32.1	l	58.0	18.8	11.4	40.0	31.8
3	FREEDOM	36.9		38.0	16.3	23.1	70.0	35.8
4	PIONEER2545	60.0	h	73.0	36.3	45.7	85.0	37.6
5	15VDH-FHB-MAS10-25	21.1	l	28.0	1.3	15.0	40.0	37.7
6	15VDH-FHB-MAS31-30	33.8	l	25.0	5.0	60.0	45.0	35.3
7	16VDH-SRW03-023	56.3	h	63.0	33.8	53.3	75.0	.
8	DH15SRW67-151	28.0	l	38.0	8.8	10.0	55.0	34.9
9	12VTK20-102	35.2		62.0	8.8	45.0	25.0	35.3
10	VA18W-54	49.1	h	73.0	15.0	38.3	70.0	37.4
11	MI16W0102	26.6	l	72.0	12.5	6.7	15.0	30.1
12	MI17W0121	36.1		48.0	16.3	20.0	60.0	32.2
13	MI16R0830	36.2		28.0	20.0	41.7	55.0	33.6
14	MI17R0386	34.4	l	43.0	16.3	23.3	55.0	27.6
15	KWS263	42.2	h	52.0	30.0	21.7	65.0	.
16	KWS305	37.1		32.0	16.3	30.0	70.0	.
17	KWS316	47.1	h	50.0	18.8	49.6	70.0	36.3
18	KWS317	42.3	h	43.0	18.8	32.2	75.0	33.3
19	KWS319	46.5	h	72.0	8.8	50.0	55.0	33.7
20	IL16-36048	17.0	l	37.0	7.5	3.5	20.0	24.5
21	IL16-8048	24.8	l	25.0	18.8	15.2	40.0	28.2
22	IL16-23972	27.5	l	35.0	11.3	3.6	60.0	23.2
23	IL16-36206	18.3	l	30.0	10.0	3.0	30.0	24.4
24	IL16-4364	26.6	l	43.0	5.0	13.4	45.0	26.4
25	OH15-131-31	27.8	l	40.0	20.0	21.2	30.0	30.4
26	OH16-182-26	20.7	l	20.0	0.0	7.6	55.0	28.7
27	OH16-167-76	52.3	h	62.0	25.0	52.0	70.0	28.8
28	OH16-168-48	49.1	h	67.0	32.5	36.7	60.0	.
29	15VDH-FHB-MAS02-10-2-6-3	26.9	l	43.0	16.3	18.3	30.0	34.1
30	X12-862-16-13-5	36.1		48.0	6.3	40.0	50.0	30.8
31	X12-461-32-3-1	32.5	l	58.0	13.8	43.3	15.0	31.0
32	X12-3049-57-4-3	27.4	l	57.0	7.5	10.0	35.0	29.3
33	X12-839-11-18-5	39.5		50.0	11.3	56.7	40.0	29.6
34	0527A1-9-9-2-4	49.1	h	60.0	26.3	45.0	65.0	33.9
35	984RE1-57-5	52.8	h	68.0	26.3	51.7	65.0	.
36	09186A1-10-2	38.0		72.0	10.0	10.0	60.0	29.8
37	10518RA1-1-6	30.9	l	57.0	10.0	16.7	40.0	31.6
100	AVERAGE	35.6		48.2	15.2	28.0	50.8	.
101	MINUMUM	17.0		15.0	0.0	3.0	15.0	.
102	MAXIMUM	60.0		73.0	36.3	60.0	85.0	.
103	LSD(0.05)	18.1		.	.	.	.	.

Table 27. Summary of severity (SEV, %) data from the 2019-2020 PNUWWSN

ENTRY	NAME	AVG		ILURB	INWLA*	MIMAS	VAWAR	GEBV
1	TRUMAN	17.4	l	15.8	2.5	6.5	45.0	11.5
2	ERNIE	35.2		72.6	22.5	15.6	30.0	19.6
3	FREEDOM	35.4		49.0	15.0	17.8	60.0	18.1
4	PIONEER2545	53.6	h	73.2	27.5	43.7	70.0	25.7
5	15VDH-FHB-MAS10-25	23.9	l	42.7	1.3	11.7	40.0	20.1
6	15VDH-FHB-MAS31-30	23.0	l	15.5	5.0	36.7	35.0	19.7
7	16VDH-SRW03-023	46.7	h	73.4	35.0	23.3	55.0	.
8	DH15SRW67-151	26.7	l	46.9	10.0	10.0	40.0	19.2
9	12VTK20-102	36.7		55.5	26.3	30.0	35.0	23.1
10	VA18W-54	42.8	h	62.2	27.5	21.7	60.0	23.4
11	MI16W0102	29.6		75.1	20.0	13.3	10.0	18.7
12	MI17W0121	34.1		50.8	18.8	11.7	55.0	22.5
13	MI16R0830	29.1		40.8	7.5	33.3	35.0	19.3
14	MI17R0386	37.8	h	66.9	12.5	16.7	55.0	14.1
15	KWS263	41.5	h	63.7	27.5	15.0	60.0	.
16	KWS305	41.2	h	56.7	35.0	18.3	55.0	.
17	KWS316	30.4		48.2	10.0	18.5	45.0	20.2
18	KWS317	35.2		64.2	13.8	22.9	40.0	19.1
19	KWS319	42.6	h	81.4	7.5	41.7	40.0	15.8
20	IL16-36048	15.8	l	25.7	7.5	5.1	25.0	10.4
21	IL16-8048	15.7	l	14.9	13.8	9.2	25.0	15.4
22	IL16-23972	15.4	l	14.8	7.5	4.5	35.0	8.2
23	IL16-36206	11.4	l	16.9	10.0	3.7	15.0	10.0
24	IL16-4364	23.4	l	45.0	5.0	8.6	35.0	11.7
25	OH15-131-31	27.3	l	45.2	16.3	17.8	30.0	19.6
26	OH16-182-26	13.1	l	10.3	0.0	7.0	35.0	14.2
27	OH16-167-76	48.8	h	72.9	28.8	33.6	60.0	12.5
28	OH16-168-48	43.2	h	70.3	32.5	25.0	45.0	.
29	15VDH-FHB-MAS02-10-2-6-3	19.4	l	20.5	8.8	13.3	35.0	17.8
30	X12-862-16-13-5	32.0		48.2	6.3	18.3	55.0	17.4
31	X12-461-32-3-1	17.1	l	17.3	11.3	15.0	25.0	13.0
32	X12-3049-57-4-3	15.4	l	19.8	5.0	11.7	25.0	11.6
33	X12-839-11-18-5	20.9	l	16.4	8.8	28.3	30.0	12.7
34	0527A1-9-9-2-4	42.0	h	63.7	27.5	26.7	50.0	10.6
35	984RE1-57-5	51.1	h	60.6	48.8	40.0	55.0	.
36	09186A1-10-2	30.1		64.3	6.3	5.0	45.0	11.1
37	10518RA1-1-6	31.2		55.9	13.8	15.0	40.0	16.4
100	AVERAGE	30.7		47.0	15.8	18.8	41.4	.
101	MINUMUM	11.4		10.3	0.0	3.7	10.0	.
102	MAXIMUM	53.6		81.4	48.8	43.7	70.0	.
103	LSD(0.05)	16.1		.	.	.	.	.

Table 28. Summary of index (IND, %) data from the 2019-2020 PNUWWSN.

