U.S. Wheat and Barley Scab Initiative
FY02 Final Performance Report (approx. May 02 – April 03)
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Cover Page

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Grant Number:	**59-0790-9-048**
Grant Title:	**Fusarium Head Blight Research**
FY02 ARS Award Amount:	**$ 87,317**

Project

Program Area	Project Title	USWBSI Recommended Amount
BIO	Development of markers lined to FHB resistance in durum wheat.	$31,500
BIO	Development of markers linked to FHB resistance in hexaploid wheat.	$58,000
	Total Amount Recommended	**$89,500**

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Principal Investigator Date

Project 1: Development of markers lined to FHB resistance in durum wheat.

1. What major problem or issue is being resolved and how are you resolving it?
The ultimate goal of this project is to develop "breeder friendly" markers for FHB resistance in durum wheat to help accelerate the process of germplasm development and time to variety release. Specific objectives of the project are to 1) identify markers closely linked to FHB resistance loci; 2) develop a PCR-based marker system for screening large populations segregating for FHB; and 3) demonstrate the utility of these markers in populations developed by various breeding programs.

2. What were the most significant accomplishments?
Analysis of Sumai3 derived recombinant inbred lines has identified one major QTL on chromosome 3BS (Anderson et al. 2001). The study in our laboratory using North Dakota Hard Red Spring wheat breeding (ND-HRS) lines carrying FHB resistance derived from Sumai3 further confirmed these results (Del Blanco et al.2003). The region on 3BS was present in 15 out of the 19 resistant ND derived lines. The probability of this happening by random chance is less than 3×10^{-15}, a highly unlikely event.

The knowledge of 3BS location was applied to a set of 2134 Sumai3 derived durum lines to determine the efficacy of selecting based on molecular markers relative to FHB score. All lines were grown as sibs (i.e. two plants per individual line were planted side by side) and evaluated for disease and scored for *Xgwm533* locus. Since the phenotypic analysis is based on a single measurement, high disease severity scores likely indicate susceptibility; however, low scores could be due to resistance and or escapes. Normally lines with low scores (FHB score of 21 or less) are evaluated again to verify the previous results. Molecular marker data were clear in identifying lines with (31%) or without (69%) the Sumai3 allele for *Xgwm533*. Data shows that we can remove the susceptible lines (as determined by FHB score of 21 or higher) from a given population at efficiency of greater than 84% based on the absence of *Xgwm533* allele. Therefore, using the marker data we could have reduced the size of the population to be screened in the greenhouse from 2134 to 646. Among these 646 lines with Sumai3 allele, more than 536 showed FHB score of 21 or less (83%). Thus, the results to date clearly indicate the value of marker assisted selection for the Sumai3 derived 3BS locus in durum wheat breeding. These lines are currently in FHB field nursery for further phenotypic evaluation. These results are expected to confirm the value of marker assisted selection in breeding for FHB resistant durum wheat cultivars.

A set of durum lines derived from Wangshuibai, as a source of FHB resistance, were evaluated for FHB resistance in the greenhouse. These lines are currently being analyzed for molecular markers believed to be associated with FHB resistance loci. Wangshuibai is believed to carry different alleles/loci for FHB resistance than Sumai3. We have initiated a backcrossing project for transferring *Qfhs.ndsu.3AS* QTL into various durum background. Lines having the smallest segment of *Triticum dicoccoides* carrying the FHB resistance QTL have been crossed to durum cultivars Ben, Lebsock, Maire and Plaza. We are currently at BC2F1 stage of development for these lines. These three sets of durum lines (Sumai3 derived, Wangshuibai derived, and *T. dicoccoides* derived) can possibly be used to pyramid resistance loci in a single cultivar.

Project 2: Development of markers linked to FHB resistance in hexaploid wheat.

1. What major problem or issue is being resolved and how are you resolving it?
The ultimate goal of this project is to develop "breeder friendly" markers for FHB resistance in hexaploid wheat to help accelerate the process of germplasm development and time to variety release. Specific objectives of the project are to 1) study the effect and interaction of major FHB resistance QTL from Sumai3; 2) analyze recombinant inbred populations from Wangshuibai, a Chinese source for FHB resistance, for the presence of Sumai3 QTL; and 3) identify additional QTL in Wangshuibai populations.

