USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY08 Final Performance Report (approx. May 08 – April 09)
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Cover Page

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Fiscal Year:	2008
USDA-ARS Agreement ID:	59-0790-8-068
USDA-ARS Agreement Title:	Characterization of Resistance to Fusarium Head Blight in Wheat and Its Relatives.
FY08 USDA-ARS Award Amount:	$ 66,071

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Adjusted Award Amount
DUR-CP	Fine Mapping of Qfhs.ndsu-3AS in Durum Wheat.	$31,195
VDHR-SPR	Enhancing Resistance to Fusarium Head Blight in Wheat Using Alien Species.	$ 34,876
	Total Award Amount	**$ 66,071**

Xiwen Cai 7/15/09
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
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: *Fine Mapping of Qfhs.ndsu-3AS in Durum Wheat.*

1. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?**
   The quantitative nature of FHB resistance and complex environmental and background effects on the resistance cause various encumbers for FHB resistance gene introgression and selection in wheat breeding and germplasm development. Molecular markers closely tagging the resistance genes of interest can be useful for assisting selection of the resistance in wheat germplasm development and breeding. We have developed new molecular markers, including STS (sequence tagged site), SSCP (single strand conformation polymorphism), and CAPS (cleaved amplified polymorphic sequences), which flank the FHB resistance QTL *Qfhs.ndsu-3AS* on the short arm of chromosome 3A (3AS) by taking the advantage of the mcrocollinearity between the wheat genomic region harboring *Qfhs.ndsu-3AS* and the corresponding rice and *Brachypodium* genomic regions. Also we have developed molecular markers to saturate this QTL region using BAC end sequences and physical mapping information from the USDA-AFRI funded 3AS physical mapping and sequencing project. The PCR-based molecular markers we have developed near *Qfhs.ndsu-3AS* have been provided to the USDA-ARS Cereal Genotyping Center in Fargo, ND for the use in genotyping of breeding materials and marker-assisted selction (MAS). In addition, we have genotyped a large $F_{2:3}$ mapping population with 1,800 individuals at the marker loci flanking the QTL to increase resolution of the genetic map and to place the resistance QTL within a smaller chromosomal interval.

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:
   To date, we have identified 22 new molecular marker loci within the chromosomal region of 12.3 cM that harbors the resistance QTL *Qfhs.ndsu-3AS* on 3AS. Four of them (*Xwgc1143*, *Xwgc716*, *Xwgc1204*, and *Xwgc1188*), which co-segregated with each other, are 0.6 cM from *Xgwm2*, an SSR marker most closely linked to the QTL peak. A genetic map with significantly higher resolution has been constructed in the large mapping population with 1,800 individuals. The newly developed PCR-based molecular markers closely linked to the QTL have been found more user-friendly than *Xgwm2* and have been used in MAS.

   Impact:
   This project has more precisely positioned the FHB resistance QTL on 3AS using newly developed molecular markers and physical mapping information currently available for 3AS. Results from this research have provided a better understanding of the chromosome region harboring *Qfhs.ndsu-3AS*, in terms of the genetic and physical relationships among the molecular marker loci and the QTL. Importantly, the fine map constructed in this project will improve the utility of the molecular markers in breeding for FHB resistance through MAS and facilitate the utilization of this resistance QTL in wheat germplasm and variety development.

Project 2: *Enhancing Resistance to Fusarium Head Blight in Wheat Using Alien Species.*

1. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?**

   Fusarium head blight resistance has a complex inheritance and strong interaction with environments, which causes various difficulties in the identification, evaluation, and introgression of FHB resistance genes. This project has identified FHB resistance from relatives of wheat and wheat-alien species derivatives and developed over 1,000 introgression lines from different crosses through chromosome manipulation and disease screening in each of the generations. A total of 280 lines consistently exhibited resistance under greenhouse screening environments for three seasons. To verify their resistance under field conditions, we grew all the 280 lines at Prosper, ND; 153 most resistant lines with three replicates under a mist system at Langdon, ND; and 93 of them with three replicates at Jianyang, China during the last funding period. Most of the lines consistently showed resistance at three locations although variation in resistance levels was observed among some of the lines. This year, 116 lines exhibiting best resistance in the previous evaluation experiments have been grown at Prosper to further evaluate their agronomic performance and to increase seed for distribution. In addition, we have been analyzing haplotypes of these resistant lines at the marker loci near the currently identified FHB resistance QTL to determine the novelty of the resistance QTL in the introgression lines.

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 three sections (repeat sections for each major accomplishment):**

   Accomplishment:
   We developed over 100 advanced introgression lines with FHB resistance in the adapted spring wheat backgrounds and evaluated these lines for FHB resistance and agronomic traits at three field locations. They were derived from various crosses, where different alien species or wheat-alien species derivatives were involved, and exhibited diverse agronomic characteristics. Some of the lines may contain novel FHB resistance genes derived from alien species according to the haplotyping data. We have been increasing seed of the resistant lines in the field. The lines with high levels of resistance and desired agronomic performance will be officially released to the public.

   Impact:
   The alien introgression lines with FHB resistance and other desirable agronomic traits represent an invaluable gene source for the development of superior wheat cultivars. They are breeder-friendly germplasm because the favorable genes were placed in the adapted wheat backgrounds. Utilization of these germplasm in wheat breeding will broaden the genetic basis of FHB resistance and enhance resistance of wheat cultivars to FHB. Deployment of the alien resistance genes in wheat cultivars will reduce the economic losses caused by this devastating disease.

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.

Cai, X., Xu, S.S., Oliver, R.E., Zhang, Q., Stack, R.W., Zhong, S., Friesen, T.L., Halley, S., and Elias, E.M. 2008. Alien Introgression for FHB Resistance in Wheat - Challenges and Strategies. p. 716-718. In: Proc. 11th Intern. Wheat Genet. Symp. (Eds.) R. Appels, R. Eastwood, E. Lagudah, P. Langridge, M. Mackay, L. McIntye, and P. Sharp. Sydney University Press, Brisbane, Australia. Aug. 24-29, 2008.

Zhang, Q., Oliver, R.E., McArthur, R.I., Chao, S., Stack, R.W., Zhong, S., Xu, S.S., and Cai, X. 2008. Introgression of FHB Resistance from Alien Species-Derived Lines into Spring Wheat. p.219 (abstr.). *In* Proc. 2008 National Fusarium Head Blight Forum, Indianapolis, IN, December 2-4, 2008.

Chu, C., Chao, S., Cai, X., Zhong, S., and Xu, S.S. 2008. Haplotype analysis of genes for Fusarium head blight resistance in tetraploid wheat germplasm. p.156 (abstr.). *In* Proc. 2008 National Fusarium Head Blight Forum, Indianapolis, IN, December 2-4, 2008.

If your FY08 USDA-ARS Grant contained a VDHR-related project, 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. If this is not applicable (i.e. no VDHR-related project) to your FY08 grant, please insert 'Not Applicable' below.

Some of the spring wheat germplasm lines with FHB resistance we have developed will be released late this year or early next year. Detailed information of the germplasm lines will be made available in the release publications.