USDA-ARS / USWBSI
FY03 Final Performance Report (approx. May 03 – April 04)
July 15, 2004

Cover Page

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Year:	**FY2003 (approx. May 03 – April 04)**
FY03 ARS Agreement ID:	**59-0790-9-025**
FY03 ARS Agreement Title:	**Breeding and Genetics of Fusarium Head Blight Resistance in Wheat.**
FY03 ARS Award Amount:	**$ 176,552**

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
BIO	Targeted Saturation Mapping of a Major Wheat QTL for Resistance to Fusarium Head Blight.	$ 67,596
VDUN	Breeding Fusarium Head Blight Resistant Wheat.	$ 77,902
VDUN	Assessing the Breeding Value of Fusarium Head Blight Resistance Genes.	$ 31,054
	Total Amount Recommended	**$ 176,552**

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Principal Investigator Date

* BIO – Biotechnology
CBC – Chemical & Biological Control
EDM – Epidemiology & Disease Management
FSTU – Food Safety, Toxicology, & Utilization
GIE – Germplasm Introduction & Enhancement
VDUN – Variety Development & Uniform Nurseries

Project 1: ***Targeted Saturation Mapping of a Major Wheat QTL for Resistance to Fusarium Head Blight.***

1. What major problem or issue is being resolved and how are you resolving it?

A major QTL (*Qfhs.ndsu-3BS*) for FHB (Fusarium head blight) resistance, derived from 'Sumai 3', has been identified and verified by several research groups via molecular marker analysis. Further research of this major QTL is justified by the significant and consistent effect of this QTL.

The objectives of this research were to:

1) increase marker density near *Qfhs.ndsu-3BS* using wheat ESTs
2) select recombinants in the *Xgwm533 – Xgwm493* interval from a fine mapping population of 3,000 F_2 plants from a cross between two near isogenic lines (NILs) for *Qfhs.ndsu-3BS*
3) Collect FHB phenotype data on selected recombinants to further narrow the location of *Qfhs.ndsu-3BS*

2. What were the most significant accomplishments?

One pair of NILs (near isogenic lines) for *Qfhs.ndsu-3BS*, derived from heterozygous plants of advanced breeding lines, was used to generate a population of more that 3,000 F_2's. The F_2's were genotyped with markers *Xgwm533* and *Xgwm493* that flank the QTL. The recombinants were screened with additional polymorphic markers developed from wheat ESTs, using the genomic resources of rice to help us find closely linked markers. A map containing 11 markers between *Xgwm533* and *Xgwm493* has been constructed. This map was used to compare the orientation of genes in wheat with barley and rice (Liu and Anderson, 2003 *Genome*).

Sixteen homozygous recombinants, representing different intervals along the fine map, were tested for FHB reaction in greenhouse tests in Fall 2003 and Spring 2004 at the University of Minnesota and North Dakota State University. A smaller subset of recombinants was also evaluated at Kansas State University. We have placed the *Qfhs.ndsu-3BS* QTL on this fine map between two markers that are less than 1cM apart.

Project 2: ***Breeding Fusarium Head Blight Resistant Wheat.***

1. What major problem or issue is being resolved and how are you resolving it?

Wheat varieties with greater resistance to *Fusarium* head blight (FHB) would make a substantial contribution to reducing the losses from this devastating disease. Research in our program and other breeding programs has demonstrated that breeding progress toward resistance to this disease is possible with proper germplasm and screening procedures.

The specific objectives and long-term goals of this research are the same because of the long period of time required for these activities. These objectives are:

1) Screen new putative FHB resistance sources and develop improved spring wheat germplasm containing enhanced levels of FHB resistance.
2) Develop *Fusarium* head blight resistant wheat varieties adapted for commercial production in Minnesota and the surrounding region.

2. What were the most significant accomplishments?

Note: In-house funds also contributed to these accomplishments.

- At the 2003 USWBSI Forum we presented research showing that 2-3 replications were satisfactory for routine screening of germplasm for reaction to FHB (Fuentes et al., 2003). Six environments are necessary to correctly characterize the reaction of a line, thus justifying our use of three locations per year for FHB screening.
- One advanced experimental line, MN97803, was increased by the Minnesota Crop Improvement Association on 12 acres in 2003, and is undergoing further increase in 2004. This line is similar to HJ98, but has higher grain protein and test weight. FHB reaction of this line is moderately susceptible.
- Five new experimental lines were grown in the 2003 Uniform Regional Scab Nursery. These lines were identified in previous testing as having improved levels of FHB resistance and were among the best performers in the nursery. Five new resistant lines were entered in the 2004 nursery. These lines combine FHB resistance from different sources and are candidates for germplasm release.
- During the 2003 growing season, *Fusarium* head blight-inoculated, misted replicated nurseries were established at Crookston, Morris, and St. Paul (Table 1). Data on FHB severity (spread of disease symptoms within the spike) and visual scabby kernels from harvested grain was collected for all materials.

Table 1. 2003 University of Minnesota wheat breeding project field FHB screening nurseries.

