

**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:	59-0790-4-113
USDA-ARS Agreement Title:	Fusarium Head Blight Research in Winter Wheat.
FY08 USDA-ARS Award Amount:	\$ 120,043

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Adjusted Award Amount
VDHR-NWW	Accelerating the Development of Scab Resistant Soft Red Winter Wheat.	\$77,503
VDHR-NWW	Mapping Fusarium Head Blight Resistance in Truman Wheat.	\$ 42,540
	Total Award Amount	\$ 120,043

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 Sinter Wheat Region

(Form FPR08)

Project 1: *Accelerating the Development of Scab Resistant Soft Red Winter Wheat.*

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

Fusarium head blight (FHB) resistance in the soft red winter wheat variety Truman developed and released at the University of Missouri is broad-based, having excellent levels of types I and II resistance as well as good kernel quality retention and low DON under heavy disease pressure. Little, however, is understood about the genetics of this source of resistance, other than that haplotype data suggests it differs from the resistance in Sumai 3 and its derivatives as well as the resistance in Ernie. In that Truman has good levels of all four types of resistance; this project will involve several steps. In 2008/09, our objectives were: (1) identify QTL associated with type II resistance to FHB in a set of 250 F_{2:8} recombinant inbred lines developed from the cross Truman/MO 94-317; (2) Phenotype type I resistance to FHB in Truman using the above mapping population; (3) phenotype kernel quality retention in Truman following field inoculations of the above mapping population; (4) phenotype the above mapping population for DON levels following greenhouse and field inoculation with FHB.

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 (repeat sections for each major accomplishment):

Accomplishment 1:

In 2008 we completed the second year of a replicated (3 replication; randomized complete block design) greenhouse phenotyping experiment for type II resistance on a set of 239 recombinant inbred lines (RILs) developed from the cross Truman/MO 94-317. For each RIL, eight plants per RIL per replication were phenotyped (total 5736 plants). The population was also increased for field screening in the 2009/10 crop season. Consistent with data from 2007, analysis of the data indicated that type II resistance is quantitative and distributions which were skewed towards resistance, suggest both additive and dominant components of the phenotypic variance. Whole genome polymorphism tests have been completed and mapping QTL associated with Type II resistance will commence in August.

Impact/Clientele Benefit:

Truman, the resistant check in the Northern Scab Nursery, is arguably the most FHB resistant cultivar available to growers in the soft red winter wheat region. It is widely adapted and has excellent yield potential along with excellent test weight and stripe rust resistance. It has immediately lessened economic losses due to FHB in regions where it is grown. Once markers are identified and published, they will be a valuable resource for marker-assisted selection.

Accomplishment 2:

In 2008, the first year of a collaborative coordinated phenotyping effort was conducted. Missouri (Dr. McKendry) was the lead institution while Purdue (Dr. Herb Ohm), The Ohio State University (Dr. Clay Sneller) and the University of Kentucky (Dr. David Van Sanford) collaborated to generate phenotypic data on the recombinant inbred lines from the cross Truman/MO 94-317. Field data were collected on Type I resistance, Fusarium damaged kernels and DON, and were forwarded to Missouri for analysis.

Impact/Clientele Benefit:

Because of the variability associated with Type I data and with DON, a second year of phenotypic data was funded in FY09. Additionally, seed quantities permitted replicated testing across locations. Once QTL are identified and published, these data will provide valuable markers for marker-assisted-selection which should enable breeders to do F2 enrichment and or backcrossing to pyramid genes for all four types of resistance in regional variety development efforts. Publication of these results in peer-reviewed journal(s) when complete will benefit the scientific community as a whole.

Accomplishment 3:

A hiring freeze instituted at Missouri resulted in the delayed hiring of post-doc to conduct the genotyping of the RILs developed from Truman because only part of the funding for this person was from the USWBSI and the remainder from other Missouri wheat breeding funds. In April 2009, we hired an experienced doctoral student exclusively on the USWBSI portion of the funds who has now completed the polymorphism tests on Truman, MO 94-317 and Bess (a full sib of Truman – resistant check in the southern nursery). Genotyping of the RIL population will begin in earnest August 1 and preliminary data on QTL associated with all four types of resistance is expected to be available by December 2009. We are fast-tracking the development of a set of RILs for Bess to help validate QTL identified from Truman.

