

**USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY09 Final Performance Report
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Cover Page

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USDA-ARS Agreement ID:	59-0206-9-077
USDA-ARS Agreement Title:	Fusarium Head Blight Research in Winter Wheat.
FY09- USDA-ARS Award Amount:	\$ 119,994

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.	\$ 77,502
VDHR-NWW	Mapping Fusarium Head Blight Resistance in Truman Wheat.	\$ 42,492
	Total Award Amount	\$ 119,994

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
 DUR-CP – Durum 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

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

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 the broadly based, effective, genetically different, native sources of resistance identified in Missouri wheat germplasm; an approach that has been shown to accelerate the development and release of FHB resistant cultivars for the soft red winter wheat region. In 2009 our general 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 (both native and exotic), as they are verified, into elite Missouri soft red winter wheat breeding lines; (4) genetic characterization through haplotyping of Missouri resistant breeding germplasm; (5) to convey information on scab resistance of commercially available wheat cultivars through evaluation of the 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 sections (repeat sections for each major accomplishment):

Accomplishment 1: Our most significant accomplishment in 2009 was the identification of a completely new, broad-based, native source of resistance in our breeding materials. This family of lines was developed from a cross of Coker material with one of our own, breeding lines, MO 92-599. Since its discovery, the resistance in this group has been verified in the Illinois breeding program (MO 080104 - 5-State Nursery). Two lines from this family (MO 080104 and MO 080103) were entered in the 2010 Northern and Preliminary Scab Nurseries, respectively, and preliminary data appears to confirm the high level of resistance in these lines. Within our own breeding program, I am particularly excited by MO 080104. We reported on this line in 2008 and it continues to excel. Our screening shows 20% incidence at 10-d post inoculation, 70% incidence 21-d post inoculation, 5.4% severity and a field Fusarium head blight index (FHBI) of 3.8% compared with Truman (our most resistant check) which showed 10-d incidence of 10%, 21-d incidence of 60% and a mean severity on the head of 9.25%. The FHBI for Truman in the same test was 5.5%. Several attributes of this family and of MO 080104 in particular are also exciting and differentiate it from Truman. It is shorter (although it doesn't carry the common alleles of Rht 1, 2 or 8) and much earlier than Truman and has superior overall agronomic type. In our advanced yield trials it won the state. Across the 5-State Nursery locations in 2009, it finished 3rd. In 2010 it is being evaluated in Missouri Winter Wheat Performance Trials and the Eastern nursery. It has excellent test weight. It is stripe rust resistant and has acceptable levels of resistance to other relevant pathogens. It carries *Ppd-D1a* for photoperiod insensitivity and therefore should perform across the region.

Impact: Should MO 080104 proceed to release, it will provide growers in the soft red winter wheat region with a cultivar that has excellent agronomic type, superior yield and test weight potential, and broad-based FHB resistance that equals or exceeds that of Truman. It will add to the group of commercial cultivars released from the University of Missouri that will immediately lessen economic losses due to FHB in the region where it is grown. In addition, it carries none

of the known FHB resistant markers and based on pedigree data, differs from Truman by descent. Therefore, once genetically characterized, MO 080104 has the potential to contribute novel FHB resistance alleles that can be pyramided through marker-assisted-selection with other known native or exotic alleles to potentially build more complete FHB resistance in our cultivars.

Accomplishment 2: We have increased the FHB resistance levels in most of our advanced and preliminary yield nursery entries through native resistance combinations including those from the Truman family of lines (Truman, Bess, 980829, 980725), Ernie, Roane, McCormick, and several Illinois lines as well as combinations of Missouri native sources (primarily) with Sumai 3 (and genotypes derived from the FHB resistance in Sumai 3), Seu Seun 6 (South Korea), Colorben 4 and Quaderna (Italy – Mentana source), and a number of Eastern European breeding lines. Most lines were developed from two sources of resistance but many result from 3, and 4 genetically different sources. To accelerate development and release, unadapted lines make up 25% or less of the pedigree. Any susceptible line (>25% FHBI) is automatically discarded and resistance in the remaining lines is getting better. Across 308 lines in advanced testing, 70 lines (23%) had FHB resistance levels better than Truman and 208 lines (68%) had a field FHB index (incidence x severity) that was less than 25%. An additional 1700 entries in our preliminary yield nurseries have been developed from comparable or newer sources of resistance and it is expected that these will perform similarly when evaluated in the scab nursery in 2011.

