

**USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY08 Final Performance Report (approx. May 08 – April 09)
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Cover Page

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Fiscal Year:	2008
USDA-ARS Agreement ID:	59-0790-4-091
USDA-ARS Agreement Title:	Breeding and Development of DNA Markers for Fusarium Head Blight Resistance in Wheat.
FY08 USDA-ARS Award Amount:	\$ 185,387

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Adjusted Award Amount
GDER	Construction and Utilization of a BAC Library of Sumai 3.	\$26,507
VDHR-SPR	Breeding Fusarium Head Blight Resistant Spring Wheat.	\$ 115,285
VDHR-SPR	QTL Mapping of Wheat Fusarium Head Blight Resistance in the Japanese Landrace PI 81791.	\$ 43,595
	Total Award Amount	\$ 185,387

Principal Investigator

Date

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

(Form FPR08)

Project 1: *Construction and Utilization of a BAC Library of Sumai 3.*

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

Bacterial Artificial Chromosome (BAC) libraries are an essential tool for gene cloning and sequence analysis. It has become clear from other gene cloning projects in wheat that access to a BAC library of a genotype containing the gene of interest is essential. There are no BAC libraries of wheat available in the U.S. and none of the few existing libraries worldwide were constructed using a known FHB resistance source. The main purpose of this grant is to develop genomics resources that will be useful in our cloning of *Fhb1*, the major QTL for Fusarium head blight resistance in wheat. A BAC library of Sumai 3, the donor of *Fhb1* and at least two other important FHB resistance QTL is being constructed. This library may be useful to other groups attempting to clone other FHB resistance from Sumai 3.

The objectives of the grant are to:

- 1) Construct a BAC library of Sumai 3 for the wheat community.
- 2) Construct a Sumai 3 BAC contig spanning *Fhb1*.
- 3) Compare the sequences between Sumai 3 and Chinese Spring for the *Fhb1* region to identify additional candidate genes, if any.

2. List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):

Accomplishment:

The next step of the project after construction of the Sumai 3 BAC library was development of the BAC contig covering the *Fhb1* locus. The BAC library of Sumai 3 was arrayed on high-density filters for the identification of BAC clones spanning the *Fhb1* locus. A total of 21 high-density filters were hybridized with radioactively labeled molecular probes previously developed by sequencing the BAC and cosmid clones spanning the *Fhb1* locus in Chinese Spring (CS) and Sumai 3. Out of 18 identified positive BAC clones, 12 were located on the wheat chromosome 3B. To cover the two potential gaps in the Sumai 3 *Fhb1* contig and develop Sumai 3-based sequence of the region, three BAC clones were selected for shotgun sequencing by paired-end Sanger sequencing approach. A total of 2,256 Sanger sequence reads were obtained for two of these BAC clones and the sequencing of third BAC clone is in the progress. If gaps indeed exist, additional markers will be developed based on the sequences of these BAC clones and used to search for additional overlapping clones in the Sumai 3 library. Sanger reads have been assembled in contigs using the phrap program and currently are being annotated by comparing with the databases of expressed sequence tags, proteins and repetitive elements.

Impact:

Our laboratory, working with Kansas State University are close to cloning and having a better understanding of the most important FHB resistance gene, *Fhb1*. Knowing the sequence of Sumai 3 in the *Fhb1* region may identify new gene candidates and/or clarify which of our current 7 candidate genes is most likely to be *Fhb1*. Knowledge of the function

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of *Fhb1* could provide THE breakthrough in providing FHB resistance that our stakeholders have been demanding.

Project 2: *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?

Wheat varieties with greater resistance to Fusarium head blight (FHB) have been released in the spring wheat region and continue to make a substantial contribution to reducing the losses from this devastating disease. However, we rate the best FHB resistant varieties as 3-4 on our 1-9 scale in which 1 represents immunity. There can be additional improvements in FHB resistance levels, even compared to the best cultivars available today. The main objective of this project is to develop Fusarium head blight resistant wheat germplasm and varieties adapted for commercial production in Minnesota and the surrounding region and characterize the level of FHB resistance of all wheat varieties grown in the region.

2. List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):

Accomplishment (1):

The new variety ‘Sabin’ was released in 2009. Sabin has moderate resistance to FHB, contains the *Fhb1* gene and has high grain yields. Sabin is a good complement to the moderately resistant variety we released in 2008, ‘Tom’ because it has good adaptation to the southern portion of the spring wheat growing area and Tom has better adaptation to the northern regions.

Impact:

Sabin is rated as a 4 for FHB resistance on our 1-9 scale in which 1 is the highly resistant and 9 highly susceptible. Currently, ten other wheat varieties in the region have a scab rating this good. Sabin has higher average grain yield in Minnesota than 8 of these other 9 varieties. Sabin’s moderate FHB resistance can help reduce losses to this disease. We have used Sabin extensively in our crossing program and it has proven to have very good combining ability for FHB resistance.

