USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY14 Final Performance Report
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Cover Page

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Fiscal Year:	FY14
USDA-ARS Agreement ID:	59-0206-4-019
USDA-ARS Agreement Title:	Breeding and Genomic Selection for Fusarium Head Blight Resistance in Spring Wheat.
FY14 USDA-ARS Award Amount:	$ 160,488

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-SPR	Breeding Fusarium Head Blight Resistant Spring Wheat.	$ 118,357
VDHR-SPR	Genomic Selection for Fusarium Head Blight Resistance in Spring Wheat.	$ 42,131
	FY14 Total ARS Award Amount	**$ 160,488**

Principal Investigator Date

* MGMT – FHB Management
FSTU – Food Safety, Toxicology, & Utilization of Mycotoxin-contaminated Grain
GDER – Gene Discovery & Engineering Resistance
PBG – Pathogen Biology & Genetics
EC-HQ – Executive Committee-Headquarters
BAR-CP – Barley Coordinated Project
DUR-CP – Durum Coordinated Project
HWW-CP – Hard Winter Wheat Coordinated Project
WES-CP – Western Coordinated Project
VDHR – Variety Development & Uniform Nurseries – Sub categories are below:
SPR – Spring Wheat Region
NWW – Northern Soft Winter Wheat Region
SWW – Southern Soft Red Winter Wheat Region

Project 1: *Breeding Fusarium Head Blight Resistant Spring Wheat.*

1. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?**

   Although a dramatic increase in genetic resistance to FHB has been observed in the spring wheat region of the U.S. in the past five years and these varieties are being widely adopted, there are still susceptible varieties in production. Furthermore, even the moderately resistant varieties available today can suffer significant damage due to FHB and elevated DON in environments favorable for disease development. Therefore, the overall level of FHB resistance of regional varieties must be improved.

2. **List the most important accomplishments and their impact (i.e. how are they being used) to minimize the threat of Fusarium Head Blight or to reduce mycotoxins. Complete both sections; repeat sections for each major accomplishment:**

   Accomplishment: 'Bolles' hard red spring wheat was released by the University of Minnesota's Agricultural Experiment Station in January 2015. Bolles is a mid-to-late maturity hard red spring wheat variety with high baking quality and competitive grain yields, in addition to very high grain protein content. Prior to its release, Bolles was tested as MN08165-8 and showed excellent leaf rust resistance and moderate resistance to bacterial leaf streak and Fusarium head blight (4 on our 1-9 scale). Bolles also has excellent preharvest sprouting resistance.

   Impact: I expect that Bolles will replace acreage of other high protein varieties, all of which have less resistance to Fusarium head blight compared to Bolles. Varieties rated as 3 or 4 are currently the best available in the north central spring region of the U.S.

   Accomplishment: Five experimental lines were entered and evaluated in the 2014 Uniform Regional Scab Nursery. These lines were identified in previous testing as having high levels of FHB resistance. Of the 24 entries and 5 checks in the trial, the four best MN lines ranked 1st, 2nd, 4th, and 5th for lowest VSK (one MR check ranked 3rd) and 1st, 2nd, 5th, and 6th for lowest DON level.

   Impact: These lines combine FHB resistance from different sources and are candidates for future germplasm release. All of them were advanced to at least one year of yield trial testing, so they have good agronomic characteristics as well. Seed of these lines have been requested by and provided to other wheat breeders in the region for use as crossing parents.

   Accomplishment: Scab nurseries were established at two field sites in 2014. A total of 3,225 genotypes were evaluated in 7,806 total rows at the locations. The Crookston and St. Paul FHB screening nurseries were excellent, and provided highly discriminatory data. As a result of these nurseries and results from previous years, the FHB resistance of 31 spring wheat cultivars was assessed and reported to growers via print media, web-accessible publications, winter meetings, and field day presentations.

Impact: Good field screening nurseries are needed to maintain progress in breeding for FHB resistance. Our screening of more 2,000 F_5 lines for FHB reaction at two locations eliminates virtually all susceptible lines from our breeding pipeline before they enter yield trials. Growers consider our FHB resistance ratings an important feature when choosing varieties.

Accomplishment: Marker-assisted selection was completed for 692 selected F_5 (pre-yield trial) lines, and 1,177 plants from 55 BC_1 and top-cross families segregating for FHB resistance QTL and other important genes. The F_5 lines were processed by the USDA-ARS Genotyping Center in Fargo and the BC_1 and top-cross samples were processed in-house. *Fhb1* and the 5AS FHB QTL were used to screen all 692 F_5 lines and selected in 44 and 14, respectively, of the 55 BC_1 and topcross populations subjected to MAS.

