USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY05 Final Performance Report (approx. May 05 – April 06)
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Cover Page

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Fiscal Year:	**2005**
FY05 ARS Agreement ID:	**NA**
Agreement Title:	**Characterization of Novel QTL for FHB Resistance in Asian Wheat Cultivars.**
FY05 ARS Award Amount:	**$ 75,620**

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
BIO	Characterization of Novel QTL for FHB Resistance in Asian Wheat Cultivars.	$ 55,620
VDUN	Improve Fusarium Head Blight Resistance of Hard Winter Wheat through Marker-assisted Selection.	$ 20,000
	Total Award Amount	**$ 75,620**

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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

PI: Bai, Guihua
ARS Agreement #: NA

Project 1: *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 resistance 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 scab resistance gene diversity and provide new genes to enhance scab resistance level through gene pyramiding. We screened a collection of Asian wheat cultivars and landraces to identify new resistance sources different from Sumai 3, map scab resistance QTL in Wangshuibai, Chinese Spring from China and Chokwang from Korea that are different from Sumai 3 with SSR markers, and to elucidate genetic effects of these QTL by testing the mapping populations for FHB resistance and DON content under greenhouse conditions and field conditions. The results are also expected to provide breeders with selectable markers for breeding wheat cultivars with low DON and high levels of scab resistance to speed up breeding process.

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. One new major QTL from Chokwang was mapped on 5DL using 77 RILs derived from Chokwang/Clark. This QTL showed a major effect and is different from the one in Sumai 3. To validate the QTL in a larger population, the population with 250 additional RILs was developed from the same cross. F5 population was evaluated in the greenhouse Spring 2006 and SSR marker *Xbarc* 239, the closed marker to the 5DL QTL, was screened in the population. In addition, another population was developed from cross of Ning7840/Chokwang to study the effect of pyramiding QTLs from 3BS and 5DL.
2. About 140 F6 RILs from Wangshuibai/Wheaton were evaluated for Type I resistance and DON content in greenhouse. QTL mapping indicated that major QTLs for DON usually overlapped with QTL for Type II or Type I resistance. Type II resistance explains large portion of phenotypic variation, but genetic effect of Type I resistance is relatively small and mainly affected by environmental factors. This population was also planted in field nurseries at South Dakota State University (SDSU) and Kansas State University in Manhattan, however, plants were failed in SDSU and FHB occurred so late that genotypes with different levels of resistance could not been differentiated unambiguously.
3. The QTL analysis was also conducted for the population of Chinese Spring / Annong 8455. QTLs for FHB resistance and susceptibility were identified from Chinese spring. This result was also validated using Chinese Spring ditelosomic lines

Impact:

To date, most of FHB work has focused on identification of resistance gene/QTLs. Our results indicated that susceptible factors may play an important rule on overall resistance of a cultivar. We proposed that resistance can be achieved by removal of susceptible factors or

adding resistance factors. This is the first time to propose susceptible factors for FHB in peer reviewed journals. The new finding may lead to development of new breeding strategy that removes or silence the susceptible factor to improve FHB resistance.
The 5DL QTL from Chokwang is important for FHB resistance improvement. It is the first QTL identified with major effect on FHB resistance from Asian source. If combination of this QTL with the 3BS major QTL from Sumai 3 show additive effect, breeding for a high level of FHB resistance may need to handle only a few QTLs with major effect, instead of many minor QTLs.

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 were 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 marker in their research or breeding programs. Also, the new concept that wheat has susceptible factors for FHB is published in peer-reviewed journals and 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.

Project 2: *Improve Fusarium Head Blight Resistance of Hard Winter Wheat through Marker-assisted Selection.*

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

Available FHB resistance sources are mainly spring type derived from Chinese sources. Hard winter wheat in the US is usually highly susceptible to FHB. Progress in breeding HWW for FHB resistance has been slow. Major FHB resistance QTL from Sumai 3 has been mapped and widely used in spring wheat or soft winter wheat breeding programs with great success. To improve FHB resistance in hard winter wheat, we initiated a marker-assisted backcross project to transfer the 3BS major QTL into adapted hard winter wheat background. The results are expected to provide breeders with hard winter wheat lines that have low DON and 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 are being transferred into hard white winter wheat cultivar Trego from Kansas, and hard red winter wheat Wesley from NE and Harding from South Dakota. Bc1F3 plants (3000) were screened with markers for 3BS and 5A QTL and individual with homozygous 3BS QTL was backcrossed to 3 recurrent parents respectively. The hybrid seeds were advanced and Bc2F2 seeds were obtained for further genotyping to select homozygous plants for field FHB evaluation.