ENTRY	NAME	AVG		ILCHA	ILURB	INLAF*	INWLA	MIMAS	OHWOO	VAWAR	GEBV
1	TRUMAN	10.6	l	10.0	3.0	30.0	0.1	1.0	9.3	21.0	9.0
2	ERNIE	32.0		55.0	42.3	80.0	4.2	2.7	27.5	12.0	15.5
3	FREEDOM	27.7		37.5	17.6	65.0	2.4	3.9	25.2	42.0	16.0
4	PIONEER2545	51.4	h	90.0	53.5	80.0	10.0	19.9	46.8	59.5	24.2
5	15VDH-FHB-MAS10-25	21.5		30.0	12.1	70.0	0.0	1.9	20.4	16.0	17.3
6	15VDH-FHB-MAS31-30	14.4	l	12.5	3.9	35.0	0.3	21.8	12.1	15.0	14.5
7	16VDH-SRW03-023	40.2	h	72.5	46.3	80.0	11.8	12.6	17.1	41.0	.
8	DH15SRW67-151	21.9		37.5	18.5	55.0	0.9	1.0	18.1	22.0	15.1
9	12VTK20-102	25.6		35.0	34.8	65.0	2.3	14.3	19.0	9.0	19.0
10	VA18W-54	36.9		72.5	45.7	65.0	4.1	8.3	20.5	42.0	20.1
11	MI16W0102	28.5		55.0	54.3	65.0	2.5	0.8	20.7	1.5	14.7
12	MI17W0121	27.3		50.0	23.1	55.0	3.0	2.3	24.7	33.0	19.7
13	MI16R0830	19.5		20.0	15.1	55.0	1.5	14.7	9.9	20.0	17.1
14	MI17R0386	30.2		60.0	28.8	60.0	2.0	5.1	24.6	31.0	12.2
15	KWS263	35.9		65.0	34.6	80.0	8.3	3.5	20.7	39.0	.
16	KWS305	28.9		42.5	17.7	75.0	5.7	5.5	17.2	38.5	.
17	KWS316	28.2		47.5	23.7	70.0	1.9	9.8	13.3	31.5	17.8
18	KWS317	26.6		47.5	27.9	60.0	2.6	8.1	9.9	30.5	17.4
19	KWS319	36.0		52.5	58.4	70.0	0.7	23.2	24.9	22.0	14.7
20	IL16-36048	9.2	l	5.0	11.5	30.0	0.6	0.0	12.1	5.5	8.9
21	IL16-8048	8.6	l	5.0	3.9	30.0	2.6	1.4	6.2	11.0	14.6
22	IL16-23972	10.8	l	5.0	5.1	30.0	0.8	0.7	12.0	22.0	7.2
23	IL16-36206	7.2	l	5.0	6.0	25.0	1.0	0.1	8.0	5.0	7.4
24	IL16-4364	16.1	l	20.0	20.0	40.0	0.3	1.7	14.6	16.0	9.0
25	OH15-131-31	17.1	l	22.5	13.4	55.0	3.3	4.4	12.0	9.0	19.0
26	OH16-182-26	10.7	l	7.5	2.1	40.0	0.0	1.3	4.9	19.0	13.1
27	OH16-167-76	34.1		40.0	44.9	70.0	7.2	18.1	16.3	42.0	12.1
28	OH16-168-48	31.2		45.0	47.0	65.0	10.6	9.0	13.8	28.0	.
29	15VDH-FHB-MAS02-10-2-6-3	9.7	l	10.0	9.5	25.0	1.4	2.6	8.2	11.0	16.0
30	X12-862-16-13-5	20.9		20.0	25.4	55.0	0.4	7.7	10.0	27.5	18.2
31	X12-461-32-3-1	9.8	l	5.0	9.7	30.0	1.5	6.8	11.4	4.0	13.7
32	X12-3049-57-4-3	12.7	l	5.0	10.7	50.0	0.4	1.3	12.4	9.0	14.6
33	X12-839-11-18-5	12.4	l	5.0	8.7	35.0	1.0	16.0	8.9	12.0	15.4
34	0527A1-9-9-2-4	35.9		62.5	38.2	75.0	7.2	11.9	23.3	33.0	13.6
35	984RE1-57-5	32.3		40.0	41.5	60.0	12.8	23.1	11.9	36.5	.
36	09186A1-10-2	20.8		15.0	46.1	45.0	0.6	0.5	11.0	27.5	9.4
37	10518RA1-1-6	24.9		37.5	32.8	60.0	1.4	2.8	22.8	17.0	15.1
100	AVERAGE	23.4		33.7	25.3	55.0	3.2	7.3	16.3	.	.
101	MINUMUM	7.2		5.0	2.1	25.0	0.0	0.0	4.9	.	.
102	MAXIMUM	51.4		90.0	58.4	80.0	12.8	23.2	46.8	.	.
103	LSD(0.05)	12.0		.	.	.	.	.	.	.	.
				* indicates a value converted to % from a 0-9 scoring							

Table 29. Summary of Fusarium Damaged Kernel (FDK, %) data from the 2019-2020 PNUWWSN.

ENTRY	NAME	AVG		ILCHA	ILURB	INLAF	OHWOO	VAWAR	GEBV
1	TRUMAN	7.7	l	2.0	2.3	5.0	20.0	9.0	9.9
2	ERNIE	19.8		15.0	26.7	20.0	22.5	15.0	16.6
3	FREEDOM	27.0		17.5	35.0	30.0	20.0	32.5	21.5
4	PIONEER2545	55.5	h	42.5	55.0	60.0	75.0	45.0	22.6
5	15VDH-FHB-MAS10-25	19.0		10.0	13.3	20.0	30.0	21.5	19.6
6	15VDH-FHB-MAS31-30	12.9	l	5.0	13.3	25.0	10.0	11.0	17.5
7	16VDH-SRW03-023	31.0		12.5	35.0	40.0	37.5	30.0	.
8	DH15SRW67-151	17.8		12.5	15.0	25.0	15.0	21.5	15.3
9	12VTK20-102	21.5		12.5	35.0	30.0	15.0	15.0	18.1
10	VA18W-54	27.8		22.5	31.7	20.0	32.5	32.5	18.5
11	MI16W0102	18.7		12.5	18.3	20.0	15.0	27.5	17.4
12	MI17W0121	20.3		7.5	6.7	20.0	22.5	45.0	22.9
13	MI16R0830	26.7		10.0	18.3	30.0	30.0	45.0	19.1
14	MI17R0386	17.2		7.5	21.7	30.0	15.0	12.0	10.2
15	KWS263	30.2		15.0	38.3	25.0	40.0	32.5	.
16	KWS305	22.2		17.5	13.3	20.0	25.0	35.0	.
17	KWS316	21.3		7.5	26.7	25.0	17.5	30.0	16.0
18	KWS317	14.2		5.0	13.3	15.0	12.5	25.0	16.4
19	KWS319	19.3		15.0	11.7	25.0	22.5	22.5	14.5
20	IL16-36048	4.8	l	1.0	7.0	10.0	5.0	1.0	8.7
21	IL16-8048	4.9	l	2.5	2.3	10.0	6.5	3.0	10.2
22	IL16-23972	6.1	l	2.5	2.3	15.0	5.0	5.5	5.5
23	IL16-36206	4.6	l	0.0	2.3	5.0	10.0	5.5	9.4
24	IL16-4364	13.5	l	3.5	10.0	30.0	10.0	14.0	11.4
25	OH15-131-31	13.3	l	3.5	21.7	20.0	11.5	10.0	16.5
26	OH16-182-26	14.1		5.0	6.7	30.0	15.0	14.0	16.2
27	OH16-167-76	31.3		12.5	36.7	50.0	30.0	27.5	13.3
28	OH16-168-48	27.8		12.5	51.7	20.0	22.5	32.5	.
29	15VDH-FHB-MAS02-10-2-6-3	13.9	l	7.5	23.3	10.0	17.5	11.0	21.7
30	X12-862-16-13-5	16.7		12.5	23.3	20.0	7.5	20.0	18.5
31	X12-461-32-3-1	22.7		15.0	48.3	15.0	15.0	20.0	14.8
32	X12-3049-57-4-3	15.5		0.0	18.3	30.0	15.0	14.0	16.6
33	X12-839-11-18-5	13.8	l	12.5	9.0	20.0	10.0	17.5	18.6
34	0527A1-9-9-2-4	26.5		15.0	38.3	35.0	25.0	19.0	14.7
35	984RE1-57-5	24.3		6.0	36.7	30.0	25.0	24.0	.
36	09186A1-10-2	13.0	l	3.5	21.7	20.0	7.5	12.5	14.7
37	10518RA1-1-6	14.0	l	7.5	8.7	25.0	11.5	17.5	18.0
100	AVERAGE	19.2		10.1	21.6	23.8	19.6	21.0	.
101	MINUMUM	4.6		0.0	2.3	5.0	5.0	1.0	.
102	MAXIMUM	55.5		42.5	55.0	60.0	75.0	45.0	.
103	LSD(0.05)	9.5		.	.	.	.	.	.

