USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY06 Final Performance Report (approx. May 06 – April 07)
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Cover Page

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Fiscal Year:	2006
USDA-ARS Agreement ID:	NA
USDA-ARS Agreement Title:	Fusarium Head Blight Research.
FY06 ARS Award Amount:	$ 74,488

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Award Amount
HGR	Improve FHB Resistance to Hard Winter Wheat by High-throughput Marker-assisted Selection.	$ 24,503
HGG	Characterization of Novel QTL for FHB Resistance in Asian Wheat Cultivars.	$ 49,985
	Total Award Amount	**$ 74,488**

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Principal Investigator Date

* CBCC – Chemical, Biological & Cultural Control
EEDF – Etiology, Epidemiology & Disease Forecasting
FSTU – Food Safety, Toxicology, & Utilization of Mycotoxin-contaminated Grain
GET – Genetic Engineering & Transformation
HGR – Host Genetics Resources
HGG – Host Genetics & Genomics
PGG – Pathogen Genetics & Genomics
VDUN – Variety Development & Uniform Nurseries

Project 1: *Improve FHB Resistance to Hard Winter Wheat by High-throughput Marker-assisted Selection.*

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

The best source of FHB resistance in wheat is mainly spring type that derived from Sumai 3 from China. Hard winter wheat cultivars grown in the U.S. are usually highly susceptible to FHB. Progress in breeding HWW for improved FHB resistance has been slow. Major FHB-resistance QTL from Sumai 3 has been mapped and closely linked markers were identified. This QTL has been widely used in spring wheat or soft winter wheat breeding programs in the U.S. with great success. To improve FHB resistance in hard winter wheat, we used marker-assisted backcross method transferred the 3BS major QTL into adapted hard winter wheat backgrounds. The results are expected to provide breeders with hard winter wheat lines that have low DON content and a high level of FHB resistance.

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:

The major QTL on 3BS from Sumai 3 and its derivatives has been transferred into hard white winter wheat cultivar Trego from Kansas, and hard red winter wheat Wesley from NE and Harding from South Dakota. The 3000 Bc2F2 plants were analyzed with 3 markers (GWM533, GWM493 and STS256) linked to 3BS QTL and about 300 homozygous plants were selected. All 300 homozygous Bc2F3 lines were evaluated for FHB resistance in both greenhouse and field of Manhattan, greenhouse of Nebraska and field of South Dakota.

Impact:

This is the first time to use marker-assisted backcross to transfer 3BS resistance QTL into US hard winter wheat. The resulting breeding lines will be used as breeding parents for FHB improvement in hard winter wheat region and may also be released as FHB resistant cultivars after further field selection and FHB evaluation.

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?

Current elite breeding lines from HWW regional nurseries don't carry the 3BS major QTL FHB resistance. After the project is accomplished, breeders from Kansas, South Dakota and Nebraska will have wheat breeding materials that carry 3BS major QTL for FHB resistance.

Project 2: *Characterization of Novel QTL for FHB Resistance in Asian Wheat Cultivars.*

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

Effective utilization of FHB resistant resources relies on identification of new sources of resistance and understanding inheritance of their resistance to FHB and to DON accumulation in wheat grain. Major scab resistance QTL from Sumai 3 has been mapped and widely used in breeding programs. Identification of resistance genes from new sources may enrich FHB resistance gene diversity and provide new genes to enhance FHB resistance level through gene pyramiding. We identified new resistant sources that might be different from Sumai 3 after screening a collection of Asian wheat cultivars and landraces. We mapped scab resistance QTL in Chinese landrace Wangshuibai and Chokwang from Korea. We elucidate genetic effects of these QTL in Whangshuibai by testing the mapping populations for FHB resistance and DON content under both greenhouse and field conditions. The results are also expected to provide breeders with quality markers for breeding wheat cultivars with low DON and high levels of FHB resistance to speed up breeding process. Meanwhile we are going to map new QTL in Japanese landrace AsozairaIII and Chinese landraces Haiyanzhong, Huangcandou, and Huangfangzhu that were not mapped previously and showed different SSR marker profiles from that of Sumai 3 in 3BS QTL region.

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:

1. The population with 250 additional RILs was developed from the cross of Clark/Chokwang and the F5:6 progenies were evaluated in the greenhouse in fall 2006 and field in spring 2007. New bulks contrasting FHB resistance was formed to screen new SSR markers and a potential QTL in 4AL was identified. In addition, another population from cross of Ning7840/Chokwang was evaluated for FHB resistance in fall 2006 and spring 2007.
2. About 140 F6 RILs from Wangshuibai/Wheaton were evaluated for field resistance and DON content in Manhattan. The same population has also been transplanted in Brookings, SD for FHB evaluation.
3. Four new populations with Chinese/Japanese landraces, AsozairaIII, Haiyanzhong, Huangcandou, and Huangfangzhu, as resistant parents have been advanced to F5. They are ready for FHB evaluation this fall.

Impact:

Wangshuibai is a highly resistant landrace from China. We evaluated the RIL mapping population for all three types of resistance in greenhouse conditions and concluded that: 1) the QTL on 3BS located on the same position as that in Sumai 3, but the effect is smaller.

