Project FY22-SP-006: Determining FHB Susceptibility in Wheat Cultivars in the Western US

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1. What are the major goals and objectives of the research project?

FHB damage in spring grain continues to increase in southern and eastern Idaho. Several years in a row, fields of spring wheat showed signs of the disease, and many spring wheat fields tested at >5 ppm DON, even after appropriate treatments with fungicides. Growers now regularly incorporate fungicide treatments for FHB suppression as standard practices for susceptible varieties, especially for hard white spring wheats, one of the two very susceptible classes (hard white spring and durum). The majority of the wheat varieties that are available to growers in the area are susceptible to FHB. Growers need information on FHB susceptibility of the varieties that currently are being grown and those newly released. Breeders need information on advanced lines and breeding material to release selections with reduced vulnerability to FHB damage and DON accumulation. Management practices need to be tested under the unique conditions in the irrigated production regions of the Intermountain West to develop appropriate management practices to reduce FHB and DON in susceptible cultivars. Project goals: Our specific objectives for this proposal were to: 1) determine the degree of susceptibility that exists in currently grown varieties and advanced lines to local *Fusarium graminearum* isolates, 2) provide DON data to local breeders and growers to increase the ability to select the best varieties for breeding and production. Awareness of variety reaction to FHB determines need for potential fungicide applications. Specific objectives - The specific objectives were to screen currently grown varieties to determine degree of susceptibility and assess risk of DON under intermountain west irrigated production conditions, and to select for increased resistance in breeding lines of wheat and barley to improve FHB resistance and reduce DON in newly released varieties.

2. What was accomplished under these goals or objectives? *(For each major goal/objective, address these three items below.)*

What were the major activities?

An assessment of released wheat cultivars and advanced lines from entries in the University of Idaho Extension Variety trials was conducted in on-station FHB nurseries at the Aberdeen Research and Extension Center. A second location at the USDA-ARS research facility at Kimberly, Idaho was added to add winter wheat testing, increase the number of environments and to include an environment more conducive to infection. Additional breeder material from Montana State University and a private breeding company (a division of Nutrien Ag) were included for testing. Winter wheat classes of soft white winter, hard white winter, and hard red winter where tested in Kimberly in conjunction with the USDA-ARS sites in Aberdeen and Kimberly. Spring wheat classes of soft white, hard white and hard red spring wheat were tested of existing varieties and advanced cultivars. Resistant and susceptible checks were: (for spring wheat) Jefferson hard red spring (susceptible check), and Rollag hard red spring (resistant check). Experimental units consisted of two-row plots with two replications using a randomized complete block design. Plots were 5-foot-long rows planted with a Hege 1000 headrow planter. Special irrigation systems were designed and installed to provide an environment conducive for FHB infection while simultaneously meeting the irrigation needs of the crop.

Autoclaved corn was inoculated with *F. graminearum* and allowed to grow for three weeks before drying. Corn spawn was spread in the field approximately three weeks prior to anthesis of the earliest lines at 60 grams per plot. During and after anthesis, plots were irrigated every other day for two hours. An irrigation system with sprinkler nozzles every 20 feet is used both for irrigation and increasing humidity in the plant canopy. A misting system provided additional moisture to increase likelihood of infection every day Monday through Sunday (run intermittently for 5 hours in the evening 5pm-10pm and three hours in the morning 6am-9am).

FHB was assessed in each plot at about soft dough (Feekes 11.2). Scab readings were done 21 days after flowering (24 days post-heading). Thirty spikes per plot were rated for percent disease severity. Percent incidence was determined by calculating the proportion of infected and the total number of assessed heads. FHB index is calculated using the formula: FHB Index = (% severity x % incidence) /100. On-site weather stations were used to collect temperature and humidity data. Plots were harvested using Wintersteiger Classic small plot combine and weighed for yield and test weight. Harvested samples were assessed for VSK prior to testing for DON. Samples were ground and submitted to the USWBSI-funded DON testing laboratories in St. Paul, MN for DON analysis.

What were the significant results?

Good disease formed in the winter and spring nurseries in Kimberly. (The spring nurseries in Aberdeen were misplanted and not reported.) DON levels were also obtained with the collaboration of Dr. Yanhong Dong, University of Minnesota. Consistent levels of disease have been achieved for several years.

In spring wheat for the hard red and white group, Rollag had the lowest FHB Index at 6.0 and 0.2 ppm DON (Table 3). DON levels ranged from a low of 0.2 ppm to 10.6 ppm in the hard red spring wheat Hale. In the soft white spring wheat, the most susceptible lines were the club wheats, and the most resistant was Seahawk (Table 4).

