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

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Fiscal Year:	2009
USDA-ARS Agreement ID:	59-0206-9-070
USDA-ARS Agreement Title:	Breeding and Development of DNA Markers for Fusarium Head Blight Resistance in Wheat.
FY09- USDA-ARS Award Amount:	$ 158,880

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Adjusted Award Amount
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	**$ 158,880**

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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: *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:

   Four lines were approved to be released as germplasm by the University of Minnesota's Crop Variety Release Committee in 2009: MN99112-10, MN99126-1-3, MN00187-3, MN02222. A registration article for the Journal of Plant Registrations is in preparation. The four lines are described in greater detail at the end of this report.

   Impact:

   The four released lines have been evaluated in U of MN FHB nurseries since 2000 and regional FHB nurseries from 2001-2006. They represent the best FHB resistance that the University of Minnesota's wheat breeding program has developed during the past decade. These lines have been available upon request since their entry in the regional nurseries and have been used as parents by several public and private wheat breeding programs. The germplasm release is meant to make these materials available to a wider audience of breeders to improve FHB resistance in their germplasm.

   Accomplishment:
   Five experimental lines were entered in the 2009 Uniform Regional Scab Nursery. These lines were identified in previous testing as having improved levels of FHB resistance. Of the 28 experimental lines entered from 7 regional breeding programs, excluding checks, the five U of MN lines ranked 1, 2, 4, 5, and 8 for the lowest DON content.

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

Accomplishment:
Scab nurseries were established at 3 field sites in 2009. A total of 2,193 genotypes were evaluated in 6,191 total rows among the locations. Dry, hot weather resulted in low FHB at the Morris location, but informative data from the St. Paul nursery. The Crookston FHB screening nursery was excellent, and provided highly discriminatory data. As a result of this nursery and results from previous years, the FHB resistance data of 30 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.

Accomplishment:
The breeding line MN05214-3 was approved for winter increase during 2009/2010. This line is moderately resistant to FHB and, if released in 2011 as expected, will be rated as a 3 (1-9 scale) for FHB reaction. This represents better FHB resistance than the recent U of MN – developed varieties 'Tom' (2008) and 'Sabin' (2009) which were both rated as 4's. Moreover, MN05214-3 has much better straw strength of any U of MN released variety since the 1990's. MN05214-3 has better than average test weight and grain protein and average grain yield. We are experimenting with increased seeding rates to improving the yield of MN05214-3.

Impact:
Growers want high yielding wheat varieties with adequate protein, straw strength, and disease resistance. Our FHB resistance ratings are an important part of growers' decision regarding which variety they will grow. None of the most FHB resistant varieties available (those with 3 or 4 ratings) have good straw strength. Therefore, MN05214-3 should be in demand with its unique combination of best available FHB resistance and strong straw.

Project 2: *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 were completed in four different field environments and two greenhouse environments to map type I and II resistance to *Fusarium graminearum*, resistance to DON accumulation, post-harvest grain traits and agronomic traits. The phenotypic data was used to select resistant RILs as crossing parents and to develop QTL validation populations. A subset of 94 RILs was genotyped with 377 SSRs. After an initial QTL analysis, SSR markers associated with FHB resistance traits were mapped on the remaining 56 RILs.

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:
New QTL for the FHB traits incidence, disease severity, 30 head weight, test weight, VSK, and DON content were identified. The resistance QTL derived from PI 81791 on chromosomes 2B, 3B, and 3D explain the largest amount of variation observed for many of the resistance traits. Additional type II resistance QTL were identified on 3A in greenhouse environments, explaining as much as 23.2 and 15.8% of the phenotypic variation observed.

Impact:
The new QTL can be pyramided with other FHB QTLs to increase resistance. The adapted cultivars with the best FHB resistance are still vulnerable under environmental conditions that are suitable for development of epidemics. Incremental improvements in FHB resistance can be achieved by combining additional QTL, eliminating susceptibility alleles, and robust phenotypic screening.

Accomplishment:
QTL-NIL populations are under development in 11 populations. A total of 1,740 F5 derived F6 headrows are being screened for heterozygotes at three QTL loci.

