USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY09 Final Performance Report
July 15, 2010

Cover Page

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Fiscal Year:	2009
USDA-ARS Agreement ID:	59-0206-9-083
USDA-ARS Agreement Title:	Breeding for FHB Resistance in the Southeaster U.S. - Uniform Nursery and Marker Characterization.
FY09- USDA-ARS Award Amount:	$ 82,345

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Adjusted Award Amount
VDHR-SWW	Enhancement of Fusarium Head Blight Resistance in the Southeastern US Germplasm Pool.	$ 58,126
VDHR-SWW	Marker Characterization of Soft Winter Wheat Scab Screening Nurseries.	$ 24,219
	Total Award Amount	**$ 82,345**

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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: *Enhancement of Fusarium Head Blight Resistance in the Southeastern US Germplasm Pool.*

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

Fusarium Head Blight is a major concern to the wheat industry in North Carolina due to the annual occurrence of the disease in commercial production. We are resolving this problem by: 1) developing southeastern adapted cultivars and germplasms with moderate to high levels of FHB resistance combined with superior productivity, disease and insect resistance and end-use quality; 2) coordinating the Uniform Southern Soft Red Winter Wheat Scab Nursery to provide breeding programs with reliable, independent data on FHB resistance in advanced generation lines, and 3) seeking to provide eastern U.S. wheat breeders with doubled haploid lines developed from crosses between parents exhibiting scab resistance and overall agronomic superiority.

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:

Advanced Lines

Field data collected under natural and inoculated FHB epidemics provided an opportunity to observe program progress in cultivar development. Two advanced lines slated for release in 2010 (NC-Yadkin), 2011 (NC05-19896), were confirmed to have moderate levels of FHB resistance. Both genotypes have native resistance of unknown origin. Both have excellent agronomic and good end-use quality characteristics. Data collected in inoculated nursery on 60 entries in the NC Official Variety Test and 75 entries in the cooperative Gulf Atlantic Wheat Nursery (GAWN), and results distributed to cooperators, producers and end-users. Of the 150 entries entering Preliminary Testing in fall 2010 we have seven doubled haploid lines, 11 lines containing *Fhb1*, 30 lines with Belgian, Serbian or CIMMYT parentage resistant to FHB, and 56 lines with native resistance parentage. Of the 40 lines entering Advanced Testing in fall 2010, six have moderate FHB resistance confirmed over years, six have exhibited moderate FHB resistance in at least one year, three contain *Fhb1*, and seven are doubled haploids without FHB evaluations. Twenty two of 62 $Bc_1F_{3:6}$ lines from crosses between the susceptible NC99-13022 and a diverse set of exotic resistant lines selected in replicated FHB Observation test during 2009-10. Some will enter Uniform Southern Scab Nursery in fall 2010.

The 2008-09 Uniform Southern Nursery program contained 53 entries submitted by 10 US public and private breeding programs. Fourteen cooperators (12 US and one each in Romania and Hungary) returned laboratory, greenhouse and/or field nursery data. The data were summarized in a nursery report distributed to wheat breeders and pathologists in Dec 2009. The 2009-10 Uniform Southern Nursery containing 54 entries submitted by ten US public and private breeding programs was distributed for planting in fall 2009.

Doubled Haploid Program

Approximately 400 doubled haploid lines in head rows were harvested in 2010. All were derived from parents that were moderately resistant to FHB. These DH lines will be distributed to interested US wheat breeders for evaluation in 2010-11. Included in this material are two populations suitable for mapping studies: NC-Neuse x Bess and MD01W233-06-1 x SS8641. Seven additional F_1 populations with parentage containing either *Fhb1* in a semi-adapted background, or native FHB resistance, are in the doubled haploid pipeline.

Early Generation Materials

Approximately 530 crosses involving FHB resistant parents were made during winter 2009-10. Eight 3-way F_1 populations were enhanced for *Fhb1, Fhb5A* and the Frontana *3A* and *5A* complex. Twenty two 3-way F_1 populations were sent to Argentina for generation advance in an off-season nursery

Impact:

The 2008-09 Uniform Southern Nursery provided cooperators with comprehensive evaluations of the FHB resistance in their advanced generation lines. Data collected on cooperative GAWN nursery represents an expansion of effort. These data are vital for release decisions and for choosing and sharing parents for further population development. The NC program produced advanced generation lines that have moderate to good levels of FHB resistance combined with good overall agronomic and end-use quality. Several of these are of sufficient overall merit to enter regional cooperative trials, which suggests they may be of variety quality. Multi–year evaluations of FHB resistance in state OVT entries helps growers make informed decisions on variety selection. Thus should result in a decline in the use of susceptible cultivars that are high performers in the absence of FHB epidemics, but extremely poor performers in the presence of FHB epidemics. One line is being increased for release in 2011 combines overall agronomic and end-use excellence with enhanced FHB resistance. Breeding lines with resistance from the Sando collection of intergeneric hybrids will enter Uniform Scab Nurseries in fall 2010 and hopefully provide breeders with novel sources of resistance in a soft red winter wheat background adapted to the southeastern US.