Impact/Clientele Benefit:

Dr. Gina Brown-Guedira is closely involved in the progress of the genotyping effort and once markers are identified they will be made immediately available to the genotyping labs for use in F2 enrichment and or backcrossing efforts, thereby enabling either Dr. Brown-Guedira or other breeders to pyramid genes for all four types of resistance in regional variety development efforts. Publication of these results in peer-reviewed journal(s) when complete will benefit the scientific community as a whole.

Project 2: *Mapping Fusarium Head Blight Resistance in Truman Wheat.*

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

Fusarium head blight, in wheat continues to be an important problem in the north-central region of the United States. This ongoing project has focused largely on the exploiting native resistance identified in Missouri wheat germplasm; an approach we believe accelerates the development and release of FHB resistant cultivars. In 2008/09 our objectives were: (1) the continued identification and verification of useful sources of FHB resistance in the Missouri wheat breeding program; (2) the verification of potentially useful sources of FHB resistance through evaluation of both the Preliminary and Advanced Northern Uniform Winter Wheat Scab Nurseries, and the Southern Uniform Winter Wheat Scab Nurseries; (3) the incorporation of new sources of resistance, as they are verified, into elite Missouri soft red winter wheat breeding lines; (4) evaluation of lines with diverse sources of resistance (2, 3- and 4-way crosses) derived in 2007 from mass selection populations involving native and exotic sources of resistance; (5) to convey information on scab resistance of commercially available wheat cultivars through evaluation of the 2009 Missouri Winter Wheat Performance Tests.

1. 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 (repeat sections for each major accomplishment):

Accomplishment 1 - Breeding Program:

In 2008/09, 208 advanced breeding lines, and 336 preliminary yield nursery (PYN) genotypes were screened for type II resistance in the greenhouse and for type I, the field scab index, Fusarium damaged kernels and DON in the field nursery. These lines were lines that had survived one or more years of selection for yield, test weight, and relevant agronomic traits in our breeding nursery. Following these two cycles of selection (greenhouse and field), 104 genotypes were retained for re-screening in 2009/10. Two lines were exciting; MO 081777 [severity 8.1% compared with Truman (11.6%)] which contains resistance from MO 980829 (a full-sib of Truman with better FHB resistance) and MO 080104 (severity 9.6%) topped both the Fusarium nursery and the advanced yield trial nursery. The source of resistance in MO 080104 is unknown. Among the PYN entries, 118 were retained that had highly functional levels of resistance and type I resistance ranging from 20% to 60%. Of these, 38 had resistance levels equal to or better than Truman. Field severity of 22 of these lines was less than 10%. These lines will be re-evaluated in both the greenhouse and the field in 2009/10 to verify resistance.

Impact/Clientele Benefit:

The release of FHB-resistant cultivars is a primary goal of the USWBSI. Our program has had considerable success focusing on native resistance through screening and recombination in adapted backgrounds. The verification of resistance in these lines will accelerate our decision-making on both retention of lines, and elimination of lines, in the breeding program. The lines above have survived one or more years of selection for agronomic worth and FHB resistance and, if released, will immediately lessen the devastating impact of FHB in Missouri and surrounding states. All lines in Missouri are public releases with the opportunity for joint release

with other public institutions. Superior sources will also be shared through the uniform scab nursery system, with breeders in other states who will be able to utilize these resources as parents in their respective breeding programs.

Accomplishment 2 - Nursery Evaluation:

In 2008/2009, we evaluated all 56 entries in the Missouri Winter Wheat Performances tests under greenhouse conditions, and the FHB field scab index (incidence x severity) in our FHB inoculated field nursery. As anticipated, the best public lines in these commercial trials were Truman, and Bess. About 5 other brands had some function level of resistance. These data will be published in the 2009 Missouri Winter Wheat Performance Tests Special Report and on the Agricultural Education Bulletin Board <http://agebb.missouri.edu> under crop performance testing for soft red winter wheat. In addition, my program evaluated and will report data for the Northern Uniform and Preliminary FHB Nurseries and for the Southern FHB Nursery.

