USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY11 Final Performance Report
July 13, 2012

Cover Page

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Fiscal Year:	FY11
USDA-ARS Agreement ID:	NA
USDA-ARS Agreement Title:	Identification and Deployment of FHB Resistance QTL in US Hard Winter Wheat.
FY11 USDA-ARS Award Amount:	$ 74,233

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
HWW-CP	Mapping and Deploying FHB Resistance QTL in US Hard Winter Wheat.	$ 55,608
HWW-CP	Using Association Mapping to Identify and Validate New FHB Resistance QTL and Integrate the QTL into HWW.	$ 18,625
	Total ARS Award Amount	**$ 74,233**

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
DUR-CP – Durum Coordinated Project
HWW-CP – Hard Winter Wheat Coordinated Project
VDHR – Variety Development & Uniform Nurseries – Sub categories are below:
SPR – Spring Wheat Region
NWW – Northern Soft Winter Wheat Region
SWW – Southern Soft Red Winter Wheat Region

Project 1: *Mapping and Deploying FHB Resistance QTL in US Hard Winter Wheat.*

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

Effective utilization of FHB resistant resources relies on identification of new resistance genes and understanding the inheritance. A major FHB resistance QTL (*Fhb1*) from Sumai 3 has been mapped and widely used in breeding programs. *Fhb1* can significantly improve the resistance in diverse genetic backgrounds. However, it only provides 20-40% reduction in FHB severity in different genetic backgrounds, thus more resistance genes are needed to enhance the levels of resistance and to provide sufficient protection from severe FHB epidemics. Thus, identification of additional resistance genes from Sumai 3 source and other new sources may enrich FHB resistance gene diversity and provide new resistance genes to enhance FHB resistance levels through gene pyramiding. We used two approaches: 1) continue searching new genes from Chinese sources and 2) to identify new resistant sources that might be different from Sumai 3 from US native sources. We evaluated FHB resistance in mapping populations with two Chinese landraces Huangcandou and Baisanyuehuang and one U.S. cultivar Heyne as resistant parents. The results are 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 using marker-assisted backcross method to transfer major FHB resistance QTL *Fhb1* and other QTL from Asian sources into adopted hard winter wheat cultivars to quickly deploy these QTL in hard winter wheat germplasm and cultivars. As a result, several hard winter lines with *Fhb1* and good adaptation in Wesley, Harding and Trego backgrounds were developed without scarifying yield and quality potential. These lines are used as resistant parents in breeding programs in the Great Plains.

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:

1. QTL for FHB resistance in two Chinese landraces, Huangcandou (HCD) and Baisanyuehuang (BSYH), and a US cultivar Heyne were mapped in RIL populations. We found that both Chinese landraces have *Fhb1*, but not in US wheat Heyne. QTL were found on 3BS near centromere in BSYH, on 3AS in HCD and Heyne, and 4AL and 4DL of Heyne. Those newly identified QTL can be good candidates for combining *Fhb1* to pyramid different FHB resistance genes.

2. Used marker-assisted backcross, we successfully transferred *Fhb1* into US hard winter wheat Wesley, Harding and Trego. Some of the selected lines were used in breeding programs from OK, KS, NE and SD for further crosses. In another MAS project, *Fhb1*

and several other FHB resistance QTL were transferred into HWW Jagger (KS), Overland (NE) and Overley (KS). About 300 lines with at least one QTL were selected. These lines will be released to breeding programs for further selection for agronomic traits and yield testing.

Impact:

Huangcandou and Baisanyuehuang are two highly resistant landraces from China. The FHB resistance QTL from both accessions has not been reported before. This study identified new QTLs on 3A and 3BS centromere, which have not been reported before from Chinese sources. This QTL combined with *Fhb1* provide a very high level of resistance in these landraces. These QTL can be used to improve the level of FHB resistance in currently used cultivars after further validation in different genetic backgrounds.

The germplasm or cultivars from marker-assisted backcross will be important for breeding programs in OK, NE, SD, ND and KS as FHB resistant parents. Some selected Wesley lines can be directly used as a cultivar to quickly relieve FHB damage in HWW growing region where FHB resistant cultivar currently is not available because Wesley is still a popular cultivar growing in SD and NE. In addition, this is first time to demonstrate that marker-assistant backcross can a powerful tool to quickly deploy FHB QTL when breeding programs closely collaborate with the USDA genotyping lab.

