

**USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY06 Final Performance Report (approx. May 06 – April 07)
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Cover Page

PI:	Mohamed Mergoum
Institution:	North Dakota State University
Address:	Dept. of Plant Sciences Rm 166 Loftsgard Hall Fargo, ND 58105-5051
E-mail:	Mohamed.Mergoum@ndsu.nodak.edu
Phone:	701-231-8478
Fax:	701-231-8474
Fiscal Year:	2006
USDA-ARS Agreement ID:	59-0790-4-100
USDA-ARS Agreement Title:	Mapping and Pyramiding Resistance Genes and Developing Hard Red Spring Wheats Resistant to FHB.
FY06 ARS Award Amount:	\$ 145,109

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Award Amount
HGG	Molecular Mapping and Pyramiding of New Scab Resistance Genes.	\$ 26,541
VDUN	Development of Hard Red Spring Wheat Cultivars Resistant to Scab.	\$ 118,568
	Total Award Amount	\$ 145,109

Principal Investigator

Date

* CBCC – Chemical, Biological & Cultural Control
EEDF – Etiology, Epidemiology & Disease Forecasting
FSTU – Food Safety, Toxicology, & Utilization of Mycotoxin-contaminated Grain
GET – Genetic Engineering & Transformation
HGR – Host Genetics Resources
HGG – Host Genetics & Genomics
PGG – Pathogen Genetics & Genomics
VDUN – Variety Development & Uniform Nurseries

(Form – FPR06)

Project 1: *Molecular Mapping and Pyramiding of New Scab Resistance Genes.*

1. What major problem or issue is being resolved and how are you resolving it?

Major genes for resistance to FHB in spring wheat lines trace back to the Chinese line ‘Sumai-3 or its derivatives’, most of which share the same QTL’s. One of our main goals in the NDSU spring wheat breeding is to explore and identify more FHB resistance genes from other sources. This will enhance genetic diversity of the resistance and allow pyramiding of these resistance genes with the ultimate objective of developing effective and durable FHB resistant varieties. Marker assisted selection for FHB resistance may be an efficient tool that can accelerate selection, germplasm development and release of wheat varieties with durable resistance to FHB. Recently, released Hard Red Spring Wheat (HRSW) variety ‘Steele-ND’ from NDSU HRSW breeding program shows good resistance to FHB. Steele-ND is not a Sumai3 derivative. A RIL population comprising 212 F_{2:7} lines derived from a cross between Steele-ND and ND 735 experimental line were developed by the breeding program for the purpose to determine the FHB resistance genes in Steele-ND and to map these genes.

**2. List the most important accomplishment and its impact (how is it being used?).
Complete all three sections (repeat sections for each major accomplishment):**

Accomplishment:

Field /Laboratory (Phenotypic) Evaluation:

- Phenotypic data from field evaluation of the RIL population along with its parents and relevant checks was done in summer 2005.
- In 2006, the same nursery (including the RIL and their parents) was grown under field conditions with artificial FHB inoculation and mist irrigation. However, climatic conditions (excessive drought and heat) did not allow successful inoculations.
- A greenhouse screening of the RIL population was also accomplished in spring 2005. The disease assessment was done following the protocols developed by Stack and McMullen (1998).
- Although this [project was not funded for 2007-2008, the RIL and their parents are being tested in the field to accumulate more phenotypic data.

Molecular Work:

- DNA extraction and quantification of 138 among the 212 F_{2:7} RIL of the ND735/Steele-ND population, the parents involved in the cross (Parshall and ND706) along with other relevant checks including Sumai3, Alsen, Reeder, and Glenn; has been done.
- All these genotypes have been screened with 50 previously identified molecular markers linked to FHB resistance located on different chromosomes.
- Polymorphism among the parents was observed many markers. Presently, we continue to screen the RIL population with more polymorphic markers in order to develop a map for the ND735/Steele-ND population.

- Phenotypic data that will be generated in 2007 will be used to finish the mapping work.