2. What were the most significant accomplishments?
Previously we employed a set of lines derived by the North Dakota-Hard Red Spring (ND-HRS) wheat breeding program carrying Sumai#3 derived FHB resistance and their susceptible parental and sister lines. Analysis of these lines for presence of markers coming from Sumai#3 indicates two significant regions. First a region on 3B (identified by *Xgwm533*), previously identified by Waldron et al.1999 in a RI population, was present in 15 out of the 19 resistant ND derived lines. The probability of this happening by random chance is less than 3×10^{-15}, a highly unlikely event. Second a region we believed to be located on chromosome 7B (identified by *Xgwm274*) was present in 10 of the 19 derived lines. The probability of this occurring by random chance is 5×10^{-7}, a highly unlikely event. Other markers spread through out the genome did not show the same association (Del Blanco et al., 2003). Upon mapping of this second marker on wheat aneuploid stocks and deletion lines, we realized that the locus associated with resistance also maps to 3BS. Therefore, we could not study the interaction between these two QTL, as they represented the same locus.
Wangshuibai is a Chinese hexaploid line that shows a good level of resistance to the spread of the infection (Type II). In our greenhouse evaluations using single floret inoculation the spread of the infection after 21 days ranged from 7 to 11% compared to 15 to 21% range for Sumai3. We have developed 2 recombinant inbred line (RIL) populations consisting of 388 F_6 derived lines from the cross of Wangshuibai to ND671 (an adapted HRS wheat line) and the reciprocal cross. Majority of these lines have been evaluated for FHB in both greenhouse and field over 4 seasons. The resistant lines from this population are even more resistant than the lines derived from Sumai3; indicating either a more potent QTL on 3B or other resistance genes coming from Wangshuibai. We now have a map of this population with 183 loci [SSRs, STSs and TRAPs (Targeted Region Amplified Polymorphisms; Li & Quiros 2001). Preliminary QTL analysis indicates a major QTL located on 3BS ($R^2 > 25\%$) for disease scores of 21 days after infection. Other minor QTL regions on 3D and 7B also exist at this date. For disease scores of 14 days after infection QTL regions on 3B, 7B, 2B, 5A, 6B and 7D have been identified. Due to the size of this population we expect to be able to identify individuals carrying these QTL regions individually or in combination. This may allow us to study the QTL x QTL interaction, which we believe may be one factor in making lines derived from Wangshuibai more resistant that those derived from Sumai3.

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.

Hartel, KD, Berzonsky WA, Kianian SF, and Ali S. 2003. Expression of *Triticum turgidum* L. var. *dicoccoides* source of Fusarium head blight resistance transferred to synthetic hexaploid wheat. Genome (submitted)

Berzonsky WA, Hartel KD, Kianian SF, and Leach GD. 2003. Registration of four synthetic hexaploid wheat germplasm lines with resistance to Fusarium head blight. Crop Sci. (submitted)

Del Blanco IA, Frohberg RC, Stack RW, Berzonsky WA, and Kianian SF. 2003. Detection of QTL linked to Fusarium head blight resistance in Sumai-3 derived North Dakota bread wheat lines. TAG 106: 1027.

Gonzalez-Hernandez JL, del Blanco, A, Berzonsky WA, and Kianian SF. 2002. Genetic analysis of Type II Fusarium head blight resistance in hexaploid wheat cultivar 'Wangshubai'. 2002 National Fusarium Head Blight Forum.

Suresh B, Elias EM, Gonzalez-Hernandez JL, and Kianian SF. 2002. Efficiency and efficacy of marker assisted selection over phenotypic selection for FHB resistance in durum wheat. 2002 National Fusarium Head Blight Forum.

Osenga MM, Kalavacharla V, Gonzalez-Hernandez JL, Otto CD, Elias EM, and Kianian SF. 2002. Saturation mapping of a major Fusarium head blight QTL in tetraploid wheat. American Society of Agronomy Annual Meeting.

Hartel KD, Berzonsky WA, and Kianian SF. 2002. Evaluation of Fusarium head blight resistance from *Triticum turgidum* L. var. *dicoccoides* in a synthetic hexaploid background. American Society of Agronomy Annual Meeting.

Hartel KD, Berzonsky WA, and Kianian SF. 2002. Development of synthetic hexaploids with Fusarium head blight resistance from *Triticum turgidum* L. var. *dicoccoides*. Intl. Plant and Animal Genome X Conf.