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:	59-0200-3-004
USDA-ARS Agreement Title:	Identification and QTL Mapping of Fusarium Head Blight Resistance in Wheat and Durum Wheat.
FY13 USDA-ARS Award Amount:	$ 52,640

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
DUR-CP	Identify FHB Resistance in Timopheevii Wheats and Introgress it into Durum Wheat.	$ 15,587
VDHR-SPR	Enhancing FHB Resistance Screening Capacity and Efficiency for Spring Wheat Breeding Programs.	$ 10,778
VDHR-SPR	Fine Mapping of QTL for FHB Resistance in PI 277012 and Introgression of the Resistance into Adapted Spring Wheat Varieties.	$ 26,275
	FY13 Total ARS Award Amount	**$ 52,640**

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: *Identify FHB Resistance in Timopheevii Wheats and Introgress it into Durum Wheat.*

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

   Having different sources of resistance to Fusarium head blight (FHB) is important for development of FHB resistant cultivars to combat the serious disease. We aimed to evaluate all available *T. timopheevii* accessions in field nurseries and greenhouse with the goal of identifying new sources of FHB resistance from these *T. timopheevii* accessions and use them for durum wheat breeding program.

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 finished evaluating all *Triticum timopheevii* subsp. *armeniacum* and *Triticum timopheevii* subsp. *timopheevii* for FHB resistance using the single floret point inoculation method in the greenhouse. Most of them were susceptible to FHB although the levels of susceptibility varied among them.

   Four spring type *Triticum timopheevii* accessions (PI 94760, PI 288033, PI 343447, and PI 418584) were found to have a good level of FHB resistance (FHB severity<30%). We crossed each of them with the durum wheat cultivar Divide and the spring wheat cultivar Wheaton, respectively and obtained F1 and F2 seeds. We are advancing these materials to higher generations for FHB resistance evaluation and genotyping.

   Impact:

   a. Information about the FHB susceptibility of *Triticum timopheevii* accessions is useful for geneticists and breeders who are using *Triticum timopheevii* as new source of FHB resistance for durum and spring wheat improvement.
   b. Those progenies derived from the crosses made between accessions with some level of resistance to FHB and the durum wheat and spring wheat cultivars may produce new sources of FHB resistance for durum wheat breeding programs.

Project 2: *Enhancing FHB Resistance Screening Capacity and Efficiency for Spring Wheat Breeding Programs.*

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 376 advanced breeding lines (120 from SD, 150 from ND, and 106 from MN) and 161 diverse wheat accessions in the Hangzhou nursery from November 2013 to May 2014. The disease severity ranged from 7.0% to 91.6% among the entries evaluated. Approximately 46% (249) 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 is an alternate location for evaluation of US spring wheat materials for FHB resistance. It provides high quality field data to measure 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 so farmers can use FHB resistant varieties to minimize the threat of FHB and/or reduce mycotoxins.

Project 3: *Fine Mapping of QTL for FHB Resistance in PI 277012 and Introgression of the Resistance into Adapted Spring Wheat Varieties.*

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 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. 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 identified 2,877 polymorphic SNP markers between the two parents PI 277012 and Grandin using the wheat 9K-SNP array. These SNP markers were mapped to 903 loci of the genetic maps using the 130 DH lines derived from the cross between PI 277012 and Grandin. Fifty five of the SNP marker loci were linked on 5A. Fifteen and 16 SNP markers were closely linked to the 5AS and 5AL QTLs, respectively.

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. Highly resistant and susceptible RILs were identified in this population. The newly identified SNP markers linked to the two QTL are being used to genotype these recombinant inbred lines using the KASP assays, and will be used for for selection of the FHB resistance QTLs transferred into adapted wheat germplasm.

We developed several advanced FHB resistant spring wheat lines from crosses between PI 277012 as the FHB resistance donor and adapted spring wheat cultivars as recipient parents. These wheat lines showed a high level of FHB resistance based on the greenhouse inoculation experiments and contained major QTL derived from PI 277012.

Impact:

The FHB resistance QTL from PI 277012 is a novel source of FHB resistance and is being used in wheat and during breeding programs. The SNP markers closely linked to them will

be very useful in developing new FHB resistant wheat varieties by marker assisted selection and gene pyramiding.

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.

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.

Mergoum, M., ElDoliefy, A. E., Anderson, J., Glover, K., Alamri, M. S., Kumar, A., Kianian, S., Simsek, S., Zhong, S., and Chao, S. 2013. Revealing the Genetics of *Fusarium* Head Blight Resistance in Major Adapted and High Quality USA Spring Wheat Cultivars. Proceedings of the 12th International Wheat Genetics Symposium. (Eds.).

Zhu, X., Zhong, S., Chao, S., Elias, E., and Cai, X. 2013. Fine Mapping of the Genomic Region Harboring the Fusarium Head Blight Resistance QTL *Qfhs.ndsu-3AS* in Durum Wheat. Proceedings of the 2013 National Fusarium Head Blight Forum, Dec 3-5, 2013, Milwaukee, WI. P47.

Mergoum, M., Simsek, S., Zhong, S., Acevedo, M., Friesen, T. L., Alamri, M. S., Frohberg, R. C. 2013. Combating fusarium head blight in the US spring wheat region: 'Elgin-ND', a new hard red spring wheat cultivar with high level of resistance. Proceedings of the 2013 National Fusarium Head Blight Forum, Dec 3-5, 2013, Milwaukee, WI. P27-31.