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?

Breeders from Kansas, South Dakota and Nebraska will have wheat breeding materials that carry 3BS major QTL for FHB resistance.

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

1. Yu, Jian-Bin, **Gui-Hua Bai**, Shi-Bin Cai, and Tomohiro Ban 2006. Marker-assisted Characterization of Asian Wheat Lines for Resistance to *Fusarium* Head Blight Theor. Appl. Genet. Online First at http://dx.doi.org/10.1007/s00122-006-0297-z
2. Amy Bernardo, Guihua Bai, Peiguo Guo, Kai Xiao, Arron C. Guenzi, and Patricia Ayoubi. 2006. *Fusarium graminearum*-induced changes in gene expression between Fusarium head blight-resistant and susceptible wheat cultivars. Functional and Integrative Genomics Online First: DOI 10.1007/s10142-006-0028-1
3. Ma, H-X., **G-H. Bai,** X. Zhang, W-Z. Lu. 2006. Main Effects, Epistasis and environmental interactions of QTLs for Fusarium head blight resistance in a recombinant inbred population. Phytopathology 96:534-541
4. Jia, Gaofeng, Peidu Chen, Genji Qin, **Gui-hua Bai**, Wang Xiue, Suling Wang, Bo Zhou, Shouzhong Zhang and Dajun Liu. 2005. QTLs for Fusarium head blight response in a wheat DH population of Wangshuibai/ Alondra's'. Euphytica 146:183-191.
5. Yang, Jun, **Gui-hua Bai,** Gregory E. Shaner. 2005. Novel QTL for Fusarium head blight resistance in wheat cultivar Chokwang. Theor. Appl. Genet. 111:1571-1579.

Meeting Abstracts

1. Guihua Bai. 2006. Implementation of Marker-Assisted Selection in the US Wheat Breeding Programs. Plant and Animal Genome IX, January 15 - 19, 2006 San Diego, CA.
2. Bernardo, Amy, Guihua Bai and Harold N. Trick. 2005. Functional analysis of putative genes for FHB-resistance/susceptibility in wheat using RNAi. Proceedings of the 2005 National Fusarium Head Blight Forum. P101.Milwaukee, WI, Dec 11-13, 2005.
3. Yu, J-B, G-H. Bai, W-C. Zhou, F.L. Kolb, Y-H. Dong, P. Hart, 2005. Mapping QTLs for different types of resistance to *Fusarium* head blight in Wangshuibai. Proceedings of the 2005 National Fusarium Head Blight Forum. P101. Milwaukee, WI, Dec 11-13, 2005.
4. H-X. Ma G-H. Bai W-Z. Lu and X. Zhang. 2005. Main Effects, Epistasis and environmental interactions of QTLs for Fusarium head blight resistance in CS-SM3-DS7A/Annong 8455. Proceedings of the 2005 National Fusarium Head Blight Forum. P101. Milwaukee, WI, Dec 11-13, 2005.
5. Yang J, Shaner GE, Bai G-H. 2005. Identifying new QTLs for wheat resistance to Fusarium head blight using SSR and TRIP markers. Plant and Animal Genome XIII, January 15 - 19, 2005 San Diego, CA.
6. H-X. Ma G-H. Bai W-Z. Lu and X. Zhang. 2005. Main Effects, Epistasis and environmental interactions of QTLs for Fusarium head blight resistance in CS-SM3-

DS7A/Annong 8455. ASA-CSSA-SSSA. 69th Annual Meeting, Salt Lake City, Utah, Nov 6-10 2005.

7. Yu J-B, Bai G-H, Zhou W-C, Kolb FL, Dong Y-H, and Hart P. 2005. Fine mapping of wheat QTL for resistance to FHB and DON in Chinese landrace Wangshuibai. Plant and Animal Genome XIII, January 15 - 19, 2005 San Diego, CA.