Table 30. Summary of INC/SEV/FDK (ISK, %) data from the 2019-2020 PNUWWSN

ENTRY	NAME	AVG		ILCHA	ILURB	INLAF	OHWOO	VAWAR	GEBV
1	TRUMAN	14.6	l	6.8	5.7	20.0	13.6	27.0	13.0
2	ERNIE	34.8		39.0	32.4	56.0	25.5	21.1	19.5
3	FREEDOM	34.3		29.5	28.7	51.0	23.1	39.1	22.0
4	PIONEER2545	58.4	h	71.0	44.0	72.0	58.1	46.7	24.8
5	15VDH-FHB-MAS10-25	27.7		22.0	18.1	50.0	24.2	24.1	21.8
6	15VDH-FHB-MAS31-30	17.2	l	9.5	10.0	31.0	11.3	24.0	18.9
7	16VDH-SRW03-023	42.6		48.5	36.0	64.0	25.3	39.1	.
8	DH15SRW67-151	27.2		27.5	20.1	43.0	16.9	28.6	18.9
9	12VTK20-102	28.6		26.0	30.7	51.0	17.4	18.1	20.7
10	VA18W-54	39.0		52.5	31.3	47.0	25.3	39.1	21.2
11	MI16W0102	28.2		38.0	29.9	47.0	18.4	7.6	19.1
12	MI17W0121	30.1		33.0	17.9	41.0	23.8	34.7	24.2
13	MI16R0830	25.1		16.0	19.6	45.0	17.9	27.2	20.8
14	MI17R0386	33.9		39.0	28.7	48.0	20.8	33.0	13.9
15	KWS263	40.7		45.0	34.4	58.0	28.4	37.6	.
16	KWS305	33.1		32.5	22.3	53.0	20.3	37.6	.
17	KWS316	31.6		31.5	25.1	52.0	15.0	34.6	20.2
18	KWS317	28.5		30.5	24.6	42.0	10.9	34.6	19.3
19	KWS319	34.2		37.5	29.1	52.0	23.9	28.6	18.3
20	IL16-36048	11.7	l	3.4	10.5	22.0	9.3	13.5	12.6
21	IL16-8048	11.4	l	4.0	5.4	22.0	6.3	19.5	15.1
22	IL16-23972	14.2	l	4.0	5.4	24.0	9.2	28.5	10.5
23	IL16-36206	9.7	l	3.0	6.0	17.0	8.8	13.5	12.1
24	IL16-4364	20.8		13.4	17.5	36.0	12.8	24.1	13.8
25	OH15-131-31	21.6		14.9	22.2	41.0	11.8	18.0	20.0
26	OH16-182-26	16.9	l	6.5	5.8	36.0	8.9	27.1	17.6
27	OH16-167-76	37.7		29.0	36.5	62.0	21.8	39.1	15.7
28	OH16-168-48	33.9		32.0	41.8	47.0	17.3	31.6	.
29	15VDH-FHB-MAS02-10-2-6-3	15.0	l	9.0	15.5	19.0	11.9	19.5	21.7
30	X12-862-16-13-5	24.5		17.0	23.8	41.0	9.0	31.6	20.9
31	X12-461-32-3-1	16.5	l	9.0	24.5	24.0	12.8	12.1	18.1
32	X12-3049-57-4-3	18.0	l	3.0	13.3	42.0	13.4	18.1	19.8
33	X12-839-11-18-5	15.2	l	8.0	8.5	29.0	9.3	21.1	20.7
34	0527A1-9-9-2-4	39.1		43.5	34.4	59.0	24.0	34.6	14.9
35	984RE1-57-5	32.1		26.4	32.8	48.0	17.1	36.1	.
36	09186A1-10-2	22.9		10.4	28.0	35.0	9.6	31.6	15.6
37	10518RA1-1-6	26.8		25.5	20.2	46.0	18.3	24.1	18.4
100	AVERAGE	27.0		24.3	22.7	42.5	17.6	27.7	.
101	MINUMUM	9.7		3.0	5.4	17.0	6.3	7.6	.
102	MAXIMUM	58.4		71.0	44.0	72.0	58.1	46.7	.
103	LSD(0.05)	8.5		.	.	.	.	.	.

Table 31. Summary of deoxynivalenol (DON, ppm) data from the 2019-2020 PNUWWSN.

ENTRY	NAME	AVG		ILCHA	ILURB	OHWOO	VAWAR	GEBV
1	TRUMAN	3.5		0.5	0.2	12.0	1.2	3.0
2	ERNIE	3.9		2.5	3.3	9.0	1.0	4.3
3	FREEDOM	3.7		2.7	2.1	7.2	2.9	5.2
4	PIONEER2545	15.8	h	13.6	13.2	25.8	10.6	7.1
5	15VDH-FHB-MAS10-25	3.6		1.9	0.8	10.2	1.5	5.1
6	15VDH-FHB-MAS31-30	2.7	l	2.2	1.4	6.2	1.2	3.9
7	16VDH-SRW03-023	4.3		4.6	3.2	6.8	2.6	.
8	DH15SRW67-151	2.4	l	1.2	1.5	5.8	1.2	4.8
9	12VTK20-102	3.8		3.9	3.6	6.1	1.5	4.2
10	VA18W-54	5.3		4.4	3.9	9.1	3.9	5.0
11	MI16W0102	2.8	l	1.8	3.1	4.0	2.2	4.0
12	MI17W0121	4.7		2.6	1.4	9.9	4.7	7.4
13	MI16R0830	4.1		2.9	3.3	7.1	3.2	6.4
14	MI17R0386	2.7	l	2.1	2.4	5.1	1.1	3.1
15	KWS263	5.0		3.2	3.5	10.0	3.3	.
16	KWS305	6.8		5.9	1.5	15.1	4.7	.
17	KWS316	4.7		3.3	2.3	9.8	3.6	4.3
18	KWS317	3.7		2.2	2.3	6.2	3.9	4.3
19	KWS319	3.9		2.3	4.5	6.0	2.7	3.0
20	IL16-36048	0.8	l	0.1	0.2	2.5	0.3	0.2
21	IL16-8048	0.5	l	0.2	0.2	1.2	0.3	2.2
22	IL16-23972	0.5	l	0.3	0.3	1.1	0.4	0.4
23	IL16-36206	0.5	l	0.1	0.1	1.6	0.2	1.5
24	IL16-4364	1.7	l	0.5	1.1	4.0	1.1	2.4
25	OH15-131-31	2.3	l	0.9	1.3	6.1	1.0	3.7
26	OH16-182-26	1.9	l	0.8	0.7	5.1	1.0	4.0
27	OH16-167-76	3.2		1.4	3.9	5.7	1.9	3.0
28	OH16-168-48	3.5		1.4	4.5	6.8	1.4	.
29	15VDH-FHB-MAS02-10-2-6-3	1.4	l	1.1	1.0	2.7	0.9	5.6
30	X12-862-16-13-5	2.8		1.6	1.9	6.3	1.5	5.2
31	X12-461-32-3-1	2.8		1.2	3.3	6.1	0.7	3.3
32	X12-3049-57-4-3	1.3	l	0.3	1.5	2.9	0.6	4.8
33	X12-839-11-18-5	2.0	l	2.0	1.5	3.4	1.2	5.8
34	0527A1-9-9-2-4	3.5		2.6	1.8	7.7	2.1	4.3
35	984RE1-57-5	3.9		1.7	3.4	8.4	2.1	.
36	09186A1-10-2	2.3	l	1.4	2.5	4.1	1.3	3.6
37	10518RA1-1-6	1.9	l	1.7	1.3	3.1	1.4	4.3
100	AVERAGE	3.4		2.2	2.4	6.8	2.1	.
101	MINUMUM	0.5		0.1	0.1	1.1	0.2	.
102	MAXIMUM	15.8		13.6	13.2	25.8	10.6	.
103	LSD(0.05)	2.3		.	.	.	.	.

