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:	59-0790-4-102
USDA-ARS Agreement Title:	Validation, Fine Mapping Marker Assisted Selection, and Accelerated Breeding for Scab Resistance in Soft Red Winter Wheat.
FY08 USDA-ARS Award Amount:	$ 123,450

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Adjusted Award Amount
VDHR-SWW	Breeding and Genomics of FHB Resistance in Soft Red Winter Wheat.	$121,437
BAR-CP	Screening Hordeum Germplasm for Resistance to Fusarium Head Blight and DON Accumulation.	$ 2,013
	Total Award Amount	**$ 123,450**

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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
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: *Breeding and Genomics of FHB Resistance in 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?** In addition to marker assisted selection (MAS) and breeding for FHB resistance, our research focuses on mapping and validating different types of FHB resistances in a few native sources addressing the following objectives:
   1) Scab resistant varieties derived from exotic FHB resistant parents have lower yields than those of widely grown commercial cultivars. Such lines have been crossed with superior elite lines and widely grown cultivars to enhance yields and other critical agronomic traits. FHB resistance is being integrated into elite lines having resistance to other diseases such as powdery mildew and leaf rust, as well as acceptable quality traits via MAS using available diagnostic markers to facilitate the development of FHB resistant wheat cultivars with high and stable yield and good end-use quality.
   2) Identification, validation and application of tightly linked markers for specific FHB resistance QTL in each unique source. We collaborated with USDA genotyping center in Raleigh, NC to use markers for 3BS and 6BS QTL from Sumai 3 in MAS breeding. We saturated markers on the QTL regions of Ernie and used breeder friendly diagnostic markers in MAS of target FHB resistance QTL. We constructed genetic maps using DArT and SSR markers on Becker/Massey RILs and mapped QTL for FHB resistance in a native variety Massey. A RIL population of VA00W-38/Pioneer26R46 is being used to test if there are identical or different alleles for FHB resistance in VA00W-38 versus Ernie and Massey.

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):**
   1) Cultivars having moderate scab resistance derived from native sources recently released from our program include 'Jamestown' in 2007, 'SS 5205' in 2008, and VA04W-90 in 2009. In Virginia Tech's inoculated, mist irrigated scab nursery, the three year average FHB index (0-100) and DON (ppm) values for these cultivars vary from 6 to 11 for index and from 0.28 to 0.80 ppm for DON versus those of susceptible cultivars SS 520 and Pioneer Brand 26R24 ranging from 26 to 32 for index and from 1.4 to 1.9 ppm for DON.
   2) A total of 236 F_{11} RILs of Ernie/MO 94-317, 152 F_{13} RILs of Becker/Massey, and 200 F_7 RILs of VA00W-38/Pioneer26R46 were phenotyped for type I, II, DON and FDK resistance. A set of 56 SSR markers were mapped onto the target QTL regions of Ernie on chromosomes 2B, 3BSc, 4B and 5A. A set of 589 DArT markers and 58 SSR markers were mapped onto the Becker/Massey population. Two major QTL in Massey were mapped onto chromosomes 4B and 4D which are associated with FHB incidence, severity, index and FDK and explained 6% to 33% of phenotypic variation. *Rht1* from Massey is associated with FHB resistance while *Rht2* from Becker is associated with FHB susceptibility. *Rht8* and *Ppd1* genes are also associated with the minor QTL for incidence, severity, index, and DON. Other minor QTL on chromosomes 2B, 3BSc, and 5A have the same alleles with those of Ernie. The phenotypic data were collected a 2nd year at two locations and DON and FDK will be analyzed accordingly.
   3) The Virginia Tech cultivar Tribute has resistance to scab and lower DON accumulation. A double haploid population is being developed at CIMMYT to characterize and map genes governing scab resistance in this unique native source.
   4) Marker-assisted selection of parents for diverse FHB resistance QTL and other agronomic traits: Haplotyping elite lines with available diagnostic markers for FHB resistance in Ernie and Sumai-3 derivatives, as well as resistances to other diseases (powdery mildew, leaf rust, stripe rust), quality (1B.1R, 1A.1R and gluten), and dwarfing genes (*Rht1*, *Rht2*, and *Rht8*). A set of

86 soft red winter wheat, 21 FHB resistance soft red winter wheat, 29 bread wheat and 21 winter durum wheat lines were screened for parental profiling at these loci.

