

**USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY14 Final Performance Report
July 15, 2015**

Cover Page

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Fiscal Year:	FY14
USDA-ARS Agreement ID:	59-0206-4-013
USDA-ARS Agreement Title:	Development of Hard Spring Wheat Cultivars Resistant Scab Disease.
FY14 USDA-ARS Award Amount:	\$ 129,309

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-SPR	Development of Hard Spring Wheat Cultivars Resistant Scab Disease.	\$ 129,309
	FY14 Total ARS Award Amount	\$ 129,309

07/07/15

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: *Development of Hard Spring Wheat Cultivars Resistant Scab Disease.*

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

The US Northern Central Plains in general, and in North Dakota (ND) in particular, Fusarium Head Bight (FHB) or scab disease remains the major threat for wheat production and its uses. North Dakota is the leading state for hard red spring wheat (HRSW) with about 6 million acres grown annually. HRSW is also the leading crop in ND. FHB is a complex disease and causes significant reduction in grain yield and impacts negatively the wheat quality. In the past two decades, FHB disease had tremendous implications on wheat on ND HRSW producers; end-users; and export market. The NDSU HRSW wheat breeding program is addressing this problem by developing elite and adapted genotypes/ lines/cultivars and breeding populations that incorporate diverse genetic resistance with desired agronomic and quality traits. The strategy used is based on incorporating genes of resistance into elite germplasm and pyramiding several types of genetic resistance to the disease from diverse sources using classical breeding methods and appropriate novel technologies such as selected molecular markers. Based on our accomplishments and impact (Listed in this and previous reports), we strongly believe that genetic resistance provides a strategic long-term, economically, and environmentally sound solution to this problem. In 2014-15 growing cycle, our efforts have continued to develop elite HRSW germplasm and cultivars that are adapted to ND in particular, and the spring wheat region, in general. Many significant accomplishments have been achieved and are listed in this report.

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:

Progress in combating the FHB disease have been sustained across years and in 2014 by the NDSU HRSW breeding program. This is illustrated in the release and potential release of many HRSW cultivars and elite germplasm that are hallmark in wheat production and research in the region as well as in USA and across the world. The cultivars we released are grown on large scale in ND and in the neighboring States including MN, SD, and MT generating hundreds of millions of dollars of benefits to the wheat growers, the industry and export market. These most recent cultivars and germaplsm releases/potential for release are the following:

Cultivars/Germplasm:

- ❖ **ND817** is a line that was presented for release and accepted and recommended by the release committee to the NDSU Director of NDS-AES under the name of “Ayr”. However, ND817 was not released. ND817 presents many excellent characters that may contribute to the improvement of wheat production in the US spring wheat

region. In addition to its excellent agronomic and quality performances, ND817 has very good resistance to scab. Its FHB resistance level equals or surpasses in many cases, the best FHB resistant cultivars so far released, including Glenn. ND817 is being prepared for germplasm release.

- ❖ **Recent release: ‘Elgin-ND’ (ND818):** In 2014, more than 160,000 acres (25 of about 6 million acres of ND HRSW) were grown to Elgin-ND. These acres are primarily for production certified/registered seed. Therefore, we are expecting that in this 2015 crop season, Elgin-ND will be grown on a large scale in ND and the region. Elgin-ND is a HRSW cultivar released in 2013. It has wide adaptation allowing it to compete very well with most dominant cultivars in ND and neighboring state including MN, SD and MT. In addition, Elgin-ND quality attributes are much improved compared to Faller, the dominant cultivars in Eastern ND and Western MN, the FHB prone zone. Elgin-ND has very high protein content, very close to Glenn, the current quality check cultivar. Overall, Elgin-ND has good milling (flour extraction similar to Glenn) and baking qualities similar to Barlow and Howard. Elgin-ND possesses an excellent diseases resistances package. It is moderate resistant/moderate susceptible to FHB. It is resistant to leaf and stem rusts prevalent races and medium susceptible/resistant to the new emerging leaf rust race Lr21.

Impact:

It is estimated that the wheat cultivars released by our HRSW breeding program at NDSU generate **Hundreds of millions of dollars** every year for the spring wheat growers, US wheat industry, and for the international wheat export market. This impact has been sustained across years as following:

- * In average, about 50-60% (3.3-4 million acres) of ND spring wheat acreages are grown to NDSU wheat cultivars. This demonstrates the good performance and adaptation of our cultivars to meet wheat growers and end-users. Among these common grown NDSU cultivars with FHB resistance are **Barlow, Glenn, Faller, Prosper, Steele-ND, Howard, and Alsen**. All of these cultivars have excellent agronomic/quality traits in addition to FHB resistance. ***In 2014, among the top five leading cultivars, four (Barlow, Prosper, Faller and Glenn) are from released by our breeding program. These cultivars were grown on 15.7, 11.7, 8.8, and 8.2% respectively. These four cultivars occupied close to 45% of 6 million acres of HRSW in ND. While Barlow is still the leading cultivar for the second year, Prosper jumped to the second rank replacing Glenn which dropped the fourth place. Other NDSU cultivars, including Mott, Steele-ND, Velva, Reeder, and Alsen are still grown on significant acres in ND. Our most recent Release, Elgin-ND has gained significant acreages in 2014. It was grown on 2.7% of 5.9 million acres in ND, a significant increase from 2013, when it was grown on only 0.2%. This shows that Elgin-ND may be a major cultivar in the region in the coming years. Overall, in 2014, NDSU HRSW cultivars were grown on more than 67% of ND wheat acreages.*** These figures show that **the impact** on wheat business (growers, industry

and export market) of the FHB resistant HRSW cultivars developed by our program using partly, the USWBSI initiative funds **is tremendous**.