Accomplishment (2):

Five experimental lines were entered in the 2008 Uniform Regional Scab Nursery. These lines were identified in previous testing as having improved levels of FHB resistance and one of them, MN05149-5, had the second lowest Disease Index and VSK and 4th lowest DON level among the 36 entries in the trial. The other four Minnesota entries, one of which was Sabin, were in the top half of all entries for lowest DON.

Impact:

These lines combine FHB resistance from different sources and are candidates for germplasm release. These lines are available and have been requested by other wheat breeders in the region for use as crossing parents.

Accomplishment (3):

Scab nurseries were established at 3 field sites in 2008. A total of 2,191 genotypes were evaluated in 6,000 total rows among the locations. Dry, hot weather resulted in low FHB at the Morris location. The Crookston FHB screening nursery was excellent, similar to 2006 and 2007, and provided highly discriminatory data. As a result of this nursery and results from previous years, the FHB resistance data of 26 spring wheat cultivars was assessed and reported to growers via print media and field day presentations.

Impact:

Good field screening nurseries are needed to maintain progress in breeding for FHB resistance. FHB remains a potentially devastating disease in the region as severe damage was inflicted in 2005. Our FHB resistance ratings are an important part of growers' decision regarding which variety they will grow.

Project 3: *QTL Mapping of Wheat Fusarium Head Blight Resistance in the Japanese Landrace PI 81791.*

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

We are trying to improve FHB resistance in wheat by incorporating new resistance genes into agronomically useful lines. Earlier, in another USWBSI-funded project, the Japanese wheat landrace, PI 81791, was identified as having high levels of resistance to scab and did not contain *Fhb1*. In order to identify the QTL involved with resistance in PI 81791, a mapping population of 150 RILs was developed from a cross between PI 81791, and the agronomically adapted, susceptible line, Wheaton. Resistance screenings are being done in four different field environments and two greenhouse environments, and will be used to gather phenotypic information on type I and II resistance to *Fusarium graminearum*, resistance to DON accumulation, post-harvest grain traits and agronomic traits. This phenotypic data will be utilized to identify RILs that are both resistant and agronomically adapted for use as parents in our breeding program. These 150 RILs are also being genotyped using SSR markers. Together, the genotypic and phenotypic data will be used to identify and map scab resistance QTL in this population. The identification and mapping of these QTL will allow breeding programs to capitalize on the resistance and, potentially, for the eventual release of cultivars containing this resistance to growers. Markers associated with resistance will be assessed for their diagnostic ability to identify these resistance QTL in existing and future lines.

2. List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):

Accomplishment (1):

Completion of phenotypic data collection on RIL population, parents, and check lines. Resistance screenings have been complete in the greenhouse (Type II) and field environments (Type I & II). Greenhouse screenings were carried out in the greenhouse facilities on the St. Paul campus of the University of Minnesota in Fall 2007 and Spring 2008. Field screenings were carried out in St. Paul and Crookston, MN during the summers of 2007 and 2008. Harvested seed from the field screenings were then analyzed for post-harvest grain traits, including 30 head weight, test weight, VSK, and DON content. Additionally, other agronomically important traits were also assessed, including kernel color, height, heading date, and lodging.

Impact:

All phenotypic data will be utilized for two major purposes. First, these data will be used for the identification of QTL in the QTL mapping of the Wheaton/PI 81791 mapping population. These data are also being used to identify RILs that have a combination of a variety of resistance traits that are also agronomically adapted for use as parents in our breeding program. Lines from this population are available upon request to other breeders

for their use as crossing parents. Highly resistant lines with marker information for associated QTLs will be available.

Accomplishment (2):

Completed genotyping a subset of the Wheat/PI 81791 mapping population. A subset of 94 RILs and the two parents were genotyped using the 519 polymorphic markers identified in an initial screen of approximately 880 SSR markers done at the USDA-ARS Fargo Genotyping Lab. Markers associated with resistance and agronomic traits were also identified and have been or are currently being run on the remaining 56 RILs of the population.

Impact:

The genotyped SSR markers are being used to develop a moderately dense molecular map and to identify QTL for resistance and agronomic traits. These markers identified as being associated with traits of interest are then being used to genotype the remaining RILs of the mapping population in order to more accurately identify and more precisely map the QTL. Preliminary FHB QTL mapping results were presented at a poster at the 2008 National Fusarium Head Blight Forum. Markers associated with FHB resistance QTL can be used by wheat breeders to introgress these resistance genes into their germplasm.

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.

