USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY14 Final Performance Report
July 15, 2015

Cover Page

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Fiscal Year:	FY14
USDA-ARS Agreement ID:	59-0200-3-004
USDA-ARS Agreement Title:	Identification and QTL Mapping of Fusarium Head Blight Resistance in Wheat and Durum Wheat.
FY14 USDA-ARS Award Amount:	$ 63,777

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
DUR-CP	Identify and Map Novel QTL for FHB Resistance Introduced into Durum Wheat.	$ 19,614
VDHR-SPR	Fine Mapping and Utilization of FHB Resistance QTL Derived from PI 277012 in Spring Wheat.	$ 31,712
VDHR-SPR	Increase FHB Resistance Screening Capacity and Efficiency for Spring Wheat Breeding.	$ 12,451
	FY14 Total ARS Award Amount	**$ 63,777**

Shaobin Zhong 7-14-2015

Principal Investigator Date

* MGMT – FHB Management
FSTU – Food Safety, Toxicology, & Utilization of Mycotoxin-contaminated Grain
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
WES-CP – Western 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: *Identify and Map Novel QTL for FHB Resistance Introduced into Durum Wheat.*

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

   Lack of useful and effective sources of FHB resistance in durum wheat varieties is a limiting factor for developing durum varieties with a high level of resistance to FHB. In the past years, great efforts have been devoted to introgress FHB resistance from tetraploid and hexaploid wheat accessions into adapted durum wheat cultivars. However, most of the QTL for FHB resistance existing in the introgression lines are not well characterized or validated. Here we aim to identify and map QTLs for FHB resistance in 10Ae564 and Joppa, which carry known and unknown sources of FHB resistance. 10Ae564 is a FHB-resistant, BC1F8 durum wheat line, which is derived from cross and backcross of the durum wheat cultivar Lebsock to a hexaploid wheat line PI 277012 with major FHB resistance QTL on 5A. Joppa is a newly released durum wheat cultivar with the highest level of FHB resistance among durum wheat cultivars currently grown in ND. However, the QTL for FHB resistance in Joppa have not been identified and mapped. We developed a mapping population consisting of 241 recombinant inbred lines derived from the cross between Joppa and 10Ae564. We are collecting phenotype and genotype data for QTL analysis.

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:

   We prepared DNA samples from 210 recombinant inbred lines (RIL) (F2:7) derived from the cross between 10Ae564 and Joppa and the DNA samples will be sent to Dr. Shiaoman Chao at USDA-ARS, Fargo, for genotyping using the wheat 90K-SNP arrays.

   We evaluated the 210 recombinant inbred lines (F2:6) derived from the cross between 10Ae564 and Joppa for FHB resistance in two seasons of field experiments, including one season in Fargo location and one season in the China location. The disease severity ranged from 9% to 97% among the RILs evaluated, suggesting that resistance to FHB segregated in the population.

   We collected grain samples from the Fargo location for DON test. The data showed that DON contents ranged from 5.2 to 30.8 ppm among the RILs, indicating that the population segregated for DON accumulation in grains as well.

   Impact:

   The genotype and phenotype data generated from the research are essential for identifying and mapping QTL for FHB resistance QTL in the population. Identification of DNA markers associated with the FHB resistance QTL will accelerate the

development of FHB resistant wheat varieties by marker assisted selection and gene pyramiding. The durum wheat lines with improved FHB resistance and low DON accumulation will be provided to breeders (Dr. Elias and others) for developing FHB resistant varieties or germplasm.

Project 2: *Fine Mapping and Utilization of FHB Resistance QTL Derived from PI 277012 in Spring Wheat.*

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

PI 277012 is a hexaploid wheat line, which consistently showed a high level of FHB resistance across all environments in both greenhouse and field experiments. Two major QTL were previously identified and mapped on 5A using a mapping population consisting of 130 doubled haploid (DH) lines from the cross between PI 277012 and the hard red spring wheat cultivar 'Grandin' (susceptible to FHB). However, the regions surrounding the two QTL loci were not saturated with enough DNA markers and thus DNA markers closely linked to the QTL loci were lacking. In this project, we aim to (1) fine map the two QTL regions with additional markers for easy identification of the FHB resistance QTL loci in wheat breeding programs, and (2) introgress the QTLs into adapted spring wheat cultivars.

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:

We evaluated 1052 recombinant inbred lines (F2:7) from the cross between PI 277012 and Grandin for FHB resistance in two seasons of greenhouse experiments and one season of field experiment. Highly resistant and susceptible RILs were identified and confirmed.

We developed KASP assays for 10 newly identified SNP markers linked to the two QTL. These PCR-based markers are being evaluated in the phenotyped recombinant inbred lines. Some of them will be chosen for marker assisted selection of the FHB resistance QTLs transferred into adapted wheat germplasm.