Impact:

This work –if terminated- will have significant impact on the following:

- Use of the Marker Assisted Selection (MAS) in the breeding program: Looking for new markers to reinforce the existing markers we are using will be paramount. In addition, information on wheat EST's is being generated by the NSF funded wheat genomic project to identify and develop 'breeder friendly' markers to map the resistance of Steele-ND.
- Pyramiding FHB resistance genes: The information from this project is being used to develop markers linked to resistance QTL's from Steel-ND to fasten the process of selection for FHB resistance. Markers may represent the only mean by which pyramiding of resistance genes from different sources can be achieved in order to develop durable FHB resistant wheat varieties.
- Many crosses between Steele-ND and other sources of resistance to FHB have been initiated and advanced generations of these crosses are being evaluated for FHB resistance in greenhouse and field FHB nurseries.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before?

The aim of this work, once finished, is to map HRSW Steele-ND resistance genes for FHB resistance and developed molecular markers to be available for the scientific community. Molecular markers are particularly of interest for wheat breeder to be used in MAS to develop fast and efficiently new cultivars with FHB resistance.

Project 2: *Development of Hard Red Spring Wheat Cultivars Resistant to Scab.*

1. What major problem or issue is being resolved and how are you resolving it?

Fusarium head blight (FHB) or scab is a complex disease that reduces significantly the grain yield levels and affects negatively quality characteristics of HRSW in the spring wheat region. The disease had tremendous implications, particularly on HRSW producers in ND; users; and export market. This problem is being resolved by the development of elite parental genotypes and lines; and breeding populations to incorporate diverse genetic resistance to FHB with desired agronomic and quality traits into new HRSW cultivars adapted to ND. The combination of several types of genetic resistance to FHB from diverse germplasm sources into adapted cultivars using mainly, classical breeding methods and appropriate novel technologies such as selected molecular markers were used in 2006-07 crop season to provide a strategic long-term solution to the control of FHB not only in ND but in the entire HRSW growing region. During this growing cycle, our on-going efforts have focused on the development of elite HRSW germplasm and cultivars that are adapted to ND in particular, and spring wheat region, in general.

**2. List the most important accomplishment and its impact (how is it being used?).
Complete all three sections (repeat sections for each major accomplishment):**

Accomplishment:

- * *In 2007, we released a new HRSW cultivar under the name of ‘Faller’. Faller was tested under ND 805 experimental line for many years in different nurseries in our breeding program and in the regional nurseries, including URN and URSN. Faller is a derivative cultivar of Sumai3. Hence it has medium resistance to FHB, similar to Alsen. However, Faller has very high yield and very good leaf disease package compared to Alsen, the most grown cultivar in the spring wheat region. Faller is recommended for high rainfall and FHB prone regions.*
- * *‘Howard’ (ND 800), a new HRSW wheat variety with good FHB resistance level comparable to Steele-ND was released in 2006. Howard has wide adaptation and recommended mainly, for the regions where Reeder and Alsen are grown, particularly in the Western parts of ND because of its high yield level. Howard main attributes –in addition to FHB resistance- are high yield and quality, excellent leaf disease package (better than Alsen).*
- * *Glenn (ND747) with parentages involving Sumai-3 and Steele-ND with very good FHB resistance level (better than Alsen variety) that we released in 2005 is gaining substantial popularity while Alsen, the most grown FHB HRSW cultivar is losing acreages. In 2006, Glenn was grown on 150,000 acres in ND only (1.7% of ND total acreages). Additional acreages in MN and SD were grown to Glenn.*
- * ***Steele-ND**, the NDSU HRSW wheat variety that we released in 2004 with good FHB resistance level and wide adaptation is now a major grown cultivar in the spring wheat region. Steele-ND is recommended mainly, for the regions where Reeder and Alsen are grown, particularly in the Western parts of ND because of it high yield level. Steele-ND was grown on about 10% (700,000 acres) of ND wheat area. It expected that Steele-ND*

will replace significant acreages of Alsen and Reeder across all the State and probably other cultivars in the region.