Impact/Clientele Benefits:

Data from the Performance Tests will provide growers with previously unavailable information on the FHB resistance of commercial cultivars. The availability of these data, particularly in a year in which FHB has been a problem for growers – as has been the case in the 2008/09 crop year should move growers' decision making on variety selection towards selection of varieties with FHB resistance. This information was communicated to growers at 2009 field days and considerable interest was evident, particularly in southwest Missouri where growers were thrilled with performance of Truman this year. As for the uniform nurseries, our data hopefully will help inform breeders of the resistance levels in their material and will provide us with important new sources of resistance to use in our crossing program.

Accomplishment 3 – Use of Exotics:

In 2008/09 I made selections from 140 F5 and F6 populations that had undergone 4-5 cycles of mass selection under heavy inoculation and natural infection (in 2008 and 2009) pressure. Lines were developed from 2-, 3-, 4 and even 5 sources of resistance that included exotics (less than 25% of the cross). Each year, lines were inoculated twice, harvested, sieved for excellent kernel quality and re-planted. This process was repeated each year from the F2 generation through the F5 or F6 (depending on the population) generation. Under natural infection in 2009, I have made 15,000 -18,000 individual head selections for growth in head rows in 2009/10. Anecdotal evidence suggests that we successfully shifted the populations towards adaptation and in a year where we had a significant level of natural infection, I was impressed with the apparent FHB resistance in most populations. From head rows, they will be advanced in 2011 to preliminary yield nurseries at which time they will return to our FHB nursery for formal evaluation.

Impact/Clientele Benefit:

As with all lines in our breeding program, where the FHB resistance levels are functional, they will be entered into the uniform nursery system to provide the opportunity for breeders in other states to evaluate and use at their discretion in their own breeding programs. Additionally, where lines are released, they will be public releases with the opportunity for joint release with other public institutions. Superior lines, if adopted by growers will continue to lessen the impact of FHB on the wheat crop in Missouri and other states in which the lines are grown.

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.

Liu, S., M.D. Hall, C.A. Griffey, A.L. McKendry 2008. Meta-analysis of Fusarium head blight resistance QTL in wheat. *Crop Science* (in press)

Brown-Guedira, G., C. Griffey, F. Kolb, A.L. McKendry, J.P. Murphy, D.A. Van Sanford. 2008. Breeding FHB-resistant soft red winter wheat: progress and prospects. *Cer. Res. Comm.* 36 Supplement B. 31-35. (Proceedings of the 3rd International Symposium on Fusarium Head Blight; Szeged, Hungary; 1-5 September 2008).

McKendry, A.L. 2008. Native resistance: an essential building block for accelerating the development of scab resistant soft red winter wheat. *Cer. Res. Comm.* 36: 135-137. (Proceedings of the 3rd International Symposium on Fusarium Head Blight; Szeged, Hungary; 1-5 September 2008).

Abate, Z., S. Liu, A.L. McKendry. 2008. Validation of QTL associated with Fusarium head blight resistance in the soft red winter wheat, 'Ernie'. 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.* pp 125-128.

Liu, S., M.D. Hall, C.A. Griffey, A.L. McKendry, J. Chen, and D.A. Van Sanford. 2008. Mapping QTL for scab resistance in the Virginia wheat cultivar Massey. 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.* pp 176-177.

Liu, S., C. Griffey, A.L. McKendry, and M. Hall. 2008. Saturation mapping of scab resistance QTL in Ernie and application to marker-assisted breeding. 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.* pp 180.

Liu, S., C.A. Griffey, J. Chen, A.L. McKendry, C.H. Sneller, J.P. Murphy, and G. Brown-Guedira. 2008. Breeding and genomics of Fusarium head blight resistance in soft red winter wheat: research progress and ongoing projects. Presented at the Annual meeting of the American Society of Agronomy 5-9 October, 2008; Houston, TX.

McKendry, A.L., D.N. Tague, J.K. Solomon, B.J. Craughwell. 2008 Missouri Winter Wheat Performance Tests. Special Report 573. Missouri Agricultural Experiment Station; College of Agriculture, Food and Natural Resources, University of Missouri. August 2008 (Contains FHB ratings for commercial varieties)

FY08 (approx. May 08 – April 09)
PI: McKendry, Anne
USDA-ARS Agreement #: 59-0790-4-113

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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.

No lines were released during this period.