Impact: The release of FHB-resistant cultivars is the primary goal of the USWBSI. Our program has had considerable success focusing on native resistance through screening and recombination in adapted backgrounds. The germplasm pipeline noted above will certainly lead to future releases from the program that, where grown, will lessen the overall threat from FHB in Missouri and the surrounding states. Superior sources, whether released or used as improved germplasm will also be shared with breeders in other states through the uniform scab nursery system. By making this germplasm widely available, alleles discovered in our program should enhance the scab resistance in cultivars throughout the soft red winter wheat region.

Accomplishment 3 - Nursery Evaluation: In 2009/2010, we evaluated all 72 entries in the Missouri Winter Wheat Performances tests in our field and greenhouse inoculated nurseries. As anticipated, the best public lines in these commercial trials were Truman, Bess, and the Missouri experimental lines MO 041687 (carrying Truman resistance) and MO 080104 (carrying an unknown source of resistance). Of the 72 lines tested, 13 had a field FHBI less than 25% and of those, the FHBI of 3 lines was less than 10%. These data will be published in the on the Missouri Variety Testing Website and will be linked to Scab Smart website. In addition, my program evaluated and will report data for the Northern Uniform and Preliminary FHB Nurseries and for the Southern FHB Nursery.

Impact: Data from the Performance Tests will provide growers with previously unavailable information on the FHB resistance of commercial cultivars. That should move growers' decision making on variety selection towards selection of varieties with FHB resistance. Our Uniform Scab Nursery data 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.

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 (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. Haplotype data suggests that the resistance in Truman differs from the resistance in Sumai 3 and its derivatives as well as the resistance in Ernie. The overall objectives of this mapping project are to identify QTL associated with each of the 4 types of FHB resistance in Truman in a recombinant inbred line population consisting of 239 RILs developed from the cross Truman/MO 94-317. A collaborative phenotyping effort at Missouri, Kentucky and Purdue, and Ohio, was initiated to provide data from multiple environments upon which to base the genotyping effort.

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:

Because of a hiring freeze at the University of Missouri, this project was delayed for a year. To circumvent the hiring freeze, I hired an experienced doctoral student in May 2009 to work on the project rather than the 75% time postdoc I had originally intended to hire. In 2009, the first year of replicated phenotyping was done across 4 locations. Because of extensive genotype x environment interaction across the locations a second year of replicated phenotyping will be done in FY10. DArT analysis was completed in fall of 2009 and parents were genotyped with available SSR markers. Approximately 200 SSRs were polymorphic between the two parents. Genotyping of RILs was begun in 2009 and will be completed in FY10.

Impact: The source of FHB resistance in Truman is highly penetrant and although the resistance is quantitative, it is expected that there will be at least one major QTL associated with the resistance. 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 her genotyping lab for use in marker-assisted-selection, 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.

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.

None during this period.

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 2009. Meta-analysis of QTL Associated with Fusarium Head Blight Resistance in Wheat. *Crop Sci.* 49:1955-1968

Abate, Z.A., and A.L. McKendry. 2010. Diallel analyses of Fusarium head blight resistance in genetically diverse winter wheat germplasm. *Euphytica*. DOI 10.1007/s10681-010-0195-y

Rottinghaus, G.E. B.K. Tacke, T.J. Evans, M.S. Monstrom, L.E. Sweets, and A.L. McKendry. Fusarium Mycotoxin Concentrations in Straw, Chaff and Grain of Soft Red Winter Wheat Expressing a Range of resistance to Fusarium Head Blight. In: Canty, S.M. A. Clark, J. Mundell, E. Walton, D. Ellis, and D. Van Sanford (Eds.) *Proceedings of the National Fusarium Head Blight Forum 2009 Dec 7-9; Orlando, FL. Lexington KY: University of Kentucky.* pp.10.

Liu, S. C.A. Griffey, A.L. McKendry, M.D. Hall. Saturation Mapping of Scab Resistance QTL in Ernie and Identification of Diagnostic Markers for Breeding Scab Resistance. In: Canty, S.M. A. Clark, J. Mundell, E. Walton, D. Ellis, and D. Van Sanford (Eds.) *Proceedings of the National Fusarium Head Blight Forum 2009 Dec 7-9; Orlando, FL. Lexington KY: University of Kentucky.* pp.133

Liu, S., M.D. Hall, C.A. Griffey, A.L. McKendry, J. Chen, W.S. Brooks, G. Brown-Guedira, and D. Van Sanford. Saturation Mapping QTL for Scab Resistance in the Virginia Wheat Cultivar Massey. In: Canty, S.M. A. Clark, J. Mundell, E. Walton, D. Ellis, and D. Van Sanford (Eds.) *Proceedings of the National Fusarium Head Blight Forum 2009 Dec 7-9; Orlando, FL. Lexington KY: University of Kentucky.* pp.134.