**U.S. Wheat and Barley Scab Initiative**
**FY02 Final Performance Report (approx. May 02 – April 03)**
**July 15, 2003**

## Cover Page

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| **Year:** | **FY2002 (approx. May 02– April 03)** |
| **Grant Number:** | **59-0790-9-025** |
| **Grant Title:** | **Fusarium Head Blight Research** |
| **FY02 ARS Award Amount:** | **$ 178,413** |

## Project

| Program Area | Project Title | USWBSI Recommended Amount |
|---|---|---|
| BIO | Mapping of FHB Resistance Genes in the Wheat Lines Wuhan 3 and Fujian 5114. | $60,000 |
| VDUN | Breeding Fusarium Head Blight Resistant Wheat. | $87,585 |
| VDUN | Marker-assisted Selection for an FHB Resistance Gene Derived from Sumai 3. | $35,288 |
| | **Total Amount Recommended** | **$182,873** |

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Principal Investigator Date

**Project 1: Mapping of FHB Resistance Genes in the Wheat Lines Wuhan 3 and Fujian 5114.**

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

Screening for FHB resistance based on reaction to challenge by the causal organism is difficult due to confounding effects of the environment and multigenic control. DNA markers can expedite the process of identifying resistant individuals in breeding populations. We have discovered a major QTL for FHB resistance derived from Sumai 3 and are currently testing the feasibility and effectiveness of using it in a marker-assisted selection scheme. The objectives of this study were to identify and map new FHB resistance genes from two Chinese resistance sources, Wuhan 3 and Fujian 5114, that putatively have high levels of resistance but likely differ from Sumai 3 for one or more genes.

2. What were the most significant accomplishments?

Mapping of DNA markers and analysis for the Wuhan 3/Norm and Fujian 5114/Norm populations was continued from FY2001. The marker mapping effort has been focused on 1) regions containing QTL in Sumai 3; 2) providing skeleton genome coverage to identify new QTL; and 3) adding more markers to better refine QTL regions. FHB screening in three to four field environments and two greenhouse evaluations were completed in the previous year. Although this was the last of two years funding for this project, we continue to refine QTL locations in both populations.

<u>Wuhan3/Norm population</u>
During this reporting period, an additional 73 markers were screened for polymorphism on the parents; 39 of the markers were polymorphic and 18 were mapped in the population. These new markers were added to the 50 previously mapped, followed by a re-analysis of the the data. After the addition of new markers, two previously identified QTL regions on other chromosomes were found to be linked. As reported previously, two regions were consistently associated with FHB resistance: one on chromosome 3BS and the other on chromosome 5AS, which was confirmed via deletion line analysis. To summarize, the QTLs on 3BS and 5AS explained 16 to 42% and 27 to 30% (under field conditions), respectively, of the variation in FHB resistance. Five other QTL were identified with less consistent effects.

<u>Fujian 5114/Norm</u>
Additional investigations to add more markers to the QTL regions established earlier were conducted, particularly to add more markers near the QTL detected on chromosome 5BL. Sixty-eight additional markers were screened for polymorphism and 34 were found to be polymorphic. These new investigations did not improve the QTL mapping results in this population. To summarize, the QTLs on chromosome 3BS and 5BL explained up to 28 and 25%, respectively, of the phenotypic variation in FHB severity.

**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 increased occurrence of scab nationwide, and particularly in the Upper Midwest, is due in part to the increased usage of reduced tillage. Because this is a practice that is not likely to diminish, we can expect future epidemics to occur when favorable weather conditions exist at flowering time.

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?

- One hard red spring wheat line, 'Oklee' (MN95002) was released in January, 2003. Oklee has high grain yield, test weight, and grain protein and is moderately resistant to FHB, similar to the variety Pioneer 2375. One other line, MN97803 is being increased in 2003 and will be a release candidate in 2005. This line has yield potential similar to HJ98, but has higher grain protein, test weight, and better FHB resistance, similar to 2375.

- Five experimental lines were grown in the 2002 Uniform Regional Scab Nursery. These lines were identified in 2000 and 2001 as having improved levels of FHB resistance. I have filled numerous seed requests for one of the 2002 entries, MN00274 (McVey//Vance/MN2540W) as a result of its performance in the 2002 Regional nursery.

- A total of 2,972 plots containing breeding material and FHB resistance sources (excludes 982 near-isogenic line plots) were screened in inoculated, misted field FHB nurseries in Crookston (1419) and St. Paul (1553) during the 2002 growing season. These evaluations included 136 lines in advanced yield trials and 396 lines in preliminary yield trials.

