USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY15 Final Performance Report
Due date: July 15, 2016

Cover Page

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Fiscal Year:	2015
USDA-ARS Agreement ID:	N/A
USDA-ARS Agreement Title:	Identification and Deployment of FHB Resistance QTL in US Hard Winter Wheat.
FY15 USDA-ARS Award Amount:	$ 143,108

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
HWW-CP	Doubled Haploidy to Rapidly Develop FHB Tolerant, Low DON Wheat Cultivars.	$ 42,500
HWW-CP	Identification and Deployment of FHB Resistance QTL in US Hard Winter Wheat.	$ 55,608
EC-HQ	Genotyping Breeding Lines for FHB Resistance.	$ 45,000
	FY15 Total ARS Award Amount	**$ 143,108**

7/7/2016

Principal Investigator Date

* MGMT – FHB Management
FST – Food Safety & Toxicology
GDER – Gene Discovery & Engineering Resistance
PBG – Pathogen Biology & Genetics
EC-HQ – Executive Committee-Headquarters
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: *Doubled Haploidy to Rapidly Develop FHB Tolerant, Low DON Wheat Cultivars.*

1. **What are the major goals and objectives of the project?**
   a. Transfer Asian FHB-resistant QTL into 10 new elite hard winter wheat lines or cultivars from ND, SD, KS, OK and NE through marker-assisted backcross (MSB);
   b. Use chromosome doubling technique to quickly generate homozygous plants with target FHB resistance QTL from the backcross progenies carrying heterozygous target QTL;
   c. Use markers to remove haploid plants that have no target QTL; and
   d. Increase enough DH seeds in both greenhouse and winter nursery to be distributed to all breeding programs.

2. **What was accomplished under these goals?**
   1) major activities: about 500 DH lines increased from AZ were analyzed using markers to remove lines without target markers, and confirmed lines were repacked and sent to 6 breeding programs (KS, OK, NE, SD, ND and MT) as requested. These DH lines were also evaluated for FHB resistance and other traits in Manhattan FHB nursery 2016 summer.
   2) specific objectives: transfer Fhb1 into US HWW backgrounds and create HWW breeding parents with Fhb1.
   3) significant results: Fhb1 were transferred into 10 hard winter wheat backgrounds and they are being used by breeders from 6 states.
   4) key outcomes or other achievements: About 500 DH lines with Fhb1were produced and increased. They are confirmed to carry Fhb1 and shipped to breeding programs for breeding by request.

3. **What opportunities for training and professional development has the project provided?**
   Five graduate students and two post-doc in our lab had opportunity to visit DH lab to learn how the DH were developed and visit field FHB nursery to score FHB and conduct rogueing.

4. **How have the results been disseminated to communities of interest?**
   The increased DH seeds from all crosses were distributed to six breeding programs for further evaluation of FHB resistance and other traits in their breeding nurseries. Selected lines are used as adapted FHB resistant parents for breeding new cultivars.

Project 2: *Identification and Deployment of FHB Resistance QTL in US Hard Winter Wheat.*

1. What are the major goals and objectives of the project?

1) identify QTL and linked SNP markers in US native HWW cultivars Overland and Lyman;
2) use marker-assisted backcross (MAB) to pyramid Fhb1 and Fhb3 in US HWW backgrounds;
3) screen Fhb1markers in double haploid plants generated from backcross project;
4) develop a set of SNP markers for previously mapped QTLs using high-throughput SNP platform.

2. What was accomplished under these goals?

1) Major activities:

a) Phenotyped two populations (Overland/OverleyF7 and Lyman/CI13227F7) in FHB nursery, notes were taken for FHB severity and handing date;
b) About 100 selected lines of Overland and Jagger backgrounds carrying Fhb1, Fhb3, both Fhb1 and Fhb3 or none of them were compared for FHB resistance in the 2015 fall greenhouse experiment
c) All DH lines from the Fhb1 backcross project were rechecked with markers to confirm the presence of Fhb1
d) KASP markers were developed for 5 other minor QTL on 5A, 2D, 3D, 4D and 3BS near centromere.

