

**USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY05 Final Performance Report (approx. May 05 – April 06)
July 14, 2006**

Cover Page

PI:	Shahryar Kianian
Institution:	North Dakota State University
Address:	Department of Plant Sciences 470G Loftsgard Hall Fargo, ND 58105
E-mail:	S.Kianian@ndsu.nodak.edu
Phone:	701-231-7574
Fax:	701-231-8474
Fiscal Year:	2005
FY05 ARS Agreement ID:	59-0790-4-109
Agreement Title:	Development of Markers Linked to FHB Resistance in Durum and Hexaploid Wheat.
FY05 ARS Award Amount:	\$ 104,273

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
BIO	Development of Markers Linked to FHB Resistance in Hexaploid Wheat.	\$ 67,525
BIO	Development of Markers Linked to FHB Resistance in Durum Wheat.	\$ 36,748
	Total Award Amount	\$ 104,273

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: *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 identify and develop breeder friendly markers to improve germplasm development as well as reduce the time needed to variety release in hexaploid wheat. Specific objectives of this current project are to: 1) analyze early generation lines derived from CIt9445, a Chinese source of resistance, for the presence of important FHB QTL regions; 2) identify chromosomal regions introgressed into HRS wheat associate with FHB resistance derived from two *Triticum dicoccoides* accessions (PI478472 and PI48121); and 3).develop a PCR-based marker system for screening large wheat breeding populations segregating for these chromosomal regions.

2. List the most important accomplishment and its impact (how is it being used?).

Complete all three sections (repeat sections for each major accomplishment):

Accomplishment:

For pedigree based association mapping work on CIt9445 we have finished phenotypic evaluations for 500 F3s and 600 F4s generations for tyepII resistance to FHB. These lines are derived from two and three-way crosses with CIt9445 as resistant parent and the other parental genotypes are elite lines from the HRSW breeding program at NDSU, but susceptible to FHB. DNA has been extracted from all these lines for marker analysis. Sixty SSR markers covering all chromosomes previously associated with FHB resistance were selected. All F3 500 lines have been genotyped for these 60 markers. We are in the process of analyzing the data using a mixed model approach. The F4 lines are also being genotyped but this will ultimately be limited to those markers showing association in the F3 lines.

With regard to the second objective, phenotypic evaluations in the greenhouse for the lines used to study resistance derived from two *Triticum dicoccoides* accessions (PI478472 and PI48121) is now complete. We have also evaluated these lines an additional season in the field FHB nursery. The data from disease screening look excellent and we are now in the process of marker analysis to identify markers associated with resistance in these lines.

We continually screen new markers (i.e. EST derived primers or new microsatellite markers) for their use in our various introgression and mapping studies. These markers are first screened for their linkage relationship to the important FHB resistance regions. Then they are evaluated for their ease of application in a marker assisted selection scheme. This process will test the utility of these markers for screening large populations and their value in a breeding program designed for development of FHB resistance hexaploid wheat cultivars.

Impact: We are evaluating a methodology for marker identification and resistance gene transfer into elite material simultaneously. This approach would for the first time allow quick introgression and selection of valuable resistance loci. The *T. dicoccoides* derived lines are unique and would represent a new, never used source of resistance in hexaploid wheat.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before?:

A number of advanced HRS wheat lines with good tolerance to FHB derived from varied sources are being developed. These lines could prove highly valuable in development of lines with multiple sources of resistance to FHB. Markers used in screening these lines, and advanced germplasm are all available to the scientific community and can be used for similar introgressions in other wheat backgrounds.

Project 2: Development of Markers Linked to FHB Resistance in Durum Wheat.

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

2. 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 QTL region(s) for FHB resistance in Wangshuibai derived RIL population of durum wheat; 2) develop a PCR-based marker system for screening large durum breeding populations segregating for FHB; and 3) demonstrate the utility of these markers in populations developed for breeding programs.