Project 2: *Marker Characterization of Soft Winter Wheat Scab Screening Nurseries.*

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

   Fusarium Head Blight is a major concern to the wheat industry in the Eastern United States. We are working with breeders in the eastern region to resolve this problem by: 1) Evaluating the Eastern FHB screening nurseries with markers associated with QTL for FHB resistance and other important agronomic traits; 2) using association analysis of marker genotypes and phenotypic data available for the eastern uniform nurseries to identify new QTL for FHB resistance in locally adapted winter wheat germplasm; and 3) providing haplotype and marker polymorphism data on parents of mapping populations.

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:

   Uniform Nursery Screening:
   The entries of the Uniform Southern FHB Nursery, the Northern Uniform Winter Wheat Scab Screening Nursery (NUWWSSN) and the Preliminary NUWWSSN were evaluated with markers linked to 19 different genes, including markers linked to seven FHB resistance QTL. Data was also obtained on the *Rht-B1* and *Rht-D1* genes that have recently been implicated as affecting FHB resistance. These data were provided to the nursery collaborators and were included in the nursery reports distributed to wheat breeders and pathologist.

   Association Mapping:
   Analyses of available SSR and DArT markers revealed complex genetic relationships among entries in the 2007-2008 and 2008-2009 Scab Screening Nurseries. Different analysis methods were evaluated to account for population structure in the nurseries in order to identify genomic regions associated with the different components for FHB resistance, including DON levels. Previously mapped markers on chromosome 3B and 5A were associated with resistance in these lines as well as a new region on chromosome 2D. In order to increase the population size and the power of the analysis, marker data are being collected on entries in the 2009-2010 nurseries that will be analyzed with the previous years data.

   Mapping populations:
   SSR marker polymorphism screening of the Truman x MO94-314 mapping population was completed in July 2009. DNA of to the population was isolated and DArT marker data received during Fall 2009. This research was done in collaboration with Anne McKendry at the University of Missouri. Parents of three other SWW populations targeted for mapping of FHB resistance are being evaluated for maker polymorphism (SS8641 x MD08#560, Neuse

x AGS 2000, and 97-1808 x Clark). The screening has been completed for two populations and the third will be finished during Summer 2010.

Impact:

Our 2009 and 2010 marker evaluation placed increased emphasis on identification of unique markers associated with four FHB resistance QTL regions mapped in the soft red winter wheat cultivars, so that breeders now have information about which lines may possess these resistance QTL. Association analyses indicate that the regions on chromosomes 3B and 5A are important components of the native FHB resistance in the Eastern soft wheat germplasm, as well as a newly identified region on chromosome 2D. Breeders use the marker information on the uniform nurseries as an aid in selection of lines for crossing and advancement. The genotypic and phenotypic data set that we have developed in collaboration with the breeding programs can be used for additional analyses, including training models for doing genomic selection for FHB in eastern wheats.

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.

NC-Yadkin (NC04-20814). Moderately resistant to FHB.

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.

Benson, J., G. Brown-Guedira, C. Sneller, J.P. Murphy. 2009. Association Analysis of FHB Resistance in Soft Winter Wheat .Pp 110. In: Canty, S. M., A. Clark, E. Walton, D. Ellis, J. Mundell, and D. Van Sanford (Eds), Proceedings of the National Fusarium Head Blight Forum; 2009 Dec 7-9:Orlando, FL: University of Kentucky.

Clark,A., G. Brown-Guedira, D. Van Sanford.2009. Validation of *Fhb1* in Several Soft Red Winter Wheat Breeding Populations. Pp 115. In: Canty, S. M., A. Clark, E. Walton, D. Ellis, J. Mundell, and D. Van Sanford (Eds), Proceedings of the National Fusarium Head Blight Forum; 2009 Dec 7-9:Orlando, FL: University of Kentucky.

Kang, J., A. Clark, D. Van Sanford, C. Griffey, G. Brown-Guedira, Y. Dong and J. Costa. 2009. Evaluation of Exotic Scab Resistance Quantitative Trait Loci (QTL) Effects on Soft Red Winter Wheat. Pp 128. In: Canty, S. M., A. Clark, E. Walton, D. Ellis, J. Mundell, and D. Van Sanford (Eds), Proceedings of the National Fusarium Head Blight Forum; 2009 Dec 7-9: Orlando, FL: University of Kentucky.

Liu, S., M.D. Hall, C.A. Griffey, A. L. McKendry, J. Chen, W. S. Brooks, G. Brown-Guedira and D. Van Sanford. 2009. Saturation Mapping QTL for Scab Resistance in a Virginia Wheat Cultivar Massey. Pp 135. In: Canty, S. M., A. Clark, E. Walton, D. Ellis, J. Mundell, and D. Van Sanford (Eds), Proceedings of the National Fusarium Head Blight Forum; 2009 Dec 7-9: Orlando, FL: University of Kentucky.

Liu, S., M. Hall, C. Griffey, A. McKendry, J. Chen, G. Brown-Guedira, J. P. Murphy and D. Van Sanford. 2009. Identification of diagnostic markers for scab resistance in US wheat cultivars. AnMtgsAbsts2009.53470. ASA, Madison WI.

Murphy, J. P, and R. A. Navarro. 2009. The 2008-09 Southern Uniform Winter Wheat Scab Nursery. Pp138. 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 7-8: Orlando, Fl. University of Kentucky.
Also available at http://www.scabusa.org/pdfs_dbupload/04_ussrww_fhb_report.pdf