- ✳ *ND 756 was released as a germplasm with FHB resistance (see publications).*

Impact:

- ✳ *In ND, more than 4 million acres of spring wheat (60%) are grown to NDSU cultivars that were generated by this breeding program. Among these cultivar, **Alsen, Steele-ND and Glenn HRSW cultivars have resistance to FHB** and excellent agronomic/quality traits contribute. These three (3) cultivars occupy about 34% (2.4 million acres) of wheat grown in ND. These figures show that **the impact** on wheat business (growers, industry and export market) of the FHB resistant HRSW cultivars developed by this program using partly, the USWBSI initiative funds **is phenomenal.***
- ✳ *In addition, the above NDSU HRSW cultivars are grown in neighboring states (MN, SD, and MT) where spring wheat is a major crop and FHB is a threat. This is an important impact that should be factored in as well.*
- ✳ *Releasing superior and very high quality HRSW cultivars with improved **FHB resistance** has allowed ND growers to be competitive in the wheat market at the national and international levels.*
- ✳ *NDSU HRSW breeding program is well known **nationally and worldwide as a center of excellence** for wheat germplasm with **high quality and good sources of FHB resistance.***

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before?

As a results of the above accomplishments, the US wheat growers in the spring region are cultivating our NDSU HRSW cultivars on a large scale (3-4 millions acres). This obviously, has been generating for the growers hundreds of millions of dollars annually. Similarly, the wheat industry is having better wheat quality for their products, particularly during the scabby years. In addition, as more than 50% of total HRSW is exported for its quality, the NDSU HRSW cultivars with high quality has allowed our export market to be more competitive at the international level. Hence, substantial financial impact on wheat industry and export market due to NDSU wheat cultivars has been generated. Finally, NDSU germplasm for FHB resistance and high quality y is being used nationally and internationally in the research improvement program as a hallmark sources for these traits.

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 grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

Journal articles:

- Zhang, G., **M. Mergoum**. 2007. Molecular mapping of kernel shattering and its association with Fusarium head blight resistance in a Sumai3 derived population. **Theoretical and Applied Genetics (TAG)**. (*Accepted*)
- Mergoum, M.**, R. C. Frohberg, and R. W. Stack. 2007. Registration of spring wheat germplasm ND 756 combining resistances to Fusarium head blight, leaf spotting, and rusts diseases. **Crop Science**. (*In press*).
- Kadariya, M., **M. Mergoum**, and K. D. Glover. 2007. Biplot analysis of agronomic and Fusarium head blight resistance traits in spring wheat. **Journal of Crop Improvement**. (*In Press*)
- Zhang, G., **M. Mergoum**. 2007. Developing evaluation methods for kernel shattering in spring wheat. **Crop Science**. (*In press*)
- Mergoum, M.**, R. C. Frohberg, and R. W. Stack. 2007. Registration of spring wheat germplasm ND 751 resistant to Fusarium head blight leaf and stem rusts. **Crop Science** 47:455-457
- Mergoum, M.**, R. C. Frohberg, T. Olson, T. L. Friesen, J. B. Rasmussen, and R. W. Stack. 2006. Registration of 'Howard' wheat. **Crop Science** 46:2702-2703.

Proceedings:

- Zhang Guorong, **Mergoum Mohamed** and Robert W. Stack. 2006. Grain shattering and FHB-resistance QTLs linkage in wheat. . *In* S. M. Canty et al. (eds.) Proc. of the National Fusarium Head Blight Forum; 10-12 Dec. 2006; Raleigh, NC. USA. Michigan State Univ.: pp.128.

Abstracts:

- Guorong Zhang and **Mohamed Mergoum M.** 2006. "Tuning up" Grain Shattering Evaluation Methods in Spring Wheat. *In* ASA-CSSA-SSSA-CSSS Abstracts 2006 [CD-ROM], Indianapolis, Indiana.

Oral Presentations:

Many oral presentations on FHB breeding and cultivar development have been given to producers, industry and trade teams from around the world.