Project FY22-HW-010: Breeding for Scab Resistance in NE HWW by Optimizing Introgression and Selection

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1. **What are the major goals and objectives of the research project?**
   Obj. 1 Increase the proportion of University of Nebraska wheat breeding crosses targeted towards FHB resistance and DON accumulation: In
   Obj. 2 Improve evaluation and selection of germplasm with increased FHB resistance and reduced DON accumulation.
   Obj. 3: Evaluate the effect of genotype x fungicide treatments for FHB in our conventional vs intensive management breeding trials.

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

   What were the major activities?
   Obj 1- We completed crossing blocks in 2023 and 2024 to introgress FHB resistance.
   Obj 2- We continue to evaluate the FHB regional nurseries for public and private breeding programs in the hard winter wheat region. We also evaluate the UNL preliminary yield trial, advanced yield trial, and elite yield trial.
   Obj 3- We planted yield trials to evaluate variety performance in fungicide vs no fungicide applied experiments.

   What were the significant results?
   Obj 1- In 2023, we made 26 planned crosses to introgress Fhb1 and 7 crosses involving Fhb6. 101 other crosses were made using parents that have good phenotypic tolerance to FHB or reduced DON levels. In total, 23% of the crosses we made in 2023 involve some form of tolerance to FHB. In 2024, we made 32 planned crosses to introgress Fhb1 and 15 crosses involving Fhb6. Three of the Fhb6 crosses also involved Fhb1. Seventy-five other crosses were made using parents that have good phenotypic tolerance to FHB or reduced DON levels. In total, 28% of the crosses we made in 2024 involve some form of tolerance to FHB.
   Obj 2- We continue to evaluate the FHB regional nurseries for public and private breeding programs in the hard winter wheat region. In 2023, the trial was subjected to severe drought from planting to harvest. We achieved much better results for the 2024 trials (Table 3, Table 4). We are also seeing our efforts to increase the number of crosses focused on improving FHB tolerance and improve selection for FHB tolerant UNL wheat lines improve. Table 3 shows that the newer germplasm in the Preliminary Yield Trials (PYT) and Advanced Yield Trials (AYT) has more tolerance to FHB than in the most elite germplasm (Elite Yield Trial, EYT).
   Obj 3- In 2023, we did not observe Genotype x Management effects when comparing fungicide treated vs untreated plots due to the severe drought. We have not yet analyzed the 2024 trials, but we expect to see a difference in yield when comparing fungicide treated vs untreated plots primarily due to stripe rust. We will evaluate FDK although few physical symptoms of FHB were observed.

Table 3: Mean nursery results for the 2024 Wheat FHB Irrigated Nursery in Lincoln, NE

2024 Nursery	Average Severity	Average Incidence	Average Index
UNL PYT 2024 ($F_{3:6}$)	13.9	9.7	2.8
UNL AYT 2024 ($F_{3:7}$)	15.1	8.9	2.8
UNL EYT 2024 ($F_{3:8+}$)	20.9	9.6	4.1
2024 NUWWSN	13.7	14.8	4.3
2024 HWW Regional (NH +PI)	20.8	14.3	5.7

Table 4: Fusarium Head Blight Disease Symptoms, in the NIN Nursery, Havelock Farm, Lincoln, NE, 2024 and 2022-2024.