Winter wheat and winter barley was not planted in Aberdeen due to cooler conditions at heading that generally result in poor infection. At Kimberly, VI Presto CL+, AP Exceed, Stingray CL+ had the lowest FHB Indexes of the soft white winter, and UI Sparrow, TMC Empire and Devote had the highest. DON varied from 5.0 ppm to 36.8 ppm. Of the hard winter wheat, the lowest FHB indexes were WB4401, Utah 100, Kairos and MT Warcat, and the highest were in WB4422, UI Bronze Jade (W) and UI SRG. DON varied from 3.4 ppm to 52 ppm.

Table 1. Hard Winter Wheat Summary sorted by FHB Index – Kimberly.

Variety	Entry #	Class	INC	SEVERITY	INDEX	Yield (bu/A)	FDK (%)	DON (ppm)
WB4401	75	hww	75	28	22	40.6	8.7	3.4
Utah-100	63	hww	85	28	24	32.0	12.2	10.4
Kairos	18	hww	90	27	25	33.5	11.5	6.0
MT Warcat	29	hww	88	29	28	43.7	13.9	6.6
Keldin 1	20	hww	83	39	32	38.8	5.6	3.5
WB4510CLP	77	hww	85	38	32	40.8	8.4	4.9
Keldin 2	19	hww	93	36	33	37.7	15.9	9.3
IDO2006 (W)	15	hww	83	41	34	33.4	16.3	13.7
HSG108	13	hww	88	43	37	33.8	18.6	5.9
Balance	5	hww	85	45	39	36.8	11.8	6.1
Milestone	25	hww	85	47	40	35.2	20.2	15.2
LCS Jet	23	hww	83	51	42	31.5	17.2	9.2
OR2190064R	37	hww	70	62	43	36.1	26.4	20.0
Millie (W)	26	hww	85	51	44	37.2	11.1	8.5
Caledonia	6	Check	73	52	44	25.9	6.7	5.8
Apst52	4	hww	88	49	45	37.8	13.8	8.7
UT11223-10	61	hww	75	58	46	42.4	15.9	12.5
MT1745	28	hww	85	55	46	32.3	25.2	30.8
Scorpio	42	hww	93	52	48	29.8	29.2	24.7
WB4303	74	hww	100	48	48	37.1	13.3	7.6
Yellowstone	78	hww	78	66	50	34.7	29.0	25.3
FourOsix	11	hww	85	59	51	35.5	14.0	9.5
Sequoia	43	hww	80	65	52	15.1	15.6	15.9
Flathead	10	hww	95	58	55	33.9	24.8	20.4
UT11317-8	62	hww	90	61	56	36.7	13.0	11.6
MT 2019	30	hww	98	58	56	34.4	23.7	19.7
Juniper	17	hww	88	63	58	32.8	19.2	22.1
UI Silver (W)	52	hww	75	78	58	14.4	26.6	22.9
Promontory	41	hww	90	74	66	13.6	23.6	21.0
Irv (W)	16	hww	98	68	67	28.8	23.2	18.1
Golden Spike (W)	12	hww	90	74	67	33.0	13.0	7.3
LCS Rocket	24	hww	100	70	70	32.5	19.9	19.4
MT1491 (W)	27	hww	95	75	72	38.9	16.2	19.3
UI SRG	54	hww	90	83	75	18.1	13.2	13.4
UI Bronze Jade 1 (W)	50	hww	98	78	76	27.2	26.2	52.1
WB4422	76	hww	100	83	83	35.0	7.2	10.3
P=0.05			**0.72**	**0.01**	**0.06**	**0.0011**	**<0.0001**	**<0.0001**