We backcrossed advanced wheat lines with FHB resistance derived from PI 277012 to adapted spring wheat cultivars (Grandin and Wheaton) and obtained BC3F1 plants. These wheat lines showed a high level of FHB resistance based on the greenhouse inoculation experiments and contained major QTL derived from PI 277012 based on marker analysis, while they have other agronomic traits similar to the recurrent parents.

Impact:

The PCR-based assays for the SNP markers closely linked to FHB resistance QTL will be very useful in developing new FHB resistant wheat varieties by marker assisted selection and gene pyramiding. The FHB resistant materials with improved agronomic traits generated from this project provide novel source of FHB resistance for wheat and during breeding programs.

Project 3: *Increase FHB Resistance Screening Capacity and Efficiency for Spring Wheat Breeding.*

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

FHB resistance is a quantitative trait, which needs evaluation and validation in multiple locations and multiple years. Local nurseries in the US are sometimes not producing quality data for FHB reactions due to the occurrence of poor weather conditions (too hot, too dry, flooding and so on). We are addressing the issues by screening selected advanced spring wheat breeding lines from the three wheat breeding programs (ND, MN, and SD) in a scab nursery located in Hangzhou, China, where environmental conditions are consistently conducive for FHB development and disease epidemics each year.

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:

We evaluated 297 advanced breeding lines (116 from SD, 75 from ND, and 106 from MN) and 83 diverse wheat accessions in the Hangzhou nursery from November 2014 to May 2015. The disease severity ranged from 7.0% to 100% among the entries evaluated. Approximately 28% (107) of the materials showed a disease severity below 15%, indicating they have a very good level of FHB resistance under natural infection conditions.

Impact:

The oversea FHB nursery provides high quality field data for measuring the FHB resistance level of advanced breeding lines and other germplasm from the three breeding programs in MN, ND, and SD, respectively. The data are used to select potential advanced breeding lines for the future release or eliminate those with FHB susceptibility so farmers can use FHB resistant varieties to minimize the threat of FHB and/or reduce mycotoxins.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY14 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 FY14 award period?**

   If yes, how many? No

2. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY14 award period?**

   If yes, how many? Yes, one

3. **Have any post docs who worked for you during the FY14 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?**

   If yes, how many? No

4. **Have any post docs who worked for you during the FY14 award period and were supported by funding from your USWBSI grant gone on to take positions with private ag-related companies or federal agencies?**

   If yes, how many? No

Include below a list of all germplasm or cultivars released with full or partial support of the USWBSI during the FY14 award period. List the release notice or publication. Briefly describe the level of FHB resistance. *If not applicable because your grant did NOT include any VDHR-related projects, enter N/A below.*

N/A

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 FY14 grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

Zhang, Q., Axtman, J. E., Faris, J. D., Chao, S., Zhang, Z., Friesen, T. L., **Zhong, S**., Cai, X., Elias, E. M., Xu. S. S. 2014. Identification and molecular mapping of quantitative trait loci for Fusarium head blight resistance in emmer and durum wheat using a single nucleotide polymorphism-based linkage map. Mol. Breed. 34:1677–1687

Mergoum, M., Simsek, S., **Zhong, S.,** Acevedo, M., Friesen, T., L., Singh, P. K., Adhikari, T. B., Alamri, M. S., and Frohberg, R. C. 2014. 'Velva' Spring Wheat: An Adapted Cultivar to North-Central Plains of the United States with High Agronomic and Quality Performance. J. Plant Reg. 8:32-37.

Zhang, Q., Axtman, J. E., Faris, J. D., Chao, S., Zhang, Z., Friesen, T. L., **Zhong, S**., Cai, X., Elias, E. M., Xu. S. S. 2014. Identification and molecular mapping of quantitative trait loci for Fusarium head blight resistance in emmer and durum wheat. Proceedings of the 2014 National Fusarium Head Blight Forum, Dec 7-9, 2014, St. Louis, MO. P102. (Poster)

Zhao, M., Wang, G., Wanjugi, H., Grosz, M. D., Pitkin, J., Mergoum, M., and **Zhong, S**. 2014. Molecular mapping of Fusarium head blight resistance in ND2710. Proceedings of the 2014 National Fusarium Head Blight Forum, Dec 7-9, 2014, St. Louis, MO. P103. (Poster)

Zhu, X., **Zhong, S**., Xu, S. S., Elias, E., Joyti, J., Horsley, R., and Cai, X. 2013. Effects of durum wheat background on the expression of hexaploid wheat-derived Fusarium head blight resistance genes. Proceedings of the 2014 National Fusarium Head Blight Forum, Dec 7-9, 2014, St. Louis, MO. P104. (Poster)

Zhao, M., Xu, S. S., and **Zhong, S**. 2014. Fine Mapping of Novel QTL for Fusarium Head Blight Resistance in PI 277012. APS-CPS Joint Meeting, Minneapolis, MN. Phytopathology 104:277. (Poster)