Table 32. Summary of heading date (HD, Julian days) height (HGT, inches), and lodging (LDG) data from the 2019-2020 PNUWWN

		HEADING DATE (JULIAN DAYS)								HEIGHT (INCHES)				
ENTRY	NAME	AVG		ILCHA	INLAF	INWLA	OHWO	VAWAR	GEBV	AVG		ILCHA	VAWAF	GEBV
1	TRUMAN	142.8	h	146.0	145.0		148.7	126.0	92.7	42.5	h	39.0	46.0	38.3
2	ERNIE	137.6		143.0	142.0	143.0	146.0	114.0	88.6	40.5		38.0	43.0	36.1
3	FREEDOM	139.3		144.0	145.0	144.0	146.5	117.0	91.3	40.5		37.0	44.0	35.8
4	PIONEER2545	138.5		142.0	142.0	144.0	147.3	117.0	93.8	38.5		37.0	40.0	35.8
5	15VDH-FHB-MAS10-25	137.5		144.0	142.0	145.0	146.5	110.0	94.0	38.5		36.0	41.0	34.5
6	15VDH-FHB-MAS31-30	138.1		143.0	145.0	143.0	146.3	113.0	93.1	34.0	l	31.0	37.0	34.3
7	16VDH-SRW03-023	137.2		143.0	142.0	143.0	146.0	112.0	.	36.0		32.0	40.0	.
8	DH15SRW67-151	139.2		145.0	142.0	146.0	147.0	116.0	91.6	33.5	l	32.0	35.0	32.9
9	12VTK20-102	136.7		142.0	142.0	143.0	146.3	110.0	90.6	35.0		32.0	38.0	34.4
10	VA18W-54	138		144.0	142.0	143.0	148.0	113.0	91.7	35.0		32.0	38.0	34.3
11	MI16W0102	134.2	l	139.0	138.0	139.0	145.0	110.0	91.5	34.5	l	32.0	37.0	35.5
12	MI17W0121	136.1		141.0	142.0	143.0	144.5	110.0	96.2	38.0		35.0	41.0	37.6
13	MI16R0830	138.1		143.0	142.0	144.0	145.7	116.0	91.1	39.5		36.0	43.0	35.8
14	MI17R0386	133.7	l	138.0	137.0	138.0	142.7	113.0	93.2	36.5		33.0	40.0	35.3
15	KWS263	137.5		143.0	142.0	143.0	147.3	112.0	.	38.0		36.0	40.0	.
16	KWS305	139.9		145.0	145.0	146.0	146.7	117.0	.	38.0		35.0	41.0	.
17	KWS316	139.5		145.0	145.0	143.0	147.7	117.0	87.2	37.5		35.0	40.0	35.0
18	KWS317	139.3		144.0	145.0	143.0	146.7	118.0	88.4	35.5		34.0	37.0	35.6
19	KWS319	135.5	l	143.0	142.0	142.0	145.7	105.0	95.3	33.5	l	31.0	36.0	32.2
20	IL16-36048	134.3	l	137.0	137.0	139.0	142.3	116.0	95.0	37.5		36.0	39.0	35.4
21	IL16-8048	134.6	l	139.0	137.0	139.0	143.0	115.0	95.0	37.0		35.0	39.0	34.4
22	IL16-23972	135.7	l	139.0	137.0	139.0	143.7	120.0	93.8	35.0		33.0	37.0	35.0
23	IL16-36206	133.5	l	138.0	137.0	137.0	142.7	113.0	96.8	37.5		35.0	40.0	34.1
24	IL16-4364	135.1	l	140.0	139.5	140.0	144.0	112.0	93.6	38.0		36.0	40.0	35.3
25	OH15-131-31	138.2		144.0	145.0	143.0	145.0	114.0	96.0	38.0		36.0	40.0	35.6
26	OH16-182-26	138.4		144.0	144.5	144.0	146.7	113.0	94.1	33.0	l	30.0	36.0	34.2
27	OH16-167-76	135.3	l	140.0	142.0	139.0	143.3	112.0	95.9	35.0		33.0	37.0	34.8
28	OH16-168-48	134.9	l	139.0	139.0	141.0	143.3	112.0	.	36.5		35.0	38.0	.
29	15VDH-FHB-MAS02-10-2	133.8	l	140.0	139.0	139.0	144.0	107.0	94.0	35.0		33.0	37.0	34.7
30	X12-862-16-13-5	136.5		142.0	142.0	143.0	145.3	110.0	98.9	36.5		33.0	40.0	34.5
31	X12-461-32-3-1	136.6		141.0	142.0	143.0	146.0	111.0	98.1	33.0	l	31.0	35.0	33.5
32	X12-3049-57-4-3	135.5	l	141.0	140.5	142.0	145.0	109.0	103.1	35.5		33.0	38.0	34.7
33	X12-839-11-18-5	135.9	l	140.0	142.0	143.0	144.3	110.0	102.1	35.0		32.0	38.0	34.3
34	0527A1-9-9-2-4	137.7		143.0	142.0	143.0	146.7	114.0	94.8	37.0		34.0	40.0	33.8
35	984RE1-57-5	138.1		143.0	142.0	143.0	146.5	116.0	.	37.0		35.0	39.0	.
36	09186A1-10-2	136.2		140.0	139.5	143.0	145.7	113.0	93.5	38.5		36.0	41.0	35.5
37	10518RA1-1-6	136.2		140.0	140.5	143.0	144.5	113.0	91.0	43.5	h	40.0	47.0	35.8
100	AVERAGE	136.9		141.8	141.5	142.3	144.9	113.1	.	36.9		34.3	39.4	.
101	MINUMUM	133.5		137.0	137.0	137.0	126.0	105.0	.	33.0		30.0	35.0	.
102	MAXIMUM	142.8		146.0	145.0	148.7	148.0	120.0	.	43.5		40.0	47.0	.
103	LSD(0.05)	2.4		.	.	.	.	.	.	2.0		.	.	.

Table 33. Summary of other traits collected on the 2019-2020 PNUWWSN.