Table 2. Soft White Winter Wheat Summary sorted by FHB Index - Kimberly

Variety	Entry #	Class	INC	SEVERITY	INDEX	Yield (bu/A)	FDK (%)	DON (ppm)
VI Presto CL+	64	sww	73	30	22	35.0	7.4	5.0
AP Exceed	1	sww	68	37	28	33.9	10.9	6.6
Stingray CL+	46	sww	78	36	29	38.6	7.8	6.6
Piranha CL+	40	sww	85	34	31	39.7	15.9	9.5
Sockeye CL+	44	sww	83	39	32	40.2	13.8	11.9
UI Magic CL+	51	sww	80	40	33	30.5	11.7	10.3
UIL 17-995133B	57	sww	85	42	35	44.1	12.4	14.3
VI Voodoo CL+	66	sww	73	49	36	31.7	19.6	19.1
WA8293	67	sww	75	48	37	41.1	12.5	6.1
AP Iliad	2	sww	78	47	37	31.5	20.7	12.6
Appleby CL+	3	sww	93	40	38	33.4	11.1	9.2
IDO1708	14	sww	80	48	39	29.0	15.8	13.2
UIL15-028024	59	sww	88	45	39	39.1	24.3	15.5
WB1783	73	sww	85	49	42	31.7	41.6	36.1
Norwest Duet	31	sww	90	46	42	33.0	10.1	8.4
Nimbus	33	sww	90	48	43	36.8	13.6	13.7
WB 456	69	sww	75	55	43	37.3	8.9	5.9
Stephens	45	sww	90	49	44	25.6	30.9	30.6
Caledonia	6	Check	73	52	44	25.9	6.7	5.8
Norwest Tandem	32	sww	85	49	45	32.5	10.5	6.0
UIL13-046145A	58	sww	90	51	46	33.0	24.0	15.6
SY Ovation	48	sww	88	53	47	35.0	25.1	25.0
SY Assure	47	sww	90	53	47	31.8	19.9	10.9
LCS Hulk	22	sww	90	53	48	39.5	16.0	9.8
Eltan	8	sww	85	56	48	37.6	23.8	17.7
OR2170559	36	sww	83	59	49	31.9	28.8	18.4
UIL 17-7706 (CL+)	56	sww	93	52	49	31.3	19.9	15.7
VI Shock	65	sww	90	57	51	39.4	25.8	13.6
LCS Blackjack	21	sww	90	57	52	30.1	14.4	8.5
UIL16-478001	60	sww	83	63	53	32.3	22.7	14.0
Eltan 11-52-0	9	sww	90	60	54	39.4	23.7	15.5
OR2160243	34	sww	90	61	55	30.5	25.8	14.3
WB1376CLP	70	sww	85	68	58	31.5	12.1	8.1
WA8334	68	sww	90	64	58	30.6	23.7	22.7
Otto	39	sww	93	63	59	33.6	22.0	16.8
UIL 14-211120A	55	sww	93	64	59	36.9	22.4	21.5
OR2160264	35	sww	95	63	60	32.0	19.7	20.6
WB1529	71	sww	100	63	63	28.9	34.6	22.3
WB1621	72	sww	98	65	63	33.1	20.8	11.5
UI Sparrow	53	sww	90	72	65	35.7	15.8	13.4
TMC M-Pire	49	sww	100	65	65	20.7	32.5	36.8
ORI2190027CL+	38	sww	100	73	73	25.5	24.5	16.9
Devote	7	sww	100	74	74	32.0	28.7	29.9
P=0.05			**0.72**	**0.01**	**0.06**	**0.0011**	**<0.0001**	**<0.0001**

Table 3. Hard Spring Wheat Summary sorted by FHB Index – Kimberly.

2023 Spring Wheat FHB screening: Kimberly

Var	Entry #	Class	Severity	INC %	INDEX	Yield (bu/A)	FDK(%)	DON (ppm)
Rollag	33	hrs	30	20	6.0	7.9	0.2	0.2
Duclair	9	hws	46	15	6.7	9.3	1.8	0.5
MT1809	26	hrs	47.5	15	7.8	10.1	0.2	0.6
WB9879CLP	64	hws	42	20	8.3	9.8	5.3	5.2
Rocker	31	hws	36	25	9.1	9.8	11.0	3.7
WA 8330 (W)	44	hws	36.5	25	9.4	7.8	0.8	1.8
LCS Hammer AX	23	hrs	31.5	30	9.5	11.2	2.4	1.2
AP Venom	4	hrs	31.5	30	10.4	8.7	4.4	5.4
Alum	2	hrs	31.5	40	12.4	8.2	1.9	3.2
HRS3419	15	hrs	48.5	25	12.4	9.7	0.4	0.3
WA 8374 (W)	53	hws	31.5	40	12.4	8.8	3.9	4.5
UI Gold	40	hws	51	25	12.5	9.9	7.4	4.0
WB9724CLP	63	hrs	50.5	25	13.0	8.4	1.5	2.4
MT2030	28	hrs	51.5	25	13.1	10.6	0.9	1.5
IDO2202CL2	21	hrs	47	30	14.1	9.6	0.5	0.7
MT1939	27	hrs	47	30	14.1	11.0	3.7	2.9
WA 8359	50	hrs	41.5	35	15.4	8.3	7.5	6.4
Expresso	10	hrs	46.5	35	16.1	6.6	11.4	6.1
Dagmar	7	hrs	53.5	30	16.4	8.5	2.9	2.4
Net CL+	30	hrs	65.5	25	16.4	7.7	2.6	3.5
WB7589 (W)	59	hws	47	35	16.6	7.8	3.0	7.4
WA 8342W	46	hws	55.5	35	19.7	9.7	2.9	2.1
MT2063	29	hrs	54	35	19.7	10.7	7.4	4.3
WA 8372 (W)	51	hws	49.5	40	19.8	8.8	2.0	2.6
Dayn (W)	8	hws	50.5	35	20.3	10.1	0.7	3.2
WA 8342R	45	hrs	51.5	40	20.5	9.3	4.8	4.9
WA 8373	52	hrs	54.5	40	21.2	10.2	1.0	4.5
IDO2104HF	19	hws	53	40	21.6	9.1	0.2	4.1
IDO2105S	20	hrs	64	35	22.8	9.4	3.0	2.3
SY-Teton (W)	37	hws	51.5	45	23.3	8.0	2.0	8.2
Choteau	6	hws	53.5	45	23.9	6.5	6.0	6.0
Jefferson HF	22	hrs	69.5	35	24.3	9.1	3.3	2.4
WB7313 (W)	58	hws	62	40	24.5	9.5	1.0	4.7
WA 8357	49	hrs	71	35	24.7	8.6	2.5	1.7
WB9707	62	hrs	62.5	40	25.0	9.9	2.8	4.2
WB7202CLP (W)	57	hws	63	40	25.3	5.9	4.2	5.9
WB7696 (W)	60	hws	73.5	35	25.5	9.8	1.8	3.8
SY Gunsight	36	hrs	64.5	40	25.8	9.8	2.7	1.9
WA 8388CL+	54	hrs	64.5	40	26.1	7.3	13.2	6.8
Hale	12	hrs	61	45	27.1	8.3	13.8	10.6
IDO2002 (W)	18	hws	53	50	28.4	6.4	4.2	5.3
WA 8356	48	hrs	66	45	30.1	9.8	8.2	7.1
Glee	11	hrs	71.5	45	32.2	7.8	5.0	3.2
WB9668	61	hrs	66.5	55	36.3	7.2	12.9	7.9
Holmes	14	hrs	79	60	47.2	9.5	4.3	2.5
UI Platinum (W)	41	hws	76	70	53.4	6.2	3.9	8.0
P=0.05			**<0.0001**	**<0.0001**	**<0.0001**	**0.1840**	**<0.0001**	**<0.0001**