- * Additionally, the NDSU HRSW cultivars are also grown and leading in some neighboring states (MN, SD, and MT) where spring wheat is a major crop and FHB is a threat. From 2009 to 2012, Faller was the leading wheat cultivar in MN with about 30% of wheat acreages. In 2013 and 2014, Prosper, our release took the lead in MN followed by Faller. Both cultivars occupied about 33% of MN acreages. Other cultivars such as Barlow, Glenn, Alsen, Steele-ND, and Howard are also grown in MN, SD, and MT as well. This is an important impact that should be factored in as well.
- * NDSU cultivars which have superior agronomic performance and very high quality with improved **FHB resistance** have allowed the spring wheat crop to remain a major crop in Western MN and Eastern ND where FHB is epidemic almost every year. It has also allowed the wheat growers to be competitive in the wheat market at the national and international levels.
- * The HRSW germplasm and cultivars with FHB resistance that we have released are well known and extensively useful in the breeding program nationally and worldwide. Our HRSW breeding program continues to be the '**Center of excellence**' for wheat germplasm with high quality and **good sources of FHB** resistance.

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? One

- 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? No**

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? No**

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.

- ❖ **ND816 and ND817:** Both ND816 and ND 817 are HRSW lines that were presented for release in 2013. ND816 was not accepted by the release committee but 817 was supposed to be released in 2014 since it was accepted and recommended by the release committee to the NDSU Director of NDS-AES under the name of “Ayr”. However, ND817 was not released. ND817 presents many excellent characters that may contribute to the improvement of wheat production in the US spring wheat region. In addition to its excellent agronomic and quality performances, ND817 has very good resistance to scab. Its FHB resistance level equals or surpasses in many cases, the best FHB resistant cultivars so far released, including Glenn. Currently, both ND816 and ND817 are being prepared as germplasm releases.

- ❖ **Recent release: ‘Elgin-ND’ (ND818):** Elgin-ND is a HRSW cultivar released in 2013. It has wide adaptation allowing it to compete very well with most dominant cultivars in ND and neighboring state including MN, SD and MT. In addition, Elgin-ND quality attributes are much improved compared to Faller, the dominant cultivars in Eastern ND and Western MN, the FHB prone zone. Elgin-ND has very high protein content, very close to Glenn, the current quality check cultivar. Overall, Elgin-ND has good milling (flour extraction similar to Glenn) and baking qualities similar to Barlow and Howard. Elgin-ND possesses an excellent diseases resistances package. It is moderate resistant/moderate susceptible to FHB. It is resistant to leaf and stem rusts prevalent races and medium susceptible/resistant to the new emerging leaf rust race Lr21.

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.

Peer-reviewed articles:

1. **Mohamed Mergoum**, Senay Simsek, Shaobin Zhong, Maricelis Acevedo, Timothy L. Friesen, Pawan K. Singh, Tika B. Adhikari, Jack W. Rasmussen, Mohammed S. Alamri, and Richard C. Frohberg. **2014**. ‘Velva’ Spring Wheat: An Adapted cultivar to North Central Plains of the USA with High Agronomic and Quality Performance. **Journal of plant Registration 8 (1):32-37**
2. Jonathan T. Eckard, Karl D. Glover, **Mohamed Mergoum**, James A. Anderson and Jose L. Gonzalez-Hernandez. **2015**. Multiple Fusarium head blight resistance loci mapped and pyramided onto elite spring wheat *Fhb1* backgrounds using an IBD-based linkage approach. **Euphytica 201 (3)**. DOI 10.1007/s10681-014-1333-8 (published online: http://download.springer.com/static/pdf/701/art%253A10.1007%252Fs10681-014-1333-8.pdf?auth66=1421077533_ee5333729aa3aa8581eb7d812c3c8a67&ext=.pdf)

Abstracts/Proceedings:

1. Ahmed ElFatih ElDoliefy, James A. Anderson, Karl D. Glover, Ajay Kumar, Chao Shiaoman, Elias M. Elias, Raed Seetan, Mohammed S. Alamri, and **Mohamed Mergoum**. **2014**. ‘Glenn’ a New Source of FHB Resistance in USA Hard Red Spring Wheat. *In* ASA-CSSA-SSSA-CSSS Abstracts 2014 [CD-ROM], Along Beach, CA, USA.
2. ElDoliefy AE, Anderson J, Glover K, Kumar A, Elias EM, Chao S, Alamri M, **Mergoum M** **2014**. ‘Parshall’: an indigenous and novel FHB resistance source for fusarium head blight with high quality and adapted hard red spring wheat cultivar. *In*: National Fusarium Head Blight Forum, St. Louis, Missouri, December 7-9, 2014
3. Yaqoob Thurston, Jonathan T. Eckard, Karl D. Glover, James. A. Anderson, **Mohamed Mergoum**, Melanie Caffé, Shaukat Alai, Sunish K. Sehgal, Francois G. Marais, and Jose L. Gonzales. **2014**. Validation of Fusarium Head Blight Resistance QTLs in Wheat using Double Haploids Derived from Four-way Crosses. *In*: National Fusarium Head Blight Forum, St. Louis, Missouri, December 7-9, 2014
4. Mingxia Zhao, Guomei Wang, Humphrey Wanjugi Micheal D. Grosz, John Pitkin, **Mohamed Mergoum** and Shaobin Zhong. **2014**. Molecular Mapping of Fusarium Head Blight Resistance in ND2710. *In*: National Fusarium Head Blight Forum, St. Louis, Missouri, December 7-9, 2014