		YIELD	TW	LDG(0-5)	SEPTORIA(0-9)				PM(0-9)	LR(0-9)	FOLIAR HEALTH (0-9)
ENTRY	NAME	VAWAR	VAWAR	VAWAR	AVG	ILCHA	INLAF	VAWAR	VAWAR	VAWAR	OHWOO
1	TRUMAN	82.8	59.2	0	4.5	3.5	6	4.0	1.0	7.0	5.3
2	ERNIE	85.2	58.3	4	5.7	4.5	5.5	7.0	2.0	7.0	5.5
3	FREEDOM	73.3	55.5	2	6.0	7.0	7	4.0	1.0	8.0	5.0
4	PIONEER2545	80.1	55.6	1	5.7	6.0	8	3.0	0.0	8.0	7.0
5	15VDH-FHB-MAS10-25	112.4	61.0	0	3.5	1.5	4	5.0	0.0	1.0	3.5
6	15VDH-FHB-MAS31-30	106.6	60.4	0	3.5	2.5	5	3.0	0.0	0.5	4.7
7	16VDH-SRW03-023	122.8	59.6	0	3.5	1.5	4	5.0	0.0	1.0	3.5
8	DH15SRW67-151	106.3	58.9	0	3.2	1.0	3.5	5.0	0.0	0.5	5.3
9	12VTK20-102	103.1	61.2	0	3.2	1.0	3.5	5.0	0.0	1.0	4.7
10	VA18W-54	102.8	60.5	0	6.0	4.0	8	6.0	0.0	6.0	6.0
11	MI16W0102	91.4	56.7	0	4.7	4.5	6.5	3.0	0.0	8.0	6.3
12	MI17W0121	86.4	57.3	0	6.5	7.5	9	3.0	0.0	9.0	5.5
13	MI16R0830	85.8	60.0	0	4.7	4.0	5	5.0	0.0	5.0	4.7
14	MI17R0386	103.2	60.0	0	6.5	6.5	7	6.0	2.0	6.0	4.0
15	KWS263	121.0	58.3	0	3.3	3.0	5	2.0	0.0	0.0	5.3
16	KWS305	96.0	58.4	0	6.8	6.5	8	6.0	0.0	6.0	4.3
17	KWS316	109.7	56.5	0	5.8	4.0	8.5	5.0	1.0	0.5	5.7
18	KWS317	101.5	56.6	0	5.3	4.5	8.5	3.0	0.0	8.0	6.3
19	KWS319	86.2	55.0	1	6.3	7.5	8.5	3.0	0.0	9.0	6.0
20	IL16-36048	86.0	56.8	0	6.0	6.5	5.5	6.0	5.0	0.0	4.3
21	IL16-8048	101.6	58.8	0	4.8	4.5	4	6.0	1.0	3.0	4.7
22	IL16-23972	99.2	58.9	0	5.7	6.5	5.5	5.0	3.0	5.0	7.3
23	IL16-36206	103.8	59.0	0	4.3	4.5	3.5	5.0	2.0	3.0	4.7
24	IL16-4364	104.1	58.5	1	5.3	3.5	6.5	6.0	4.0	6.0	5.3
25	OH15-131-31	110.9	57.2	1	3.7	2.5	3.5	5.0	0.0	5.0	4.0
26	OH16-182-26	98.2	58.4	0	4.7	3.5	4.5	6.0	2.0	4.0	5.3
27	OH16-167-76	96.1	57.7	0	4.2	2.5	4	6.0	0.0	4.0	4.3
28	OH16-168-48	104.9	58.4	0	3.7	2.0	3	6.0	0.0	1.0	4.3
29	15VDH-FHB-MAS02-10-2-6-3	84.1	60.3	0	4.2	5.5	4	3.0	0.0	8.0	6.0
30	X12-862-16-13-5	96.7	56.8	0	5.3	6.0	7	3.0	0.0	8.0	6.7
31	X12-461-32-3-1	93.8	56.5	0	6.0	7.0	8	3.0	0.0	7.0	5.3
32	X12-3049-57-4-3	88.4	58.0	0	7.0	9.0	9	3.0	2.0	8.0	8.0
33	X12-839-11-18-5	97.2	58.2	0	5.7	5.5	8.5	3.0	3.0	8.0	6.3
34	0527A1-9-9-2-4	83.1	58.4	0	5.7	3.5	6.5	7.0	0.0	7.0	6.3
35	984RE1-57-5	89.4	60.0	0	5.0	4.5	5.5	5.0	0.0	6.0	5.5
36	09186A1-10-2	84.2	58.6	1	5.8	6.0	5.5	6.0	0.0	3.0	6.0
37	10518RA1-1-6	75.8	59.1	0	4.7	3.5	3.5	7.0	0.0	7.0	6.5

Table 34. Presence or absence of FHB QTL in the 2019-2020 NUWWSN entries. Entries were also genotyped for Rht, Ppd, Vrn, rust, PM, Hessian Fly, BYDV, rye translocation, and quality genes. That data is available in an excel file from sneller.5@osu.edu. Data is from the USDA Eastern Regional Small Grains Genotyping Lab , Raleigh NC.

Comments on marker/trait	**Fhb1** = FHB resistance from Sumai 3/Ning 7840 on 3BS	**Fhb_3B_Massey** = FHB resistance QTL from Massey on 3B; based on flanking markers	**Fhb_1B_Jamestown** = FHB resistance QTL from Jamestown on 1B; based on flanking markers	**Fhb_1A_Neuse** = FHB resistance QTL from NC-Neuse on 1A; based on flanking markers	**Fhb_4A_Neuse** = FHB resistance QTL from NC-Neuse on 4A; based on flanking markers	**Fhb_6A_Neuse** = FHB resistance QTL from NC-Neuse on 6A; based on flanking markers	**Fhb_2B_Bess** = FHB resistance QTL from Bess on 2B; based on flanking markers	**Fhb_3B_Bess** = FHB resistance QTL from Bess on 3B; based on flanking markers
reliability	highly diagnostic	Useful for lines with Massey in pedigree	Seem to be broadly useful	unsure	unsure	unsure	unsure	unsure
SampleID	**Fhb1**	**Fhb_3B_Massey**	**Fhb_1B_Jamestown**	**Fhb_1A_neuse**	**Fhb_4A_Neuse**	**Fhb_6A_Neuse**	**Fhb_2B_Bess**	**Fhb_3B_Bess**
TRUMAN	no	no	**Fhb_1B_Jamestown**	**Fhb_1A_Neuse**	no	no	**Fhb_2B_Bess**	**Fhb_3B_Bess**
ERNIE	no	**Fhb_3B_Massey_het**	no	**Fhb_1A_Neuse**	no	**Fhb_6A_Neuse_het**	no	no
FREEDOM	no	**Fhb_3B_Massey_het**	no	**Fhb_1A_Neuse**	no	no	no	no
PIONEER2545	no	no	no	no	**Fhb_4A_Neuse**	no	no	no
DH13SRW022-23NUE	no	no	no	**Fhb_1A_Neuse**	no	no	no	no
VA17W-75	no	no	no	**Fhb_1A_Neuse**	no	**Fhb_6A_Neuse**	no	no
15VDH-FHB-MAS33-13	**Fhb1**	**Fhb_3B_Massey**	no	no	no	no	no	no
15VTK-12-21	no	**Fhb_3B_Massey**	**Fhb_1B_Jamestown**	**Fhb_1A_Neuse**	no	no	no	no
16VDH-SRW05-205	no	no	no	no	**Fhb_4A_Neuse**	no	no	no
MI17R0325	no	no	**Fhb_1B_Jamestown**	**Fhb_1A_Neuse**	**Fhb_4A_Neuse**	no	no	no
MI17R0415	no	no	**Fhb_1B_Jamestown**	no	no	no	**Fhb_2B_Bess**	**Fhb_3B_Bess**
MI16R0682	no	no	no	**Fhb_1A_Neuse**	**Fhb_4A_Neuse**	no	no	no
MI17R0311	no	no	**Fhb_1B_Jamestown**	no	no	no	no	no
KWS246	no	no	no	no	**Fhb_4A_Neuse**	no	no	no
KWS280	no	no	no	no	no	no	no	no
KWS283	no	no	no	**Fhb_1A_Neuse**	**Fhb_4A_Neuse**	no	no	no
KWS291	no	**Fhb_3B_Massey**	no	**Fhb_1A_Neuse**	no	no	no	no
KWS333	no	no	no	no	**Fhb_4A_Neuse**	no	no	no
NY12512-1-6-17	**Fhb1**	no	no	no	no	no	no	no
NY12397-1-4-13	**Fhb1**	no	no	no	**Fhb_4A_Neuse**	no	no	no
NY99056-161	no	no	no	no	**Fhb_4A_Neuse**	no	no	no
NY12299-1-3-20	**Fhb1**	no	no	**Fhb_1A_Neuse**	no	no	no	no
NY12508-1-7-15	Fhb1?	no	no	no	**Fhb_4A_Neuse**	no	no	no
IL15-27666	**Fhb1**	no	**Fhb_1B_Jamestown**	**Fhb_1A_Neuse**	**Fhb_4A_Neuse**	no	**Fhb_2B_Bess**	no
IL15-26131	no	no	**Fhb_1B_Jamestown**	**Fhb_1A_Neuse**	no	**Fhb_6A_Neuse**	no	no
IL15-4957	no	no	**Fhb_1B_Jamestown**	**Fhb_1A_Neuse**	no	no	**Fhb_2B_Bess**	no
IL13-1960	no	no	no	no	no	**Fhb_6A_Neuse**	**Fhb_2B_Bess**	no
IL15-2639	**Fhb1**	**Fhb_3B_Massey_het**	no	**Fhb_1A_Neuse**	**Fhb_4A_Neuse_het**	**Fhb_6A_Neuse**	no	no
OH14-112-34	**Fhb1**	no	no	**Fhb_1A_Neuse**	no	no	no	no
OH14-222-49	no	no	**Fhb_1B_Jamestown**	**Fhb_1A_Neuse_het**	no	no	no	no
OH15-191-52	**Fhb1**	**Fhb_3B_Massey_het**	no	no	no	**Fhb_6A_Neuse**	no	no
OH15-42-1	**Fhb1**	no	no	**Fhb_1A_Neuse_het**	no	no	**Fhb_2B_Bess_het**	no
KY07C-1145-94-12-5	no	no	**Fhb_1B_Jamestown**	**Fhb_1A_Neuse**	**Fhb_4A_Neuse**	no	no	no
15VDH-FHB-MAS32-07-3(	**Fhb1**	no	no	no	**Fhb_4A_Neuse**	no	no	no
X12-323-61-4-5	**Fhb1**	no	**Fhb_1B_Jamestown**	no	no	no	no	no
X12-072-3-17-5	**Fhb1**	no	no	no	no	no	no	no
X12-156-9-9-3	**Fhb1**	no	**Fhb_1B_Jamestown**	no	no	no	no	no
NE-14-494	no	no	no	**Fhb_1A_Neuse_het**	**Fhb_4A_Neuse**	**Fhb_6A_Neuse**	**Fhb_2B_Bess**	no
NE-14-696	no	no	no	**Fhb_1A_Neuse**	**Fhb_4A_Neuse**	**Fhb_6A_Neuse_het**	**Fhb_2B_Bess_het**	no
NE-15-624	no	no	no	no	**Fhb_4A_Neuse**	no	no	no
NE-17-589	no	no	no	**Fhb_1A_Neuse**	**Fhb_4A_Neuse**	no	**Fhb_2B_Bess_het**	no
NW-13-493	no	no	no	**Fhb_1A_Neuse_het**	no	**Fhb_6A_Neuse_het**	no	no
LES18-0685	no	no	**Fhb_1B_Jamestown**	**Fhb_1A_Neuse**	no	no	no	no
LES18-7031	no	no	**Fhb_1B_Jamestown**	**Fhb_1A_Neuse**	**Fhb_4A_Neuse**	no	**Fhb_2B_Bess**	**Fhb_3B_Bess**
LES18-1653	no	no	**Fhb_1B_Jamestown**	no	**Fhb_4A_Neuse**	no	no	no
LES172093	no	no	**Fhb_1B_Jamestown**	**Fhb_1A_Neuse**	no	**Fhb_6A_Neuse**	no	**Fhb_3B_Bess**
10534A1-17-17	**Fhb1**	no	no	**Fhb_1A_Neuse**	no	**Fhb_6A_Neuse**	no	no
10524A1-18-1	**Fhb1_het**	no	no	**Fhb_1A_Neuse_het**	no	**Fhb_6A_Neuse_het**	no	no
04620A1-1-7-4-13	**Fhb1**	no	no	**Fhb_1A_Neuse**	no	**Fhb_6A_Neuse**	no	no
08344B-1-1	**Fhb1**	no	**Fhb_1B_Jamestown**	ND	no	no	no	no

