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:	NA
USDA-ARS Agreement Title:	Introgression of Scab Resistance from Emmer and Timopheev Wheat into Durum Wheat.
FY14 USDA-ARS Award Amount:	$ 37,740

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
DUR-CP	Mapping and Introgression of Scab Resistance from Emmer wheat to Durum Wheat.	$ 37,740
	FY14 Total ARS Award Amount	**$ 37,740**

July 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: *Mapping and Introgression of Scab Resistance from Emmer wheat to Durum Wheat.*

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

The major problem relevant to Fusarium head blight (FHB) is that the high breeding value durum wheat (*Triticum durum*) germplasms with a combination of high levels of FHB resistance, superior quality, and good agronomic traits are not available for U.S. durum wheat breeders. FHB is currently the most serious threat to durum wheat production in the U.S. To resolve this problem, we are conducting research to identify FHB resistance sources in tetraploid wheat germplasms and develop elite durum germplasms with improved FHB resistance and superior quality and agronomic performance.

For identifying FHB resistance QTL in durum and cultivated emmer (*T. dicoccum*) germplasm, we previously developed a population consisting of 200 recombined inbred lines (RILs) derived from *T. dicoccum* PI 41025 and ND durum cultivar 'Ben'. By using this population, we identified one QTL on chromosome 2A from Ben and one QTL each on 3A and 5A from PI 41025. Meanwhile, we initiated the development of another tetraploid population (DP527) of RILs derived from a cross between *T. dicoccum* PI 272527 and durum cultivar 'Divide'. A population of 140 individuals derived from this cross has been advanced to the F_7 generation and 128 of the lines with adequate seed are being evaluated in two replicated experiments (single-spikelet inoculation and grain inoculum method) in the FHB nursery in Fargo, ND in the summer of 2015. In order to expand the population size, an additional 129 lines have been advanced to the F_7 generation in the summer of 2015. A total of 238 RILs from DP527 will be genotyped with 90K SNP markers and evaluated for FHB resistance in the coming seasons. The genotypic and FHB data will be used to identify FHB resistance QTLs in PI 272527 and Divide.

To develop elite durum germplasm with improved FHB resistance and superior agronomic performance, we previously developed 30 BC_1-derived advanced durum lines (BC_1F_7 – BC_1F_{10}) and doubled haploid (DH) lines with improved FHB resistance derived from four *T. dicoccum* (PI 41025, PI 254188, PI 254193, and PI 272527) and two *T. carthlicum* (PI 61102 and PI 94748) accessions and a hexaploid wheat line PI 277012. Ten of these lines were evaluated in a yield and quality trial at two locations (Langdon and Prosper, ND) in the summer of 2014 and they are being evaluated in yield and quality trials for a second year in the summer of 2015.

Seven of the BC_1-derived advanced lines (10FAR2627 and 10FAR2891 from Divide/PI 272527//Divide, 08F285 and 08G33 from Ben/PI 41025//'Maier', 07F459 from 'Lebstock'/PI 94748//Lebstock, and 10Ae564 from Lebsock/PI 277012//Lebsock) and a DH line (LP102-14 from Lebsock/PI61102) were previously backcrossed with three new ND cultivars 'Tioga', 'Carpio', and 'Joppa'. To combine the FHB-resistant QTLs from hexaploid wheat line PI 277012 and cultivar 'Sumai 3', the PI 277012-derived durum line 10Ae564 was previously crossed to Sumai 3 and ND hard red spring wheat cultivar 'Alsen' and the F_1 hybrids were further backcrossed with Lebsock. A total of 54 BC_1F_3 and 274

BC_1F_4 lines were evaluated using replicated experiments in two FHB nurseries (Fargo and Prosper, ND) in the summer of 2014. A total of 31 BC_1F_4 and 229 BC_1F_5 lines were selected and are being evaluated for FHB resistance using replicated experiments in two FHB nurseries (Fargo and Prosper, ND) in the summer of 2015.

For the introgression of the 5A QTL derived from *T. timopheevii* PI 343447 into ND durum cultivars, the spring wheat line TC67, which carries the 5A QTL from PI 343447, was previously backcrossed with Divide, Tioga, Carpio, and Joppa. A total of 236 BC_1F_1 plants were evaluated in the greenhouse in 2014 and the BC_1F_2 progenies from 23 BC_1F_1 plants with low FHB disease severity were selected and are being evaluated in the FHB nursery in Fargo in the summer of 2015.

To speed up the development of FHB-resistant cultivars through the DH method, we have produced about 200 hybrid seed from a cross between the durum line 10Ae564 and the durum cultivar Divide (low cadmium genotype). The low cadmium Divide is developed from backcrosses Divide/Strongfield//6*Divide. The hybrid seeds are currently being used for production of DH lines at Heartland Plant Innovations Inc.

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 FHB resistance QTL was identified for the first time from ND durum cultivar Ben. This study confirmed the presence of FHB resistance in North Dakota durum cultivars, which have been successfully used for developing new cultivars (e.g. Alkabo, Divide, Grenora, Tioga, Carpio, and Joppa) with improved FHB tolerance. This work indicates that combining the QTL from native durum cultivars with other resistance sources in bread wheat and related tetraploid species will be useful for improving FHB resistance in durum.

Two hundred and sixty (31 BC_1F_4 and 229 BC_1F_5) durum lines with improved FHB resistance from the 2nd round of introgression from emmer wheat have been developed. Most of these lines possess over 90% of the genetic background of ND durum cultivars and will be useful germplasm resources for direct utilization in durum breeding.

Impact:

The durum lines developed in this project are useful germplasms for improving durum wheat for FHB resistance in the U.S. Six durum lines (14SF1735, 14SF1375, 14SF1319, 14SF1567, 14SF1667, and 12P666) derived from PI 41025, PI 272527, and PI 277012 were provided to the ND durum breeding program. They were included in the crossing blocks in the winter of 2014. About 240 of the durum lines are included in the durum panel for generating GBS (genotyping-by-sequencing) marker data to evaluate the effectiveness of genomic selection on improving FHB resistance in durum wheat.

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?** No

   If yes, how many?

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?** No

   If yes, how many?

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?** None

   If yes, how many?

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?** None

   If yes, how many?

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.*

None

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., J.E. Axtman, J.D. Faris, S. Chao, Z. Zhang, T.L. Friesen, S. Zhong, X. Cai, E.M. Elias, and S.S. Xu. 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. Breeding 34: 1677-1687.

Zhang, Q., J.E. Axtman, J.D. Faris, S. Chao, Z. Zhang, T.L. Friesen, S. Zhong, X. Cai, E.M. Elias, and S.S. Xu. 2014. "Identification and molecular mapping of quantitative trait loci for Fusarium head blight resistance in emmer and durum wheat." In: S. Canty, A. Clark, N. Turcott and D. Van Sanford (Eds.), *Proceedings of the 2014 National Fusarium Head Blight Forum*. East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative. P. 102.