3. List the most important accomplishment and its impact (how is it being used?).

Complete all three sections (repeat sections for each major accomplishment):

Accomplishment:

We have developed a population of 274 recombinant inbred lines (F_6) from a cross between D87130 (later released as the durum cultivar 'Ben') and Wangshuibai. Due to space issues, 140 of these lines have been screened for FHB resistance in three greenhouse seasons and observations were taken both at 14 and 21 days after inoculation. Data for 2005 were analyzed as RCBD showing significant correlation between replicates (0.35 at 1% significance level). Heritability for resistance on phenotypic mean basis for 21 days after inoculation is 0.38. This population has now been screened with over 215 SSR markers, with 122 of them identifying polymorphism and being mapped on the population, spanning all chromosomes of durum wheat. Among these 8 markers showed segregation distortion and the remaining 114 markers followed the ratio of 1:1. We are currently analyzing the data to identify the critical regions for resistance and have begun introgression of the critical regions using the most resistant lines into durum cultivars.

We have been introgressing the 3BS resistance QTL from Sumai3 and the 3AS QTL region from *T. dicoccoides* Israel A into durum wheat by marker assisted selection backcrossing. In 2005, population I (Ben/3/Sumai3/Sceptre//D88816) had 1814 F4 lines and population II (Lebsock/3/D901442//Sumai3/D901442) had 320 F5 lines. A total of 238 $F_{2.5}$ lines from these populations were selected and of these, 153 lines that had the *Xgwm533* allele and were resistant in greenhouse evaluations. These lines were further tested for their resistance to FHB and agronomic performance in replicated field trials at two locations (prosper and Langdon) with 2 replications at each location following a simple lattice design at either locations. Population I was in 14X 14 Lattice and Population II in 8X 8 Lattice. Population I showed highly significant differences (at 1% & 5%) at both the locations whereas Population II was significant only at Prosper (5%). These lines were further tested in 2005 fall greenhouse season in 2 replications and 40 superior lines were selected and are being tested in advanced yield trials in summer 2006.

We continually screen new markers (i.e. EST derived primers or new microsatellite markers) for their use in our various introgression and mapping studies. These markers are first screened for their linkage relationship to the important FHB resistance regions. Then they are evaluated for their ease of application in a marker assisted selection scheme. This process will test the utility of these markers for screening large populations and their value in a breeding program designed for development of FHB resistance durum wheat.

Impact: This is the first time resistance to FHB from the Chinese source Wangshuibai has been analyzed in the tetraploid durum wheat background. It is also the first time marker

assisted selection has been used to advance a number of resistance loci into adapted durum wheat cultivars. These lines are now at advanced stages of analysis and can be released as the first sources of FHB resistance in durum wheat. In a short time period we may have a number of different FHB QTL regions introgressed into a single durum background providing with even more resistant cultivars.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before?:

A number of advanced durum lines with good tolerance to FHB have been developed and are being evaluated in replicated trials. These lines will be released to growers in the regions most affected by this disease helping alleviate the associated yield losses and other problems. Markers used in screening these lines are also available to the scientific community and can be used for similar introgressions in other wheat backgrounds.

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, Ali S. 2004. Expression of a *Triticum turgidum* var. *dicoccoides* source of *Fusarium* head blight resistance transferred to synthetic hexaploid wheat. *Plant Breeding* 123(6): 516-519.

Elias EM, Manthey FA, Stack RW, and Kianian SF. 2005. Breeding efforts to develop *Fusarium* head blight resistant durum wheat in North Dakota. Presented at *Fusarium Head Blight Forum* December 11-13, 2005.

Chen X, Faris JD, Hu J, Stack RW, Adhikari T, Elias EM, Kianian SF, and Cai X. 2005. Saturation and comparative mapping of a major *Fusarium* head blight resistance QTL in tetraploid wheat. *Genome* (submitted).

Gonzalez-Hernandez JL, del Blanco IA, Ali S, Berzonsky WA, Mergoum M, and Kianian SF. 2005. Genetics of resistance to *Fusarium* head blight in hexaploid wheat Wangshuibai. *Crop Science* (submitted).