Table 35. Presence or absence of FHB QTL in the 2019-2020 PNUWWSN entries. Entries were also genotyped for Rht, Ppd, Vrn, rust, PM, Hessian Fly, BYDV, rye translocation, and quality genes. That data is available in an excel file from sneller.5@osu.edu. Data is from the USDA Eastern Regional Small Grains Genotyping Lab, Raleigh NC.

Commentsonmarker/trait	**Fhb1** = FHB resistance from Sumai 3/Ning 7840 on 3BS	**Fhb_3B_Massey** = FHB resistance QTL from Massey on 3B; based on flanking markers	**Fhb_1B_Jamestown** = FHB resistance QTL from Jamestown on 1B; based on flanking markers	**Fhb_1A_Neuse** = FHB resistance QTL from NC-Neuse on 1A; based on flanking markers	**Fhb_4A_Neuse** = FHB resistance QTL from NC-Neuse on 4A; based on flanking markers	**Fhb_6A_Neuse** = FHB resistance QTL from NC-Neuse on 6A; based on flanking markers	**Fhb_2B_Bess** = FHB resistance QTL from Bess on 2B; based on flanking markers	**Fhb_3B_Bess** = FHB resistance QTL from Bess on 3B; based on flanking markers
reliability	highly diagnostic	Useful for lines with Massey in pedigree	Seem to be broadly useful	unsure	unsure	unsure	unsure	unsure
SampleID	**Fhb1**	**Fhb_3B_Massey**	**Fhb_1B_Jamestown**	**Fhb_1A_neuse**	**Fhb_4A_Neuse**	**Fhb_6A_Neuse**	**Fhb_2B_Bess**	**Fhb_3B_Bess**
TRUMAN	no	no	**Fhb_1B_Jamestown**	**Fhb_1A_Neuse**	no	no	**Fhb_2B_Bess**	**Fhb_3B_Bess**
ERNIE	no	**Fhb_3B_Massey_het**	no	**Fhb_1A_Neuse**	no	**Fhb_6A_Neuse_het**	**Fhb_2B_Bess_het**	**Fhb_3B_Bess_het**
FREEDOM	no	**Fhb_3B_Massey**	no	**Fhb_1A_Neuse**	no	no	no	no
PIONEER2545	no	no	no	**Fhb_1A_Neuse_het**	no	no	no	no
15VDH-FHB-MAS10-25	**Fhb1_het**	no	no	**Fhb_1A_Neuse**	no	no	no	no
15VDH-FHB-MAS31-30	**Fhb1**	no	**Fhb_1B_Jamestown**	no	**Fhb_4A_Neuse**	no	no	no
16VDH-SRW03-023	no	no	**Fhb_1B_Jamestown**	no	no	no	no	no
DH15SRW67-151	no	**Fhb_3B_Massey**	no	**Fhb_1A_Neuse**	no	no	no	no
12VTK20-102	no	no	no	**Fhb_1A_Neuse**	**Fhb_4A_Neuse**	no	no	no
VA18W-54	no	no	no	no	**Fhb_4A_Neuse**	no	no	no
MI16W0102	no	no	**Fhb_1B_Jamestown_het**	no	no	no	no	no
MI17W0121	no	no	**Fhb_1B_Jamestown**	no	no	no	**Fhb_2B_Bess_het**	no
MI16R0830	no	no	no	**Fhb_1A_Neuse**	no	no	no	**Fhb_3B_Bess_het**
MI17R0386	no	no	**Fhb_1B_Jamestown**	no	no	**Fhb_6A_Neuse_het**	no	no
KWS263	no	no	no	no	no	no	no	no
KWS305	no	no	no	**Fhb_1A_Neuse_het**	**Fhb_4A_Neuse**	no	no	no
KWS316	no	no	**Fhb_1B_Jamestown**	no	no	no	no	**Fhb_3B_Bess**
KWS317	no	no	**Fhb_1B_Jamestown**	**Fhb_1A_Neuse**	no	no	no	**Fhb_3B_Bess**
KWS319	no	**Fhb_3B_Massey**	**Fhb_1B_Jamestown**	**Fhb_1A_Neuse**	no	no	no	no
IL16-36048	**Fhb1**	no	**Fhb_1B_Jamestown**	no	**Fhb_4A_Neuse**	no	no	no
IL16-8048	**Fhb1**	no	no	**Fhb_1A_Neuse**	**Fhb_4A_Neuse**	no	no	no
IL16-23972	**Fhb1**	no	**Fhb_1B_Jamestown**	no	**Fhb_4A_Neuse**	no	no	no
IL16-36206	**Fhb1**	no	**Fhb_1B_Jamestown**	**Fhb_1A_Neuse**	**Fhb_4A_Neuse**	no	no	**Fhb_3B_Bess_het**
IL16-4364	**Fhb1_het**	no	**Fhb_1B_Jamestown_het**	**Fhb_1A_Neuse_het**	no	no	**Fhb_2B_Bess_het**	no
OH15-131-31	**Fhb1**	**Fhb_3B_Massey**	no	no	**Fhb_4A_Neuse**	**Fhb_6A_Neuse**	no	no
OH16-182-26	**Fhb1**	no	no	**Fhb_1A_Neuse**	no	no	no	no
OH16-167-76	no	no	no	**Fhb_1A_Neuse_het**	no	no	no	no
OH16-168-48	no	no	**Fhb_1B_Jamestown_het**	**Fhb_1A_Neuse_het**	no	no	no	no
15VDH-FHB-MAS02-10-2-6-3	**Fhb1**	no	no	no	no	no	no	no
X12-862-16-13-5	Fhb1?	no	**Fhb_1B_Jamestown**	no	no	no	no	no
X12-461-32-3-1	**Fhb1**	no	**Fhb_1B_Jamestown_het**	**Fhb_1A_Neuse**	no	no	**Fhb_2B_Bess_het**	no
X12-3049-57-4-3	**Fhb1**	no	**Fhb_1B_Jamestown**	no	no	no	no	no
X12-839-11-18-5	**Fhb1**	no	**Fhb_1B_Jamestown**	no	no	no	**Fhb_2B_Bess_het**	no
0527A1-9-9-2-4	no	no	no	**Fhb_1A_Neuse_het**	no	no	no	no
984RE1-57-5	**Fhb1_het**	no	no	**Fhb_1A_Neuse_het**	no	**Fhb_6A_Neuse**	no	no
09186A1-10-2	no	no	**Fhb_1B_Jamestown**	**Fhb_1A_Neuse**	**Fhb_4A_Neuse**	no	no	no
10518RA1-1-6	no	no	**Fhb_1B_Jamestown_het**	**Fhb_1A_Neuse**	no	**Fhb_6A_Neuse_het**	no	no