5) Marker-assisted selection combined with phenotypic selection for FHB resistance in segregating breeding populations: a) F_4 top cross population VA02W-713 (Ning 7840 /Pioneer 2691//Roane) / Tribute // VA07W-120 (Ernie*2// Futai8944/Ernie/3/Ernie). Fifty lines in observation yield tests at Blacksburg and Warsaw, VA. Forty-three lines in headrows and 216 lines with type II GH resistance were tested in the scab nursery. Promising lines are being advanced to headrows or scab preliminary tests for next year. b) More than 800 individual plants from five top cross populations with Ning7840 or Ernie derived FHB resistance were screened for markers linked to 3BS, 5AS, 6BS, 2B, 3BSc, 4B QTL. They were planted at Warsaw in headrows for evaluation of scab, other diseases, quality and agronomic traits. c) Fifty lines from the cross of Ning7840/3* McCormick BC_2F_3 were screened in the scab nursery and yield plot tests in collaboration with University of Maryland and University of Kentucky.
6) A set of 282 F_2 to F_6 segregating populations with various sources of FHB resistance were evaluated in 160 ft^2 inoculated plots at My Holly, VA. A set of 79 F_4 to F_6 were also planted in Blacksburg, VA for head and/or bulk selection under natural scab infection.
7) About 550 soft red winter wheat lines were tested in Blacksburg scab nursery. These lines include 89 entries in VA official variety trial, 39 in FHB advance and 45 in FHB preliminary, 46 in preliminary northern uniform, 60 in northern uniform, 57 in southern uniform, and 213 lines in various observation tests.
8) An FHB management study was conducted to test the impact of resistant cultivars and fungicide to control FHB under epidemic conditions. The test was comprised of three soft red winter wheat cultivars (3 resistant, 1 susceptible) and eight winter durum lines (four moderately resistance, four moderately susceptible) with and without fungicide (Proline or Prosaro) treatment at two locations over two years.

Impact:

1) Cultivars having moderate scab resistance derived from native sources released from our program including ‘Roane’, ‘Tribute’, ‘McCormick’, ‘USG 3342’, ‘Dominion’, and ‘MPV 57’ have been grown by producers over a broad area. Seed of our latest cultivars Jamestown and SS 5205 will be available to producers in fall 2009.
2) There are only tightly linked markers for a few major QTL which are effective in MAS. Yield drag is a major problem limiting the utilization of exotic sources of FHB resistance. Our research focuses on the FHB resistance in adapted US cultivars. Our results indicate that there are some identical and different QTL between Ernie and Massey. We identified diagnostic markers for FHB resistance QTL in Ernie and shared the information with Gina Brown-Guedira who is using them for haplotyping at the USDA-ARS genotyping center. This information also is available to the wheat community (published in Fusarium Focus).
3) Deployment of phenotypic selection combined with MAS using diagnostic markers for target FHB resistance QTL to select parents and progeny with target regions for resistance to FHB, powdery mildew, leaf rust, stripe rust, Hessian fly, dwarfing genes *Rht1*, *Rht2*, and *Rht8*, photoperiod sensitive genes, and quality traits enhances efforts to develop acceptable FHB resistant cultivars.
4) Given the severe FHB epidemics that occurred in the eastern U.S. this year, data on FHB reaction of commercial cultivars and data from our FHB management study will provide producers with critical information for best management practices for controlling FHB and DON.

Project 2: *Screening Hordeum Germplasm for Resistance to Fusarium Head Blight and DON Accumulation.*

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

   In comparison to wheat, fewer FHB resistance sources have been identified, genetically characterized, and mapped. We continue to collaborate with Brian Steffenson in the evaluation of winter barley accessions to validate their FHB resistance. In addition to feed, winter barley is positioned for use as a feedstock for ethanol production. Because the byproduct, distiller's dry grain solubles (DDGS) from ethanol production has potential for use in both food and feed markets, efforts have been enhanced to characterize and enhance FHB resistance in winter barley. FHB resistant germplasm, e.g. 'Chevron', Fredrickson', and elite malt barley lines have been used as parents in our breeding program to enhance FHB resistance in winter barley.

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:

   Sixty winter barley germplasm lines received from Brian Steffenson were evaluated in a replicate test in our scab nursery and FHB and DON data were sent to him. Thirty two hulless and 33 hulled barley lines included in our state variety trial also were evaluated in replicated tests in our scab nursery for FHB and DON.

   Single and top crosses were made among scab resistance sources and F_2 to F_4 segregating populations having scab resistant parents were evaluated and advanced at two locations in Virginia.

   Impact:

   FHB and DON data on winter barley germplasm lines with facilitate the selection and validation of effective and potentially unique resistance sources which can be used as parents in variety development and in mapping studies. FHB and DON data on entries in Virginia's official variety test will enhance breeding efforts and also will provide producers with information regarding resistant versus susceptible cultivars.