2) specific objectives:

Map QTLs for FHB resistance in US HWW Overland and Lyman, and develop SNP markers for previously mapped QTLs for FHB resistance

3) significant results:
   1) Mapped one QTL on chromosome 4D of Overland
   2) Determine that Fhb3 has no effect in Jagger and Overland backgrounds in both greenhouse and field conditions when it was alone or combined with Fhb1.
   3) At least two linked KASP markers were developed for each of the 5 QTLs for FHB resistance from Chinese landraces

4) key outcomes or other achievements
   1) In MAS project, Fhb1 was transferred into 10 different elite breeding lines or newly released susceptible cultivars from 5 states. About 400 Bc2F4 lines were increased in Arizona, validated with markers, and some were sent to breeders in 6 states as requested.
   2) Overland/Overley F7 was phenotyped for FHB resistance in both greenhouse and field in the spring season. A QTL on chromosome 4D of Overland was identified using a GBS SNP map.
   3) Determined that Fhb3 is not effective in HWW when it is combined with Fhb1

3. What opportunities for training and professional development has the project provided?

Two graduate students (Ms. Nosheen Fatima and Jin Cai) have worked on these projects. They learnt FHB inoculation and disease note taking, GBS library construction and GBS data analysis, map construction, and QTL mapping. Two theses have been submitted to Kansas State University this spring semester.

4. How have the results been disseminated to communities of interest?

The increased backcross progenies from all crosses were distributed to six breeding programs for further evaluation of FHB resistance and other traits in their breeding nurseries. Breeders in the region will use the selected lines as adapted FHB resistant parents for breeding new cultivars. Developed markers for QTLs were documented as theses in Kansas State University. Marker works will be published in referral journals after further revision.

Project 3: *Genotyping Breeding Lines for FHB Resistance.*

1. What are the major goals and objectives of the project?

1) develop diagnostic markers for Fhb1 to improve selection efficiency;
2) develop tightly linked markers to QTLs other than Fhb1 through meta-analysis of multiple mapping populations;
3) develop a high-throughput marker screening system using next generation sequencing technology
4. characterize entries in the southern and northern regional performance nurseries and breeding materials from hard winter breeding programs

2. What was accomplished under these goals?

1) major activities:
a) Developed diagnostic markers based on fine mapping result of a candidate gene and designed both gel based and KASP SNP based markers for Fhb1. The markers were validated in a USDA core collection of 1200 accessions.
b) Conducted a meta-analysis for 5 bi-parental populations with Chinese landraces as a resistant parent, GBS SNPs were used to map QTL and tightly linked markers were converted into SNPs.
c) Developed GBMAS that combines a number of SNP markers in one NGS run for high-throughput analysis was evaluated.

2) specific objectives:
Develop high quality and high-throughput markers fro FHB resistance QTLs

3) significant results:
The markers for Fhb1 have been validated to be diagnostic in a diversified germplasm collection

4) key outcomes or other achievements
Diagnostic markers were developed for Fhb1 and were sent to other genotyping labs and many breeding programs for breeding screening.
SNP markers for 5 other minor QTLs were developed and will be released after further validation

3. What opportunities for training and professional development has the project provided?

Two graduate students, two visiting scientists and one post-doc have been trained to conduct KASP markers analysis

4. How have the results been disseminated to communities of interest?

These markers for *Fhb1* were released to US Genotyping Labs, CYMMIT, Canadian and Chinese breeding programs for MAS as requested.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY15 award period. The term "support" below includes any level of benefit to the student, ranging from full stipend plus tuition to the situation where the student's stipend was paid from other funds, but who learned how to rate scab in a misted nursery paid for by the USWBSI, and anything in between.

1. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their MS degree during the FY15 award period?**

   Yes. Two MS student

2. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY15 award period?**

   No

3. **Have any post docs who worked for you during the FY15 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?**

   No.

4. **Have any post docs who worked for you during the FY15 award period and were supported by funding from your USWBSI grant gone on to take positions with private ag-related companies or federal agencies?**

   No.