Table 36. Quality parameters for the 2019-2020 NUWWSN. Data is from the USDA Soft Wheat Quality Lab. Additional information is available in an excel file from sneller.5@osu.edu.

			= *check used for this evaluation*
			= *favorable quality trait value*
			= *marginal quality trait value*
Quality Data			***For highlighted entries, please see the notes in line 68**

Lab Number	Entry Number	Entry	Test Weight (LB/BU)	NIR Kernel Protein (at 12%)	SKCS Kernel Hardness	SKCS Kernel Diameter (mm)	SKCS Kernel Weight (mg)	Adjusted Flour Yield (%)	Softness Equivalent (%)	Flour Protein (at 14%)	Lactic Acid SRC (%)	Sodium Carbonate SRC (%)
2010053	53	TRUMAN	59.3	9.6	14.4	2.6	34.2	67.5	57.8	7.6	104.2	68.3
2010054	54	ERNIE	58.3	10.6	4.6	2.9	40.9	67.7	60.0	8.2	116.5	67.0
2010055	55	FREEDOM	57.2	9.8	14.9	2.8	37.7	66.9	58.5	7.5	94.7	67.6
2010056	56	PIONEER2545	56.8	8.9	11.1	2.7	38.5	66.8	61.0	7.1	91.4	69.1
2010057	57	DH13SRW022-23NUE	58.1	9.5	14.5	2.8	38.6	65.7	62.3	6.9	119.4	74.7
2010058	58	VA17W-75	60.7	10.3	21.7	2.9	42.7	66.2	56.2	7.6	125.8	75.8
2010059	59	15VDH-FHB-MAS33-13	59.6	9.2	5.6	2.8	37.5	68.1	61.1	6.7	124.3	68.4
2010060	60	15VTK-12-21	60.1	9.9	17.5	2.9	41.9	68.2	55.1	7.5	118.5	68.7
2010061	61	16VDH-SRW05-205	58.6	10.2	12.4	3.0	47.8	65.6	57.5	7.8	106.3	69.4
2010062	62	MI17R0325	60.7	10.4	18.8	3.0	40.6	66.5	58.2	8.1	120.0	72.4
2010063	63	MI17R0415	59.5	10.4	6.8	2.9	45.9	67.4	54.7	8.3	111.5	69.0
2010064	64	MI16R0682	59.8	9.9	25.2	2.9	39.4	65.9	54.3	8.2	108.7	72.9
2010065	65	MI17R0311	59.3	9.4	18.8	2.8	36.9	66.5	58.5	7.6	114.1	73.2
2010066	66	SHIRLEY	57.9	9.9	3.6	2.9	45.0	69.0	58.4	7.5	88.5	70.4
2010067	67	KWS246	57.9	9.5	15.2	2.9	44.0	68.0	59.0	7.1	93.8	70.4
2010068	68	KWS280	60.7	10.0	19.2	3.0	40.1	66.8	54.9	8.6	107.9	67.6
2010069	69	KWS283	58.3	10.5	6.3	3.0	44.9	67.4	60.3	8.1	119.0	78.9
2010070	70	KWS291	59.4	9.8	11.1	2.8	41.3	67.3	58.4	7.7	121.0	69.6
2010071	71	KWS333	58.4	10.9	-3.7	2.8	42.0	66.6	56.3	8.2	139.2	75.6
2010072	72	NY12512-1-6-17	58.9	11.5	26.3	2.7	33.2	67.7	56.2	9.4	90.1	70.1
2010073	73	NY12397-1-4-13	59.0	11.5	5.8	2.8	40.6	66.5	61.9	9.1	111.7	72.0
2010074	74	NY99056-161	57.1	9.5	21.4	2.6	35.0	68.8	60.1	7.4	108.1	69.3
2010075	75	NY12299-1-3-20	58.5	9.3	18.1	2.8	40.7	65.0	56.9	7.5	98.7	74.2
2010076	76	NY12508-1-7-15	57.5	10.2	19.5	2.9	39.5	66.3	59.7	7.7	88.2	73.3
2010077	77	PIONEER 26R59	59.1	10.0	7.3	2.8	44.1	68.6	61.0	7.3	103.8	71.8
2010078	78	IL15-27666	59.9	10.2	3.7	3.0	43.8	68.1	57.1	7.8	122.3	67.9
2010079	79	IL15-26131	59.9	9.1	11.8	2.8	39.9	68.9	59.8	6.8	112.0	68.8
2010080	80	IL15-4957	60.4	9.8	4.9	2.8	36.6	66.7	61.9	7.5	120.1	69.0
2010081	81	IL13-1960	59.2	9.0	2.9	2.8	40.9	68.5	61.7	7.0	90.1	69.0
2010082	82	IL15-2639	61.3	10.0	-0.7	2.8	38.6	68.8	59.8	7.8	103.6	67.4
2010083	83	OH14-112-34	55.4	9.0	7.1	2.6	33.2	67.3	61.5	6.9	97.2	71.7
2010084	84	OH14-222-49	57.8	9.5	4.6	2.9	42.7	70.2	58.6	7.1	105.5	65.8
2010085	85	OH15-191-52	57.9	9.7	12.9	2.8	37.8	68.3	57.1	7.7	95.3	65.2
2010086	86	OH15-42-1	57.4	9.5	9.6	2.8	37.9	69.0	58.7	7.2	92.1	65.9
2010087	87	HILLIARD	59.0	10.1	7.7	2.9	42.4	66.7	60.7	7.3	117.7	69.9
2010088	88	KY07C-1145-94-12-5	59.6	9.0	1.5	2.8	37.3	68.0	63.6	7.2	103.4	70.3
2010089	89	15VDH-FHB-MAS32-07-30-12-5	59.7	9.9	5.9	2.8	38.8	64.1	59.9	7.7	118.4	66.6
2010090	90	X12-323-61-4-5	58.2	9.6	16.1	3.0	40.0	66.7	57.6	7.7	112.4	67.9
2010091	91	X12-072-3-17-5	58.6	9.9	15.0	2.8	36.2	68.5	60.7	7.8	132.9	69.0
2010092	92	X12-156-9-9-3	57.9	10.3	32.1	2.9	37.7	65.5	51.9	8.5	124.3	74.1
2010093	93	NE-14-494	59.2	9.6	53.1	3.0	41.5	69.3	47.5	8.6	132.7	80.1
2010094	94	NE-14-696	58.0	10.4	42.1	2.8	37.5	69.6	55.4	9.1	151.0	80.1
2010095	95	NE-15-624	60.1	10.4	65.1	2.8	35.0	67.6	40.9	9.9	142.9	83.2
2010096	96	NE-17-589	58.8	10.2	49.2	2.9	36.4	69.8	48.0	9.1	119.6	73.9
2010097	97	NW-13-493	60.6	10.4	59.5	2.9	38.8	66.8	40.8	9.5	133.3	84.1
2010098	98	JAMESTOWN	60.5	10.7	11.7	3.0	39.7	66.8	56.9	8.3	122.5	73.5
2010099	99	LES18-0685	59.8	10.2	12.0	2.7	37.4	67.9	58.3	7.8	115.4	72.0
2010100	100	LES18-7031	56.8	8.4	6.4	2.9	38.1	68.1	60.3	6.5	91.1	67.7
2010101	101	LES18-1653	58.6	10.0	14.3	3.0	40.6	68.3	56.4	7.5	108.9	67.7
2010102	102	LES172093	58.5	10.0	9.5	2.7	38.6	69.0	61.6	7.9	101.5	67.9
2010103	103	10534A1-17-17	59.4	10.4	10.1	2.9	40.2	66.7	62.7	8.0	131.3	77.3
2010104	104	10524A1-18-1	58.2	11.2	13.0	2.9	36.0	66.9	56.2	9.0	110.5	72.0
2010105	105	04620A1-1-7-4-13	57.9	10.5	15.2	2.8	37.6	67.2	57.6	8.2	92.1	70.0
2010106	106	08344B-1-1	57.8	9.4	13.8	3.0	39.1	66.7	57.2	7.2	109.4	72.7
2010107	107	BRANSON	58.5	10.0	7.1	2.7	39.5	68.4	60.9	7.8	121.0	68.0
		Average	58.8	9.9	15.5	2.8	39.5	67.5	57.6	7.8	111.9	71.2
		Standard Deviation	1.2	0.6	14.2	0.1	3.1	1.3	4.6	0.7	14.8	4.2