Table 4. Soft White Spring Wheat Summary sorted by FHB Index – Kimberly.

Var	Entry#	Class	Severity	INC %	INDEX	Yield (bu/A)	FDK (%)	DON (ppm)
Seahawk	35	sws	41.5	10	4.2	11.6	0.7	0.6
IDO1902S	17	sws	46	15	6.7	6.7	4.0	0.9
Alturas	1	sws	54	15	7.5	9.3	0.2	0.6
Tekoa	38	sws	38.5	20	7.7	9.0	0.3	1.0
WA 8351	47	sws	50	20	10.0	8.9	0.2	0.5
AP Coachman	3	sws	47	25	11.6	6.4	6.2	4.3
IDO1404S	16	sws	46	25	11.6	7.5	2.3	1.0
WA 8327	43	sws	58.5	25	14.7	9.7	0.8	1.2
WB6430	56	sws	64	30	19.3	9.9	2.4	2.3
Butch CL+	5	sws	48.5	45	21.6	7.9	4.5	1.9
UI Cookie	39	sws	55.5	50	28.7	10.9	2.3	2.1
Louise	24	sws	70.5	45	31.8	5.3	11.4	6.3
UI Stone	42	sws	72	45	32.2	9.7	1.0	2.6
Ryan	34	sws	69	50	34.3	7.3	2.6	3.4
WB6211CLP	55	sws	68	50	34.9	7.7	5.4	6.4
Hedge CL+ (club)	13	sws	74.5	50	37.4	10.3	3.5	3.4
Melba (club)	25	sws	63	65	42.9	8.5	0.8	1.2
Roger (WA 8325)	32	sws	69.5	75	52.3	7.6	0.9	1.0
P=0.05			**<0.0001**	**<0.0001**	**<0.0001**	**0.1840**	**<0.0001**	**<0.0001**

List key outcomes or other achievements.

The results of the previous FHB experiments and this study was/will be presented numerous times at the local, national and international level. Consultants and breeding companies in the area have used this data to improve variety recommendations, and growers now regularly spray to reduce FHB and DON in susceptible and moderately susceptible spring wheat cultivars. Growers are now aware of the varieties that are less likely to get FHB and suffer high DON, and to spray those varieties they know are vulnerable, especially when following corn in their crop rotations.

3. What opportunities for training and professional development has the project provided? We have trained two graduate students on these projects (one PhD candidate and one MS candidate) as well as additional training for a support scientist who have or will present the results at the USWBSI National FHB Forum.

4. How have the results been disseminated to communities of interest?

The results of all the trials are published in our Annual Small Grains Report, disseminated to collaborating breeders, presented at various grower seminar and field events, and reported annually at the National FHB Forum.

5. What do you plan to do during the next reporting period to accomplish the goals and objectives? There are no proposed changes to the trials.