This QTL in Wangshuibai is most likely allelic to the one in Sumai 3; 2) the QTL in 3BS is also responsible for type I and type III resistance under greenhouse conditions, which was not reported previously; 3) most of QTLs for type II resistance are also responsible for type I or type III resistance. We proposed that selection for type II resistance may also simultaneously select for type I and type III resistance. The new finding may lead to development of new breeding strategy that focus on selection for type II resistance to save high cost of DON analysis in early breeding generations.

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?

The identified new QTL and linked molecular markers is being published in a peer-reviewed journal and represents an important technology transfer event because wheat geneticists, pathologists and breeders will have access to QTL and markers in their research or breeding programs. Also, the elucidating genetic relationship among three types of resistance will help wheat researchers to further understand the mechanism and complexity of wheat resistance to FHB and design new breeding strategy to combat the 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.

1. J.-B. Yu, G.-H. Bai, W.-C. Zhou, Y.-H. Dong, and F. L. Kolb. 2007. Quantitative Trait Loci for *Fusarium* Head Blight Resistance in Chinese Wheat Landrace Wangshuibai. Phytopathology (submitted)
2. Li Rong-Hua, Guo Pei-Guo, Gui-Hua Bai. 2007. Resistance gene analogs associated with low deoxynivalenol level in wheat. J of Guangzhou University (Natural Science Edition). 5(6): DOI:1671-4229(2006)06-0045-07
3. Hong-Xiang Ma, Gui-Hua Bai, Bikram S. Gill, L. Patrick. Hart. 2006. Deletion of A Chromosome Arm Altered Wheat Resistance to *Fusarium* Head Blight and Deoxynivalenol Accumulation in Chinese Spring . Plant Disease 90:1545-1549
4. H. X. Ma, K. M. Zhang, L. Gao, G. H. Bai, H. G. Chen, Z. X. Cai and W. Z. Lu. 2006. QTL for the resistance to wheat Fusarium head blight and deoxynivalenol accumulation in Wangshuibai under field conditions. Plant Pathology Online: DOI:10:1111/J.1365-3059.2006.01447.X
5. Guo Pei-Guo, Gui-Hua Bai, Rong-Hua Li, Gregory Shaner & Michael Baum. 2006. Resistance gene analogs associated with Fusarium head blight resistance in wheat. Euphytica 151:251-261

Meeting Abstract:

1. Guihua Bai, Paul St. Amand, Dadong Zhang, Amir Ibrahim, Stephen Baenziger, Bill Bockus, Hongxiang Ma, Allan Fritz. 2007. Use of Marker-assisted Backcross to Transfer a FHB-resistance QTL into US Hard Winter Wheat. The 2nd International Conference on Plant Molecular Breeding（ICPMB）, March 22-27, 2007. Sanya, Hainan, China.
2. Guihua Bai, Brett Carver, Stephen Baenziger, Scott Haley, Amir Ibrahim, Allan Fritz, Jackie Rudd. 2007. Roles of USDA Genotyping Center in Molecular Breeding for Hard Winter Wheat in the USA. The 2nd International Conference on Plant Molecular Breeding（ICPMB）, March 22-27, 2007. Sanya, Hainan, China.
3. Amy Bernardo, Peter Bradbury, S-W Hu, Robert Bowden, Ed Buckler and Guihua Bai. 2007. Using Gene Expression Array to Discover Single Feature Polymophism The 2nd International Conference on Plant Molecular Breeding（ICPMB）, March 22-27, 2007. Sanya, Hainan, China.
4. J. Yu, G. Bai, W. Zhou, F. Kolb, Y. Dong, P. Hart 2006 Mapping QTLs for Three Types of Resistance to *Fusarium* Head Blight in Wangshuibai. 2006 National Fusarium Head Blight Forum, December 10 - 12, 2006, Research Triangle Park (RTP), North Carolina USA.

5. Amy Bernardo, Peter Bradbury, Robert Bowden, Ed Buckler and Guihua Bai 2006 Using Gene Expression Array to Discover Single Feature Polymorphisms for Mapping of FHB Resistance in Wheat. 2006 National Fusarium Head Blight Forum, December 10 - 12, 2006, Research Triangle Park (RTP), North Carolina USA.
6. Guihua Bai, Paul St. Amand, Amir Ibrahim, Stephen Baenziger, Bill Bockus, Allan Fritz. 2006 Transfer of a QTL for FHB Resistance into Hard Winter Wheat Using Marker-assisted Backcross. 2006 National Fusarium Head Blight Forum, December 10 - 12, 2006, Research Triangle Park (RTP), North Carolina USA.
7. N. Mengistu, P. S Baenziger, S Wegulo, J Breathnach, J Cousell, G Bai, and F Dowell. 2006 Breeding for Fusarium Head Blight Tolerance: Incorporating Technology. 2006 National Fusarium Head Blight Forum, December 10 - 12, 2006, Research Triangle Park (RTP), North Carolina USA.