Release of Germplasm/Cultivars

Instructions: In the table below, list all germplasm and/or cultivars released with full or partial support through the USWBSI during the FY15 award period. All columns must be completed for each listed germplasm/cultivar. Use the key below the table for Grain Class abbreviations. *Leave blank if you have nothing to report or if your grant did NOT include any VDHR-related projects.*

Name of Germplasm/Cultivar	**Grain Class**	**FHB Resistance** (S, MS, MR, R, where R represents your most resistant check)	**FHB Rating** (0-9)	**Year Released**

Add rows if needed.

NOTE: List the associated release notice or publication under the appropriate sub-section in the 'Publications' section of the FPR.

Abbreviations for Grain Classes

Barley - BAR
Durum - DUR
Hard Red Winter - HRW
Hard White Winter - HWW
Hard Red Spring - HRS
Soft Red Winter - SRW
Soft White Winter - SWW

Publications, Conference Papers, and Presentations

Refer to the FY15-FPR_Instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY15 grant. If you did not have any publications or presentations, state 'Nothing to Report' directly above the Journal publications section.

Journal publications.

Amy Bernardo, Shan Wang, Paul St. Amand, Guihua Bai. 2015. Using Next Generation Sequencing for Multiplexed Trait-Linked Markers in Wheat. PloS ONE DOI:10.1371/journal.pone.0143890
Status: Published
Acknowledgement of Funding Support: Yes.

Zhenqi Su, Amy Bernardo, Bin Tian, Shan Wang, Hongxiang Ma, Shibin Cai, Dongtao Liu, Dadong Zhang, Tao Li, Harold Trick, Paul St. Amand, Guihua Bai. A loss-of-function mutation in an HRC-like gene confers Fhb1 resistance to Fusarium head blight in wheat. Submitted to Nature Genetics in March 7.
Status: In Review
Acknowledgement of Funding Support: Yes.

Jin Cai, Shan Wang, Tao Li, and Guihua Bai. 2016. Multiple minor QTLs responsible for Fusarium head blight resistance in a Chinese wheat landrace Haiyanzhong. Submitted to PLoS ONE.
Status: Submitted
Acknowledgement of Funding Support: Yes.

Books or other non-periodical, one-time publications.

Jin Cai. 2016. Meta-analysis of QTLs for Fusarium head blight resistance in Chinese wheat landraces using genotyping by sequencing. Ph.D. Thesis. Kansas State University
Status: Deposited
Acknowledgement of Funding Support: Yes

Nosheen Fatima. 2016. Identification and deployment of QTL for Fusarium head blight resistance in US hard winter wheat. M.S. Thesis. Kansas State University.
Status: Deposited
Acknowledgement of Funding Support: Yes.

Other publications, conference papers and presentations.

Z Su, A Bernardo, B Tian, S Wang, H Ma, S Cai, D. Liu, D Zhang, T Li, HN Trick, P St Amand, G Bai. 2016. A candidate gene regulates *Fhb1* resistance to Fusarium head blight in wheat. 5Th International Symposium Fusarium Head Blight, Costao Do Santinho, Florianopolis, SC, Brazil April 6-9, 2016. Invited Key Note Presentation.
Status: Presented
Acknowledgement of Funding Support: Yes.

Jin Cai, Shan Wang, Tao Li, and Guihua Bai. 2015. Mapping QTLs for Fusarium Head Blight Resistance in Chinese Wheat Landraces Haiyanzhong. In: S. Canty, A. Clark, S. Vukasovich and D. Van Sanford (Eds.), *Proceedings of the 2015 National Fusarium Head Blight Forum (*p. 81). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.
Status: Published
Acknowledgement of Funding Support: Yes, Abstract and Poster.

Nosheen Fatima, Guihua Bai, and William Bockus. 2015. Mapping Quantitative Trait Loci for Fusarium Head Blight Resistance in Overland using Genotyping-by-Sequencing Markers. In: S. Canty, A. Clark, S. Vukasovich and D. Van Sanford (Eds.), *Proceedings of the 2015 National Fusarium Head Blight Forum (*p. 85-86). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.
Status: Published
Acknowledgement of Funding Support: Yes, Abstract and Poster.