Project 2: *Using Association Mapping to Identify and Validate New FHB Resistance QTL and Integrate the QTL into HWW.*

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

Major scab epidemics have occurred in the HWW region in last several years. Genetically improved resistant cultivars coupled with appropriate management practices are the quickest and most cost effective way to reduce DON in the grain supply. However, little is known concerning the genetic basis of native resistance in the Great Plains germplasm and how to effectively utilize it. Using association-mapping techniques, we can validate presence of previously reported QTL in HWW germplasm and identify new QTLs from native sources of FHB resistance. In this research we selected new breeding lines and newly released cultivars from numerous sources, tested these materials for FHB resistance and DON content in both repeated greenhouse and field experiments to identify different types of resistance, used SSR and 9K SNP chip to genotype the set of materials, and used association mapping to establish relationship between phenotypic and genotypic data from these materials.

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:

Phenotypic data for FHB have been done two field and three greenhouse (experiments in Manhattan, KS. FHB severity data were collected and DON testing is in progressing. About 200 SSR markers have been screened for the population. In addition, the population was also screened with 9K SNP chip from Illumina and data scoring and analysis were done.

Impact:

The phenotypic data of the population collected from both field and greenhouse environments will be important for breeders to select right parents for crosses because the population mainly consisted of elite breeding materials and new varieties that they used most often as parents in their crosses. The QTL and associated markers identified from this work will be useful for improve FHB resistance in HWW. The 9K SNP data for the population will be a useful resource for developing SNP markers linked to important QTL in HWW.

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. XH Zhang, HY Pan and GH Bai. 2012. Quantitative trait loci responsible for Fusarium head blight resistance in Chinese wheat landrace Baishanyuehuang. Theor. Appl. Genet. DOI: 10.1007/s00122-012-1848-0
2. XH Zhang, HY Pan and GH Bai. 2012. Quantitative Trait Loci for Fusarium Head Blight Resistance in U.S. Hard Winter Wheat Cultivar 'Heyne'. Crop Sci. doi: 10.2135/cropsci2011.08.0418
3. Tao Li, Guihua Bai, Shuangye Wu and Shiliang Gu. 2012. Quantitative Trait Loci for Resistance to Fusarium Head Blight in a Chinese Wheat Landrace Huangfangzhu. Euphytica DOI 10.1007/s10681-012-0631-2
4. Baenziger, P.S., R. A. Graybosch, T. Regassa, L.A. Nelson, R. N. Klein, D. K. Santra, D.D. Baltensperger, L. Xu, S. N. Wegulo, Y. Jin, J. Kolmer, Ming-shun Chen, and Guihua Bai. 2012. Registration of 'NE01481' hard red winter wheat. Journal of Plant Registrations 6:49-53.
5. Baenziger, P.S., R. A. Graybosch, T. Regassa, L.A. Nelson, R. N. Klein, D. K. Santra, D.D. Baltensperger, J. M. Krall, S. N. Wegulo, Y. Jin, J. Kolmer, Ming-shun Chen, and Guihua Bai. 2012. Registration of 'NI04421' hard red winter wheat. Journal of Plant Registrations 6:54-59.
6. Guihua Bai, P. Stephen Baenziger William Berzonsky, Amy Bernardo, Paul St Amand, Dadong Zhang, Jin Cai, Feng Jin, Tao Li, Jianbin Yu, William Bockus and Fred Kolb. 2011. Using Maker-Assisted Selection to Improve Fusarium Head Blight (FHB) Resistance in Hard Winter Wheat. Proceedings of the 2011 National Fusarium Head Blight Form. Dec. 4-6, 2011, St. Louis, MO.
7. A.N. Bernardo, J-B Yu, H-X. Ma, F. Kolb and G-H. Bai. 2011. Clark Near-Isogenic Lines Contrasting in Fhb1 for FHB Resistance did not Show Significant Reduction in Grain Yield. Proceedings of the 2011 National Fusarium Head Blight Form. Dec. 4-6, 2011, St. Louis, MO.
8. Jin Cai and Guihua Bai. 2011. Mapping QTL for Fusarium Head Blight Resistance to Chinese Wheat Landrace Huangcandou (HCD). Proceedings of the 2011 National Fusarium Head Blight Form. Dec. 4-6, 2011, St. Louis, MO.
9. Feng Jin, Dadong Zhang, William Bockus, P. Stephen Baenziger and Guihua Bai. 2011. Fusarium Head Blight Resistance in US Hard Winter Wheat. Proceedings of the 2011 National Fusarium Head Blight Form. Dec. 4-6, 2011, St. Louis, MO.
10. Bakhsh, A., N. Mengistu, P.S. Baenziger, I. Dweikat, S.N. Wegulo, D. Rose, Guihua Bai, and K.M. Eskridge. Effect of Fusarium Head Blight (FHB) Resistance Gene *Fhb1* on Agronomic and End-use Quality Traits of Hard Red Winter Wheat. Crop Science: submitted