Impact: The screening of BC_1 and top-cross lines enriches populations for FHB resistance QTL. Likewise, selecting F_5 lines containing the *Fhb1* and 5AS QTLs enhances the chances of advancing lines with high levels of FHB resistance.

Project 2: *Genomic Selection for Fusarium Head Blight Resistance in Spring Wheat.*

1. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?**

   We are addressing Objective 2 "Increase efficiency of coordinated project breeding programs to develop and release FHB resistant varieties". Genomic selection (GS), based on estimating breeding values using a large number of genetic markers, is being used as a means to reduce cycle time and speed breeding progress. The objectives of this research are to evaluate the effectiveness of a FHB GS model developed using 350 University of Minnesota spring wheat breeding lines to 1) identify susceptible F_5 (pre-yield trial lines); and 2) predict FHB reaction of NDSU and SDSU germplasm using similar numbers of breeding lines.

2. **List the most important accomplishments and their impact (i.e. how are they being used) to minimize the threat of Fusarium Head Blight or to reduce mycotoxins. Complete both sections; repeat sections for each major accomplishment:**

   Accomplishment: We grew and phenotyped 384 F_5 lines using remnant seed of our 2012 and 2013 F_5 cohorts. Due to short seed supplies, these materials were phenotyped only in our St. Paul FHB nursery. Some lines had only a few plants, so a seed increase from single harvested spikes was conducted in the greenhouse during the 2014/2015 winter. DNA was extracted from these lines during the greenhouse increase. Genotyping data (via GBS) has been collected for these lines and comparisons with 90K SNP data that was used to genotype the training population are in progress. These materials were planted in our Crookston and St. Paul FHB nurseries in 2015.

   Impact: We will use the phenotype data collected, as well as new data coming from our 2015 season to compare to predictions from a genomic selection model. If the correlations are high, we will likely use genomic selection as a first screen to discard FHB susceptible material within our breeding program.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY14 award period. The term "support" below includes any level of benefit to the student, ranging from full stipend plus tuition to the situation where the student's stipend was paid from other funds, but who learned how to rate scab in a misted nursery paid for by the USWBSI, and anything in between.

1. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their MS degree during the FY14 award period?** No

   If yes, how many?

2. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY14 award period?** Yes

   If yes, how many? 1

3. **Have any post docs who worked for you during the FY14 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?** None

   If yes, how many?

4. **Have any post docs who worked for you during the FY14 award period and were supported by funding from your USWBSI grant gone on to take positions with private ag-related companies or federal agencies?** None

   If yes, how many?

Include below a list of all germplasm or cultivars released with full or partial support of the USWBSI during the FY14 award period. List the release notice or publication. Briefly describe the level of FHB resistance. *If not applicable because your grant did NOT include any VDHR-related projects, enter N/A below.*

Bolles hard red spring wheat released 2015. Moderate FHB resistance (4 on 1-9 scale)

Include below a list of the publications, presentations, peer-reviewed articles, and non-peer reviewed articles written about your work that resulted from all of the projects included in the FY14 grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

Anderson, J.A., J.J. Wiersma, G.L. Linkert, S. Reynolds, J.A. Kolmer, Y. Jin, R. Dill-Macky, and G.A. Hareland. 2015. Registration of 'Rollag' Spring Wheat. J. Plant Registrations 9:201-207.

Anderson, J.A., J.J. Wiersma, S. Reynolds, M. Green, and R. Caspers. 2014. Hard Red Spring Wheat. In Minnesota Varietal Trials Results, University of Minnesota Agricultural Experiment Station.

ElDoliefy, A.E., J.A. Anderson, K.D. Glover, A. Kumar, E.M. Elias, S. Chao, M.S. Alamri and M. Mergoum. 2014. 'Parshall': An Indigenous and Novel FHB Resistance Source for Fusarium Head Blight with High Quality and Adapted Hard Red Spring Wheat Cultivar. In: S. Canty, A. Clark, N. Turcott and D. Van Sanford (Eds.), Proceedings of the 2014 National Fusarium Head Blight Forum (p. 80). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.

Thurston, Y., J.T. Eckard, K.D. Glover, J.A. Anderson, M. Mergoum, M. Caffe, S. Ali, S.K. Sehgal, F.G. Marais, and J.L. Gonzalez-Hernandez. 2014. Validation of Fusarium Head Blight Resistance QTLs in Wheat using Double Haploids Derived from Four-way Crosses. In: S. Canty, A. Clark, N. Turcott and D. Van Sanford (Eds.), Proceedings of the 2014 National Fusarium Head Blight Forum (p. 98). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.