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, and A.L. McKendry. 2009. Meta-Analyses of QTL associated with Fusarium head blight resistance in wheat. Crop Science, In press.

Liu S., C.A. Griffey, and A.L. Mckendry. 2009. Diagnostic markers for scab resistance in the soft red winter wheat cultivar Ernie. Fusarium Focus. p5.

Liu S., C.A. Griffey, A.L. McKendry, J. Chen, M.D. Hall, G.Brown-Gudeara, D. Van Sanford. 2009. Saturation mapping of target scab resistance QTL in US sources and their application in marker assisted breeding. The International Plant and Animal Genome Conference. San Diego, CA USA. January 10-14, 2009.

Griffey C.A., G. Brown-Guedira, S. Liu, J.P. Murphy, and C. Sneller. 2008. Characterization and Development of FHB Resistant Soft Winter Wheat Cultivars in the Eastern U.S. In: S. Canty, A. Clark, E. Walton, E. Ellis, J. Mundell, and D. Van Sanford (Eds.), Proceedings of the National Fusarium Head Blight Forum; 2008 Dec 2-4; Indianapolis, IN. Lexington, KY: University of Kentucky. p. 162-165.

Liu S., C.A. Griffey, A.L. McKendry. M.D. Hall and G. Brown-Guedira. 2008. Saturation mapping of scab resistance QTL in Ernie and its application in marker-assisted breeding. In: S. Canty, A. Clark, E. Walton, E. Ellis, J. Mundell, and D. Van Sanford (Eds.), Proceedings of the National Fusarium Head Blight Forum; 2008 Dec 2-4; Indianapolis, IN. Lexington, KY: University of Kentucky. p. 180.

Liu S., M.D. Hall, C. A. Griffey, A.L. McKendry, J. Chen, and D. Van Sanford. 2008. Genetic mapping of scab resistance in a Virginia powery mildew resistant variety Massey. In: S. Canty, A. Clark, E. Walton, E. Ellis, J. Mundell, and D. Van Sanford (Eds.), Proceedings of the National Fusarium Head Blight Forum; 2008 Dec 2-4; Indianapolis, IN. Lexington, KY: University of Kentucky. p. 178-179.

Liu S., W.S. Brooks, S. Chao. C.A. Griffey, M.D. Hall. 2008. Association mapping of barley important traits using abundant SNPs. In: S. Canty, A. Clark, E. Walton, E. Ellis, J. Mundell, and D. Van Sanford (Eds.), Proceedings of the National Fusarium Head Blight Forum; 2008 Dec 2-4; Indianapolis, IN. Lexington, KY: University of Kentucky. p. 176-177.

Liu S., W.E. Thomason, C.A. Griffey. 2008. Scab management through resistant varieties and fungicide. In: S. Canty, A. Clark, E. Walton, E. Ellis, J. Mundell, and D. Van Sanford (Eds.), Proceedings of the National Fusarium Head Blight Forum; 2008 Dec 2-4; Indianapolis, IN. Lexington, KY: University of Kentucky. p. 42.

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. Annual meeting of the American Society of Agronomy. 2008 October 5-9. Houston, TX.

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.

The SRW wheat line VA04W-90 has a high level of scab resistance and was approved for cultivar release on March 19, 2009. It is broadly adapted, high yielding, moderately short, mid-season maturity and is resistant to powdery mildew. It had a three year (2006 – 2008) average grain yield of 88 Bu/ac and test weight of 59.8 Lb/Bu in Virginia's State Variety Trial. In Virginia Tech's inoculated, mist-irrigated FHB nursery, disease index scores (0 – 100) of VA04W-90 have ranged from 5 to 8 and DON toxin concentrations have ranged from 0.1 to 0.6 ppm

Two germplasm lines VA04W-433 and VA04W-474 were released and have better scab resistance (have 3BS and 5AS scab resistance QTL from Ning7840, respectively) and higher yields than that of Ernie. On the basis of FHB evaluations in field trials conducted in 14 to 16 environments, mean FHB incidence, severity, index, and DON toxin concentration of VA04W-433 (36%, 15%, 5.3%, and 0.86 ppm) and VA04W-474 (35%, 14%, 5.5%, and 0.48 ppm) were lower than those of the resistant check cultivar Ernie (39%, 21%, 7.3%, and 2.46 ppm). The susceptible check cultivar Coker 9835 had corresponding values of 74%, 36%, 28%, and 2.77 ppm. In greenhouse tests FHB severity values, assessed as disease spread in the spike following single floret inoculation, of VA04W-433 (8.1%) and VA04W-474 (7.6%) also were lower than those of Ernie (8.7%) and Coker 9835 (27%).