- 1,241 early generation ($F_4$:$F_5$) breeding lines were screened during Fall 2002 in the greenhouse for reaction to FHB inoculation. On the basis of the results, about 1/3 of these lines were discarded due to susceptibility to scab. An additional 1/2 were discarded based on plant agronomic type in the 2003 New Zealand winter nursery. The remaining 385 lines were entered into 2003 preliminary yield trials.

**Project 3: Marker-assisted Selection for an FHB Resistance Gene Derived from Sumai 3.**

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

Results of several QTL analysis experiments in several wheat populations indicate a major QTL (*Qfhs.ndsu-3BS*) for Fusarium head blight (FHB) resistance is located on chromosome 3BS of 'Sumai 3'. The consistent ability to detect this major QTL and the magnitude of effect in each population imply that it should be useful for marker-assisted selection (MAS). However, to justify breeding program-scale MAS for the 3BS QTL region, increased levels of resistance due to this QTL should be observed in multiple genetic backgrounds. The objective of this study is to assess the effect of *Qfhs.ndsu-3BS*-derived resistance in multiple genetic backgrounds using QTL near-isogenic lines.

2. What were the most significant accomplishments?

- Microsatellite markers flanking the QTL region were selected to develop 30 QTL-NIL pairs from 16 different genetic backgrounds. Each pair was tested in point-inoculation experiments and field FHB resistance screening nurseries during 2002. Across point-inoculation experiments, 11 of the 16 different populations had at least one QTL-NIL pair with significantly reduced disease spread. In two field FHB screening nurseries, *Qfhs.ndsu-3BS* significantly reduced disease severity and percentage of visually scabby kernels in harvested grain samples by an average of 21 and 24%, respectively.

- The combination of field and point-inoculation results indicates that *Qfhs.ndsu-3BS* should enhance FHB resistance largely independent of genetic background. Furthermore, the QTL validation methodology used should be broadly applicable to other traits and crop species.

- A population to fine map the location of this QTL resulted from the self-pollination of one heterozygote NIL developed in this work from the cross (Sumai 3/Stoa)-63//MN97448.

- Marker-assisted selection using markers for the QTL on chromosome 3BS was used to screen approximately 335 $F_4$:$F_5$ lines during 2002.

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.

Peer-reviewed Articles:

Liu, S. and J.A. Anderson. 2003. Marker assisted evaluation of Fusarium head blight resistant wheat germplasm. Crop Sci. 43:760-766.

Proceedings:

Bowen, D.E, S. Liu, R. Dill-Macky, C.K. Evans, and J.A. Anderson. 2002. Mapping Fusarium head blight resistance QTL in the Chinese wheat line Fujian 5114. p. 21 in *Proceedings of the 2002 National Fusarium Head Blight Forum,* edited by S. Canty et al., Kinko's, Okemos, MI.

Garvin, D.F., and J.A. Anderson. 2002. A historical analysis of the uniform regional scab nursery for spring wheat parents. p. 235 in *Proceedings of the 2002 National Fusarium Head Blight Forum,* edited by S. Canty et al., Kinko's, Okemos, MI.

Liu, S., and J.A. Anderson. 2002. Targeted saturation mapping of *Qfhs.ndsu-3BS* using wheat ESTs and synteny with the rice genome. p. 32 in *Proceedings of The 2002 National Fusarium Head Blight Forum,* edited by S. Canty et al., Kinko's, Okemos, MI.

Pumphrey, M.O., and J.A. Anderson. 2002. Phenotypic effects of *Qfhs.ndsu-3BS* on Fusarium head blight resistance in near-isogenic wheat lines. p. 255 in *Proceedings of the 2002 National Fusarium Head Blight Forum,* edited by S. Canty et al., Kinko's, Okemos, MI.

Abstracts:

Bowen, D.E, S. Liu, R. Dill-Macky, C.K. Evans, and J.A. Anderson. 2002. Mapping fusarium head blight QTL in Chinese wheat line Fujian 5114. *In* Agronomy abstracts. ASA, Indianapolis, IN.

Pumphrey, M.O., and J.A. Anderson. 2002. Development and characterization of wheat lines near isogenic for a Fusarium head blight QTL. *In* Agronomy abstracts. ASA, Indianapolis, IN.

Liu, S., and J.A. Anderson. 2003. Targeted saturation mapping of a wheat QTL using ESTs and synteny with rice. Page 165 in Plant & Animal Genome XI Abstracts, San Diego, CA.

Reports:

Anderson, J.A., G. Linkert, and R. Fuentes. 2002. Hard Red Spring Wheat. *In* Minnesota Varietal Trials Results, University of Minnesota Extension Service.

Anderson, J., J. Wiersma, J. Kolmer, and R. Dill-Macky. 2002. Spring Wheat. *In* Preliminary Report 24; 2002 Wheat, Barley and Oat Variety Performance in Minnesota, Preliminary Report, Edited by Jochum Wiersma.