USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY13 Final Performance Report
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Cover Page

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Fiscal Year:	FY13
USDA-ARS Agreement ID:	NA
USDA-ARS Agreement Title:	Identification and Deployment of FHB Resistance QTL in US Hard Winter Wheat.
FY13 USDA-ARS Award Amount:	$ 90,608

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
HWW-CP	Identification and Deployment of FHB Resistance QTL in US Hard Winter Wheat.	$ 55,608
HWW-CP	Doubled Haploidy to Rapidly Develop FHB Tolerant, Low DON Wheat Cultivars.	$ 35,000
	FY13 Total ARS Award Amount	**$ 90,608**

6/16/14

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: *Identification and Deployment of 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?**

   In the U.S. most of hard winter wheat are grown in the central and southern Great Plains. Currently used commercial HWW cultivars in the region are highly FHB susceptible, thus FHB is becoming one of the major breeding objectives in 5 out of 7 states in the Great Plains. A major FHB resistance QTL (*Fhb1*) from Ning7840 or Sumai3 has been mapped and proved to have stable and large effects on type II resistance. *Fhb1* significantly improves the resistance in diverse genetic backgrounds. However, it has not been deployed in HWW in the Great Plains. Because of poor adaptation of Ning7840 in the Great Plains, direct use of Sumai 3 as *Fhb1* donor has not been successful. We are using marker-assisted backcross to transfer major FHB resistance QTL *Fhb1* and other QTL from Asian sources into adapted hard winter wheat to quickly deploy these QTL in hard winter wheat germplasm and cultivars. This work will provide adapted HWW germplasm with *Fhb1* gene and some of the selected breeding lines may lead to release of new FHB resistant cultivars after further yield testing in the CP breeding programs.

2. **List the most important accomplishments and their impact (i.e. how are they being used) to minimize the threat of Fusarium Head Blight or to reduce mycotoxins. Complete both sections; repeat sections for each major accomplishment:**

   Accomplishment:

   a. Using marker-assisted backcross, we successfully transferred *Fhb1* and other QTLs from Ning 7840 into US hard winter wheat Jagger (KS), Overland (NE) and Overley (KS). About 300 selected lines with *Fhb1* were phenotyped for FHB resistance in FHB nursery at Manhattan and most of them show good resistance as expected. About 120 lines were reselected and planted in the Kansas FHB nursery for further FHB and other disease evaluation this year. These selected lines were also sent to breeding programs in Nebraska and South Dakota states for further yield testing and FHB evaluation.

   b. In another MAS project, *Fhb1* from WesleyFhb1 previously developed in my lab was transferred into 11 different elite breeding lines or newly released susceptible cultivars from 5 states. About 100 backcross seeds from each backcross were planted and screened with markers and about 30 selected plants were increased in greenhouse for seed increase and double haploid production.
   c. The cross of Overland/Overley and Lyman/Overley were increased to develop mapping populations for mapping FHB resistance QTL in the two local cultivars.

   Impact:

   Developed germplasm using marker-assisted backcross will be important for breeding programs in OK, NE, SD, ND and KS to use them as FHB resistant parents or directly to

select resistant cultivars. Because the recurrent parents were contributed by the 5 states, some selected lines will have both *Fhb1* and good local adaptation, and can be directly used as cultivars to quickly relieve FHB damage in HWW growing region where FHB resistant cultivar currently is not available. Also, these selected lines can be used as breeding parents to quickly move *Fhb1* to their elite breeding lines to develop new cultivars. In addition, this work also demonstrates that marker-assistant backcross can be a powerful tool to quickly deploy FHB QTL when breeding programs closely collaborate with the USDA genotyping lab.

Project 2: *Doubled Haploidy to Rapidly Develop FHB Tolerant, Low DON Wheat Cultivars.*

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

   Fusarium head blight (FHB) has been more frequent and severe in hard winter wheat (HWW) region of the Great Plains. Transferring major QTL into adopted hard winter wheat will minimize losses caused by FHB epidemics. Marker-assisted backcross has been used to transfer *Fhb1* and other QTL into adapted US HWW. Because marker selection was done only for *FHB* resistance QTL, not for other traits, it takes several years of selection before the selected plants become homozygous for these traits. We use double haploid technique that can quickly fix these traits and generate homozygous plants in a year. This technique in couple with marker-assisted selection significantly speeds up the breeding process and shortens the breeding cycle.