Peer-Reviewed Articles

- Anderson, J.A., G.L. Linkert, R.H. Busch, J.J. Wiersma, J.A. Kolmer, Y. Jin, R. Dill-Macky, J.V. Wiersma, G.A. Hareland, and D.V. McVey. 2009. Registration of 'RB07' Wheat. *J. Plant Registrations* 3:175-180.
- Buerstmayr, H., T. Ban, and J. Anderson. 2009. QTL mapping and marker assisted selection for Fusarium head blight resistance in wheat – a review. *Plant Breeding* 128:1-26.

Abstracts/Proceedings

- Buerstmayr, H., T. Ban, and J.A. Anderson. 2008. QTL Mapping and Marker Assisted Selection for Fusarium Head Blight Resistance in Wheat. *In Proceedings of the 3rd International Symposium on Fusarium Head Blight, Szeged, Hungary. Cereal Res. Commun.* 36 Suppl. 6:1-3.
- Gale, L.R., Ruth Dill-Macky, James A. Anderson, Kevin P. Smith, Erik Lysøe and H. Corby Kistler. 2008. Links between Population Affiliation and Toxigenic Potential in *Fusarium graminearum*. *In: Canty, S.M., E. Walton, A. Clark., D. Ellis. J. Mundell, and D.A. Van Sanford (Eds.), Proceedings of the National Fusarium Head Blight Forum; 2008 Dec 2-4; Indianapolis, IN. Lexington, KY: University of Kentucky. p. 82*
- Glover, K.D, J.A. Anderson and M. Mergoum. 2008. Development of FHB Resistant Spring Wheat in the Northern Great Plains. *In: Canty, S.M., E. Walton, A. Clark., D. Ellis. J. Mundell, and D.A. Van Sanford (Eds.), Proceedings of the National Fusarium Head Blight Forum; 2008 Dec 2-4; Indianapolis, IN. Lexington, KY: University of Kentucky. p. 160*
- Liu, S., M.O. Pumphrey, B.S. Gill, H.N. Trick, J.X. Zhang, J. Dolezel, B. Chalhoub, and J.A. Anderson. 2008. Toward positional cloning of *Fhb1*, a major QTL for Fusarium head blight resistance in wheat. *In Proceedings of the 3rd International Symposium on Fusarium Head Blight, Szeged, Hungary. Cereal Res. Commun.* 36 Suppl. 6:195-201.
- Liu, S., M.O. Pumphrey, B.S. Gill, H.N. Trick, J.X. Zhang, J. Dolezel, B. Chalhoub and J.A. Anderson. 2008. Toward Positional Cloning of *Fhb1*, a Major QTL for Fusarium Head Blight Resistance in Wheat. *In: Canty, S.M., E. Walton, A. Clark., D. Ellis. J. Mundell, and D.A. Van Sanford (Eds.), Proceedings of the National Fusarium Head Blight Forum; 2008 Dec 2-4; Indianapolis, IN. Lexington, KY: University of Kentucky. p. 113*
- Quirin, E.A. and J.A. Anderson. 2008. Mapping of FHB Resistance in the Japanese Wheat Landrace, PI 81791. *In: Canty, S.M., E. Walton, A. Clark., D. Ellis. J. Mundell, and D.A. Van Sanford (Eds.), Proceedings of the National Fusarium Head Blight Forum; 2008 Dec 2-4; Indianapolis, IN. Lexington, KY: University of Kentucky. p. 195.*

Reports

Anderson, J., J. Wiersma, J. Kolmer, and R. Dill-Macky. 2008. Spring Wheat. *In* Preliminary Report 24: 2008 Wheat, Barley and Oat Variety Performance in Minnesota, Preliminary Report, Edited by Jochum Wiersma.

Anderson, J.A., J.J. Wiersma G.L. Linkert, C. Springer, and S. Reynolds. 2008. Hard Red Spring Wheat. *In* Minnesota Varietal Trials Results, University of Minnesota Extension Service.

If your FY08 USDA-ARS Grant contained a VDHR-related project, include below a list all germplasm or cultivars released with full or partial support of the USWBSI. List the release notice or publication. Briefly describe the level of FHB resistance. If this is not applicable (i.e. no VDHR-related project) to your FY08 grant, please insert ‘Not Applicable’ below.

Cultivar Releases:

1. ‘RB07’ Moderate FHB resistance (5 on 1-9 scale in which 1 is best)

Anderson, J.A., G.L. Linkert, R.H. Busch, J.J. Wiersma, J.A. Kolmer, Y. Jin, R. Dill-Macky, J.V. Wiersma, G.A. Hareland, and D.V. McVey. Registration of ‘RB07’ Wheat. *J. Plant Registrations* 3:175-180.

2. ‘Sabin’ Moderately resistant to FHB (4 on 1-9 scale)

3. MN02072-7 Moderately susceptible to FHB (6 on 1-9 scale)