Entry	Nursery	2024 UNL EYT Performance Name	Severity	Incidence	Index	Three-Year Mean Performance (20 Severity	Incidence	Index	FDK	22-2024) DON
			%			%				ppm
1	EYT	CHEYENNE	3	7	1	12	17	7	17	5
2	EYT	SCOUT66	20	13	4	15	33	8	19	4
3	EYT	LCSValiant	3	7	1	6	27	8	21	1
4	EYT	GOODSTREAK	7	10	1	7	28	8	15	2
5	EYT	Ruth	34	20	9	12	32	14	20	2
6	EYT	Robidoux	17	7	2	10	37	11	19	6
7	EYT	NE19619	33	3	3	13	15	6	21	5
8	EYT	NE17441	33	17	6	18	27	15	15	3
9	EYT	NI17410	19	20	8	12	30	7	15	1
10	EYT	NE18455	27	10	5	13	29	13	19	4
11	EYT	NE19455	5	7	1	11	23	5	23	3
12	EYT	NE18445	33	7	7	20	24	9	23	2
13	EYT	NW15443	33	3	3	11	16	15	18	4
14	EYT	NHH19668	20	3	2	14	23	9	30	2
15	EYT	NE19406	3	3	0	10	27	10	23	2
16	EYT	NE18435	33	7	7	16	14	9	28	1
17	EYT	NHH19651	33	3	3	14	21	8	24	4
18	EYT	NE20620	3	3	0	4	13	9	20	3
19	EYT	NE21582	0	0	0	5	24	6	23	3
20	EYT	NE21489	51	47	33	22	37	18	27	5
21	EYT	NE21656	33	7	7	18	21	8	23	2
22	EYT	NE21464	37	7	4	18	28	7	24	3
23	EYT	NE21579	0	0	0	4	18	13	20	4
24	EYT	NE21503	13	3	3	10	23	14	21	4
25	EYT	NE21448	27	13	5	10	18	7	23	4
26	EYT	NE21646	33	3	3	13	15	13	17	3
27	EYT	NHH21441	7	7	1	5	20	6	21	2
28	EYT	NEB14842	20	7	4	23	19	5	1	5
29	EYT	NEB14512	3	3	0	13	18	8	16	3
30	EYT	NEB14753	37	7	4	14	19	6	13	3
31	EYT	NHH22373	47	33	16	30	38	22	1	3
32	EYT	NE22129	37	10	4	23	24	12	7	5
33	EYT	NE22155	46	17	8	31	30	20	7	5
34	EYT	NE22162	22	10	4	19	29	17	6	2
35	EYT	NE22168	10	17	2	14	45	12	4	2
36	EYT	NE22171	0	0	0	2	12	9	5	3
37	EYT	NE22172	0	0	0	8	19	17	5	3
38	EYT	NE22174	7	3	1	7	15	11	2	1
39	EYT	NE22182	3	3	0	6	22	10	2	2
40	EYT	NE22183	3	3	0	7	28	9	3	2
41	EYT	NE22195	38	20	8	29	45	18	2	4
42	EYT	NE22199	38	23	7	23	43	11	2	2
43	EYT	NE22200	10	10	2	8	27	8	1	2
44	EYT	NE22209	37	13	4	24	30	14	2	3
45	EYT	NE22212	35	20	7	22	32	12	4	2
46	EYT	NE22215	23	7	2	15	20	11	1	2
47	EYT	NE22237	47	20	9	29	32	18	1	5
48	EYT	NE22238	3	3	0	9	33	12	1	2
49	EYT	NE22244	3	3	0	10	23	17	4	5
50	EYT	NE22247	0	0	0	1	9	6	1	3
51	EYT	NE22249	3	3	0	6	23	8	0	1
52	EYT	NE22252	7	7	1	9	30	13	2	2
53	EYT	NE22262	53	23	12	33	40	16	2	1
54	EYT	NE22271	33	3	3	20	17	26	3	2
55	EYT	NE22284	36	23	12	27	43	20	3	5
56	EYT	NE22287	30	7	3	16	40	12	3	2
57	EYT	NE22289	3	3	0	11	35	12	4	4
58	EYT	NE22314	7	7	1	13	38	13	2	1
59	EYT	NE22320	3	3	0	3	12	4	3	6
60	EYT	NE22342	49	24	9	3	25	8	3	4
Mean			21	10	4	14	26	12	12	3
StDev			16	9	5	8	9	5	10	1
CV			79	94	130	55	34	39	81	45
Range			53	47	33	32	36	22	30	5

List key outcomes or other achievements.

We have generated multiyear FHB phenotype data for all our key UNL wheat nurseries as well as for the regional screening nursery supported by Dr. Jessica Rupp at KSU. This data is being used to inform selection and advancement decisions as well as to select parents for crossing to develop superior breeding lines with increased FHB resistance. We also have submitted crosses for the Doubled Haploid generation project at Texas A&M led by Dr. Shuyu Liu.

In Fall 2023, UNL released NE Prism CLP (PVP pending) a new wheat variety with moderate FHB resistance. It is targeted toward the NE Panhandle, an area where few available varieties have FHB resistance and that experienced a severe FHB outbreak in 2023.

3. **What opportunities for training and professional development has the project provided?**
   This project and the UNL BAR-CP project have supported a summer research intern in 2023 and 2024. Interns receive training in wheat breeding and genetics, field data collection, harvest and data analysis. The data summaries presented in this report were supported by 2024 Intern Jennifer Antwi.

4. **How have the results been disseminated to communities of interest?**
   We share updates on all nurseries with collaborators as well as at conferences and presentations. We also include updates on FHB infections, prevention, and research at field days such as the annual UNL Wheat Variety Tours.

5. **What do you plan to do during the next reporting period to accomplish the goals and objectives?**
   May 2024-July 2024: Field-based phenotyping of elite, advanced, and potentially preliminary breeding nurseries as well as regional nurseries. Management of misted nursery including inoculation, plot management, data collection, and harvest. Preliminary development of genomic prediction models. Selection of lines for fall crossing block.
   July 2024-Sept 2024: Harvest field disease nursery, data analysis, processing samples for DON analysis, genomic selection model testing with preliminary 2024 phenotypic data, selection of breeding lines based on GEBV and phenotypic data.
   Sept- Oct 2024: Complete fall crossing block. Fall planting in the field, selection of lines for winter crossing block.
   Nov 2024-Jan 2025: Advance lines for backcrossing, DNA extraction for genome-wide marker analysis if available
   Feb-March 2025: Analysis of genome-wide marker data, testing new training model optimization, complete main barley crossing block for the year, prepare inoculum for the field season.
   April 2025: Plant selected lines for additional backcrossing and/or three-way crosses.