Table 37. Quality parameters for the 2019-2020 PNUWWSN. Data is from the USDA Soft Wheat Quality Lab. Additional analytical data is available in an excel file from sneller.5@osu.edu.

			= *check used for this evaluation*										
PNUWWSN			= *favorable quality trait value*										
			= *marginal quality trait value*										
Quality Data			***For highlighted entries, please see the notes in line 54**										
Lab Number	Entry Number	Entry	Test Weight (LB/BU)	NIR Kernel Protein (at 12%)	SKCS Kernel Hardness	SKCS Kernel Diameter (mm)	SKCS Kernel Weight (mg)	Adjusted Flour Yield (%)	Softness Equivalent (%)	Flour Protein (at 14%)	Lactic Acid SRC (%)	Sodium Carbonate SRC (%)	Adjusted Flour Yield % Grade
2010108	108	TRUMAN	59.8	10.0	16.5	2.6	32.7	67.7	57.1	7.9	106.8	69.8	D
2010109	109	ERNIE	58.6	10.6	3.6	2.9	40.1	67.5	58.0	8.3	117.8	66.8	D
2010110	110	FREEDOM	56.8	10.0	13.7	2.7	36.5	67.1	58.3	7.5	93.2	70.0	D
2010111	111	PIONEER2545	56.2	10.1	15.5	2.6	34.5	67.2	59.6	8.3	100.7	69.9	D
2010112	112	15VDH-FHB-MAS10-25	61.9	11.6	18.0	3.1	44.0	67.0	54.5	9.3	113.2	65.1	D
2010113	113	15VDH-FHB-MAS31-30	60.5	11.0	17.6	2.9	38.6	65.8	58.1	8.6	132.9	70.2	F
2010114	114	16VDH-SRW03-023	59.4	10.6	14.4	2.9	40.8	68.0	56.1	8.2	107.5	70.5	C
2010115	115	DH15SRW67-151	59.2	10.4	12.8	2.9	39.2	68.5	56.8	7.5	114.4	68.6	C
2010116	116	12VTK20-102	60.6	11.4	35.6	3.1	42.6	65.3	48.9	8.8	121.0	77.4	F
2010117	117	VA18W-54†	60.9	10.6	19.4	2.7	39.8	66.0	59.0	8.5	128.3	74.6	F
2010118	118	MI16W0102	57.2	9.2	16.9	2.9	40.7	67.1	56.4	7.3	102.2	72.9	D
2010119	119	MI17W0121	57.5	9.7	10.4	2.9	40.5	70.1	59.2	7.1	99.8	69.5	B
2010120	120	MI16R0830	59.9	10.4	22.1	3.0	39.0	69.4	52.7	8.2	96.6	67.1	C
2010121	121	MI17R0386	59.9	9.9	16.6	2.8	37.3	68.7	54.8	7.8	115.8	68.9	C
2010122	122	SHIRLEY	57.8	10.3	3.8	2.9	44.6	68.8	57.0	7.9	91.4	71.3	C
2010123	123	KWS263	58.2	10.9	6.2	2.9	47.9	69.4	60.7	8.0	105.5	68.0	C
2010124	124	KWS305	58.4	9.5	13.3	2.8	44.5	67.9	57.0	7.5	93.1	72.7	D
2010125	125	KWS316	56.8	9.1	9.3	2.8	44.1	69.2	57.7	7.0	104.8	69.8	C
2010126	126	KWS317	56.3	9.3	0.4	2.8	40.9	69.4	62.5	6.9	109.8	70.6	C
2010127	127	KWS319	55.0	9.3	8.5	2.9	36.4	67.6	58.7	6.7	95.8	69.9	D
2010128	128	IL16-36048	56.8	9.4	16.5	2.8	37.5	68.3	60.2	7.2	93.9	67.6	C
2010129	129	IL16-8048	58.6	9.7	11.6	2.9	37.0	70.0	60.2	7.3	128.3	68.9	B
2010130	130	IL16-23972	59.6	10.1	12.8	2.8	39.2	68.6	57.6	8.2	119.6	68.3	C
2010131	131	IL16-36206	58.9	10.4	12.0	2.9	40.7	68.2	61.1	8.2	111.8	67.9	C
2010132	132	IL16-4364	58.1	9.2	4.9	2.9	40.8	69.0	59.8	6.9	110.6	66.9	C
2010133	133	PIONEER 26R59	58.4	9.8	7.2	2.8	44.3	69.0	61.8	7.2	103.7	72.5	C
2010134	134	OH15-131-31	57.0	10.4	19.7	3.0	44.3	69.6	51.6	8.1	88.9	68.0	B
2010135	135	OH16-182-26	58.6	9.8	12.7	3.0	40.5	67.7	58.6	7.4	115.9	66.5	D
2010136	136	OH16-167-76	57.8	10.6	19.9	3.0	42.2	70.4	54.1	8.2	122.2	67.4	B
2010137	137	OH16-168-48	57.6	10.2	13.8	3.1	43.8	70.7	55.6	8.2	124.4	66.1	A
2010138	138	15VDH-FHB-MAS02-10-2-6-3	60.1	10.7	12.9	3.1	45.9	67.6	58.1	8.7	108.0	72.4	D
2010139	139	X12-862-16-13-5	56.7	9.5	15.1	3.0	40.1	66.5	62.2	7.2	92.9	68.1	F
2010140	140	X12-461-32-3-1	56.2	9.5	13.1	3.1	41.8	66.2	57.7	7.8	103.9	68.3	F
2010141	141	X12-3049-57-4-3	58.2	9.5	18.9	3.0	39.2	64.5	59.4	7.5	101.9	70.6	F
2010142	142	X12-839-11-18-5	57.9	10.1	18.5	3.0	41.0	67.2	60.0	8.0	111.0	69.0	D
2010143	143	HILLIARD	59.1	10.4	11.2	2.9	41.5	66.8	59.8	7.6	120.9	70.8	D
2010144	144	0527A1-9-9-2-4	57.9	9.7	10.3	2.9	40.4	65.8	63.9	7.4	121.2	74.0	F
2010145	145	984RE1-57-5	59.9	10.6	27.0	2.9	35.0	66.9	55.0	8.5	102.9	68.3	D
2010146	146	09186A1-10-2	58.1	10.7	15.3	2.9	39.3	65.8	59.0	8.3	98.8	71.5	F
2010147	147	10518RA1-1-6	58.7	10.8	18.2	2.8	39.7	64.5	56.6	8.9	115.4	72.6	F
2010148	148	BRANSON	57.5	10.0	8.3	2.8	41.4	68.0	61.0	7.7	119.4	69.0	C
		Average	58.4	10.1	14.0	2.9	40.5	67.8	58.0	7.8	108.9	69.7	
		Standard Deviation	1.5	0.6	6.4	0.1	3.2	1.6	3.0	0.6	11.4	2.5	