Impact:
Validated QTL will be of interest to other wheat breeders. We are continuing this work using other funding and plan to have results of validation studies by the end of 2011.

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.

Germplasm Release:

Four lines were approved by the University of Minnesota's Crop Variety Release Committee in 2009. A registration article for the Journal of Plant Registrations is in preparation. The four lines are:

MN99112-10 MN93377/MN94350
MN93377 has the pedigree MARSHALL/WUHAN#3//MINNPRO. Wuhan 3 is the presumed source of FHB resistance. It was produced by researchers at CIMMYT. MN94350 is an introduced line from the southern cone region of South America and was bred by CIMMYT.

MN99126-1-3 MN94053/MN2514
MN94053 is from the cross of BR23/MN90071. BR23 is from Brazil. MN2514 is from the former Pioneer spring wheat breeding program and has the pedigree SGZ352/Guard. SGZ352 has the pedigree Ranjaja 12/Sonora 64//CGN/3/Sapsucker 3. None of the lines in the pedigree of MN99126-1-3 have been previously identified as having FHB resistance.

MN00187-3 RS 83/NING8331-4
RS 83 was developed by recurrent selection for FHB resistance by Dr. Blake Cooper, formerly employed by AgriPro. Ning8331 is from China and was bred for FHB resistance.

MN02222 MN98389/MN97518
MN98389 was developed from the cross of Oxen/McVey. MN97518 has the pedigree SBE0303-18/MN92320. SBE0303-18 has the pedigree SGZ352/Guard. MN97518 has shown particularly good combining ability as it is one of the parents of 'Sabin' and MN02072-7, both released in 2009.

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.

Abstracts/Proceedings

Talbert, L., M. Soria, J. Sherman, J. Anderson, P. Baenziger, W. Berzonsky, G. Brown-Guedira, K. Garland-Campbell, B. Carver, J. Chen, S. Chao, A. Fritz, C. Griffey, G. Bai, S. Haley, J. Johnson, S. Kianian, K. Kidwell, M. Mergoum, H. Ohm, C. Peterson, O. Riera-Lizarazu, J.

Rudd, M. Sorrells, E. Souza, R. Zemetra, J. Dubcovsky. 2009. The WheatCAP Project: Genomics for Applied Plant Breeding. *In* Agronomy abstracts. ASA, Pittsburgh, PA.

Quirin, E.A, and J.A. Anderson. 2009. QTL Mapping of FHB Resistance Traits in the Japanese Wheat Landrace, PI 81791. In: S. Canty, 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, p. 143.

Gale, L.R., R. Dill-Macky, J.A. Anderson, K.P. Smith, and H.C. Kistler. 2009. Aggressiveness and Mycotoxin Potential of U.S. Fusarium graminearum Populations in Field-Grown Wheat and Barley. In: S. Canty, 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, p. 173.

M.A. Soria, J. Sherman, J.A. Anderson P.S. Baenziger, G. Bai, B. Berzonsky, G. Brown-Guedira, K. Campbell, B.F. Carver, S. Chao, A. Fritz, C. Griffey, S.D. Haley, J.W. Johnson, S.F. Kianian, K.K. Kidwell, D.E. Matthews, M. Mergoum, H. Ohm, J. Peterson, O. Riera-Lizarazu, J. Rudd, L. Talbert, M.E. Sorrells, E. Souza, L. Yan, R. Zemetra. 2010. WheatCAP Project: Creating Public Long-Term Tools And Capabilities For Wheat Improvement. *In* Plant & Animal Genome XVIII Abstracts, San Diego, CA.

Reports

Anderson, J.A., J.J. Wiersma, G. Linkert, S. Reynolds, and C. Springer. 2009. Hard Red Spring Wheat. In Minnesota Varietal Trials Results, University of Minnesota Extension Service.

Anderson, J.A., J.J. Wiersma, G. Linkert, S. Reynolds, and C. Springer. 2009. Winter Wheat. In Minnesota Varietal Trials Results, University of Minnesota Extension Service.