2. **List the most important accomplishments and their impact (i.e. how are they being used) to minimize the threat of Fusarium Head Blight or to reduce mycotoxins. Complete both sections; repeat sections for each major accomplishment:**

   Accomplishment: About 100 plants from each cross were analyzed using markers linked to QTL and 15 selected plants from each cross were sent to HPI for DH production.

   Impact: The selected DH plants with target FHB resistance gene are homozygous for all agronomic traits. After increase, these seeds from all crosses will be distributed to all five breeding programs for further evaluation of FHB resistance and other traits in their breeding nurseries. Selected lines can be used as adapted FHB resistant parents for breeding and may result in new cultivars after further yield testing, which will lead to quick improvement of FHB resistance 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 FY13 grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

Peer Reviewed Publications:

J.T. Eckard, J.L. Gonzalez-Hernandez, S. Chao, P. St Amand, G. Bai. **2014.** "Construction of dense linkage maps 'on the fly' using early generation wheat breeding populations." *Mol. Breed.* (DOI 10.1007/s11032-014-0116-1)

Jin Cai and Guihua Bai. **2014.** "Quantitative trait loci for Fusarium head blight resistance in Huangcandou x 'Jagger' wheat population." *Crop Sci*. Firstlook. doi: 10.2135/cropsci2013.12.0835

Shuyu Liu, Jackie C. Rudd, Guihua Bai, Scott D. Haley, Amir M.H. Ibrahim, Qingwu Xue, Dirk B. Hays, Robert A. Graybosch, Ravindra N. Devkota, and Paul St. Amand. **2014.** "Molecular markers linked to genes important for hard winter wheat production and marketing in the U.S. Great Plains." *Crop Sci*. doi: 10.2135/cropsci2013.08.0564

Feng Jin, Guihua Bai, Dadong Zhang, Yanhong Dong, Lingjian Ma, William Bockus, and Floyd Dowell. **2014.** "*Fusarium*-Damaged Kernels and Deoxynivalenol in *Fusarium*-Infected U.S. Winter Wheat." *Phytopathology* **104**:5: 472-478 doi:10.1094/PHYTO-07-13-0187-R

Amy Bernardo, Guihua Bai, Jianbin Yu, Fred Kolb, William Bockus, and Yanhong Dong. **2013.** "Registration of Near-Isogenic Winter Wheat Germplasm Contrasting in *Fhb1* for Fusarium Head Blight Resistance" *J. Plant Reg*. **8**:1: 106-108.

Proceeding Abstracts:

Baenziger, P.S., S.N. Wegulo, A. Bakhsh, W. Berzonsky, M. Caffe-Treml, and G-H. Bai. 2013. "Life long learning: What we have learned breeding for scab resistance." In: S. Canty, A. Clark, Y. Salat and D. Van Sanford (Eds.), *Proceedings of the 2013 National Fusarium Head Blight Forum* (pp. 8-9). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.

Cai, Jin, Guihua Bai, Feng Jin, Paul St. Amand, William Bockus and Stephen Baenziger. 2013. "Effect of *Fhb1* on resistance to wheat FHB." In: S. Canty, A. Clark, Y. Salat and D. Van Sanford (Eds.), *Proceedings of the 2013 National Fusarium Head Blight Forum* (p. 12). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.

Eckard, J.T., J.L. Gonzalez-Hernandez, S. Chao, P. St. Amand and G. Bai. 2013. "Construction of dense linkage maps "on the fly" using early generation plant breeding populations to facilitate mapping of Fusarium head blight resistance QTL in different hard winter wheats." In: S. Canty, A. Clark, Y. Salat and D. Van Sanford (Eds.), *Proceedings of the 2013 National Fusarium Head Blight Forum* (p. 16). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.