	No. entries	No.	—— No. rows per location ——		
Material	+ checks	reps	Crookston	St. Paul	Morris
Breeding Lines	695	1-3	953	953	840
Regional Nurseries	83	2-3	207	207	–
Germplasm	114	2	228	228	228
Genetic Studies	132	1-3	241	241	–
Total	1024		1629	1629	1068

Project 3: ***Assessing the Breeding Value of Fusarium Head Blight Resistance Genes.***

1. What major problem or issue is being resolved and how are you resolving it?

Screening wheat lines for resistance to Fusarium head blight (FHB) is both time and resource-intensive, is confounded by environmental factors, and needs to be repeated over environments. Our research group is investigating DNA markers as a tool to augment the screening of germplasm for resistance to this disease. With funding from a previous USWBSI grant, we discovered new FHB QTL in the resistance sources Fujian 5114 and Wuhan 3. These QTL explain as much as 20 to 25% of the FHB resistance in greenhouse testing. Given the prevalence of Sumai 3–derived resistance and the availability of good markers for the 3BS QTL, breeding programs should benefit from the incorporation of these new QTL.

The objectives of this research were to:
1. Develop near-isogenic lines of major QTLs identified in the resistance sources Fujian 5114 and Wuhan 3.
2. Determine the effects of Fusarium head blight resistance QTL derived from Fujian 5114 and Wuhan 3 in multiple genetic backgrounds.

In addition, we continue to characterize the 3BS QTL for its effects on yield and reaction to other diseases.

2. What were the most significant accomplishments?

Additional microsatellite markers were mapped on the Fujian 5114/Norm population to identify flanking markers for each QTL. These markers were used to select heterozygous F_4 plants originating from 2002 and 2003 University of Minnesota breeding populations. Two and four populations were screened for heterozygotes for QTLs on chromosomes 5AS and 5BL, respectively. The 5AS QTL is likely the same locus as has been identified by other researchers using Sumai 3 derived materials. This QTL shows resistance to initial infection only and is not observed in point inoculation treatments. A total of four QTL-NIL pairs from two different genetic backgrounds were developed for the 5AS QTL region and seven QTL-NIL pairs from two different genetic backgrounds were developed for the 5BL QTL region. Each pair was tested in point-inoculation experiments during the Spring of 2004 and is in field FHB resistance screening nurseries during 2004. The number of QTL-NILs developed was lower than expected due to lack of close polymorphic markers and lack of polymorphism for these markers in the populations in which the QTL(s) were known to segregate. Additional effort has been placed on saturating these regions with additional markers. Due to lack of polymorphism in our breeding materials, no QTL-NIL for Wuhan derived QTLs could be developed.

No detrimental effect on grain yield, leaf or stem rust resistance was found in the 2003 field evaluation of 31 different Sumai 3 derived 3BS QTL-NILs. Yield and disease tests are being repeated during the 2004 field season.

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 you grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

Peer-reviewed Articles:

Liu, S. and J.A. Anderson. 2003. Targeted molecular mapping of a major wheat QTL for *Fusarium* head blight resistance using wheat ESTs and synteny with rice. Genome 46:817-823.

Proceedings:

Liu, S., M.O. Pumphrey, and J.A. Anderson. 2003. Fine mapping of a major wheat QTL for Fusarium head blight resistance. pp. 368-371 in *Proceedings of the 10th International Wheat Genetics Symposium, Paestum,* edited by N.E. Pogna et al.. S.I.M.I, Rome, Italy.

Pumphrey, M.O., and J.A. Anderson. 2003. QTL validation via systematic development of near-isogenic wheat lines from existing breeding populations. pp. 1227-1229 in *Proceedings of the 10th International Wheat Genetics Symposium, Paestum,* edited by N.E. Pogna et al.. S.I.M.I, Rome, Italy.

Abstracts:

Fuentes-Granados, R.G., H.R. Mickelson, R.H. Busch, R. Dill-Macky, C.K. Evans, W.G. Thompson, J.V. Wiersma, W. Xie, Y. Dong, and J.A. Anderson. 2003. Resource allocation and cultivar stability in breeding for Fusarium head blight resistance in spring wheat. pp. 251-254 in *Proceedings of The 2003 National Fusarium Head Blight Forum*, edited by S. Canty et al., Kinko's, Okemos, MI.

Liu, S., and J.A. Anderson. 2003. Complex microsynteny among wheat, rice and barley at the *Qfhs.ndsu-3BS* region. p. 24 in *Proceedings of The 2003 National Fusarium Head Blight Forum,* edited by S. Canty et al., Kinko's, Okemos, MI.

Liu, S., and J.A. Anderson. 2004. Complex microsynteny among wheat, rice, and barley at the Qfhs.ndsu-3BS region. *In* Plant & Animal Genome XII Abstracts, San Diego, CA.

Reports:

Anderson, J., J. Wiersma, J. Kolmer, and R. Dill-Macky. 2003. Spring Wheat. *In* Preliminary Report 24; 2003 Wheat, Barley and Oat Variety Performance in Minnesota, Preliminary Report, Edited by Jochum Wiersma.

Anderson, J.A., G. Linkert, and R. Fuentes. 2003. Hard Red Spring Wheat. *In* Minnesota Varietal Trials Results, University of Minnesota Extension Service.