USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY16 Final Performance Report
Due date: July 28, 2017

Cover Page

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Fiscal Year:	2016
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.
FY16 USDA-ARS Award Amount:	$ 67,613
Recipient Organization:	North Dakota State University Office of Grant & Contract Accouting NDSU Dept 3130, PO Box 6050 Fargo, ND 58108-0650
DUNS Number:	80-388-2299
EIN:	45-6002439
Recipient Identifying Number or Account Number:	FAR0020575
Project/Grant Reporting Period:	5/1/16 - 4/30/17
Reporting Period End Date:	04/30/17

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.	$ 29,749
VDHR-SPR	Identification and Deployment of Novel FHB Resistance QTL in Spring Wheat.	$ 37,864
	FY16 Total ARS Award Amount	**$ 67,613**

Shaobin Zhong 7-28-2017
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: *Identify and Map Novel QTL for FHB Resistance Introduced into Durum Wheat.*

1. **What are the major goals and objectives of the project?**
   The major goal of this project is to identify and map QTL for FHB transferred from tetraploid and hexaploid wheat accessions into adapted durum wheat cultivars by introgression. The specific objectives were to 1) Develop a genetic linkage map using a mapping population derived from the cross between durum wheat cultivar Joppa and introgression line 10Ae564; 2) Phenotype FHB resistance and morphological traits of the mapping population from the Joppa/10Ae564 cross; 3) Identify DNA markers linked to QTL for FHB resistance in Joppa and 10Ae564; 4) Transfer and pyramid the FHB resistance QTL into adapted durum wheat cultivars.

2. **What was accomplished under these goals?** *Address items 1-4) below for each goal or objective.*
   1) Major activities
      A. We phenotyped the 210 recombinant inbred lines (F2:8) derived from the cross between 10Ae564 and Joppa in two more FHB inoculation experiments, including one in the greenhouse in the spring of 2016 and one in the Fargo FHB nursery in the summer of 2016.
      B. We genotyped 210 recombinant inbred lines (RIL) (F2:8) derived from the cross between 10Ae564 and Joppa using DNA markers mapped on the 5AL QTL region associated with FHB resistance in PI 277012.
      C. We also collected DON data from the 2016 Fargo field nursery and greenhouse inoculation experiments.

   2) Specific objectives
      A. Analyze the phenotype and genotype data generated from the mapping population
      B. Identify QTL associated with FHB resistance in durum line 10Ae564 and cultivar Joppa
      C. Verify the 5AL QTL transferred from the hexaploid wheat line PI 277012 into durum wheat

   3) Significant results
      A. The results of 2016 greenhouse and field evaluations showed that disease severity varied among the population, as previously observed in the last two seasons. Also, transgressive segregation was observed in the mapping population for both inoculation experiments.
      B. Two FHB resistance QTL on chromosome 5A and 7A (designated as *Qfhb.NDWP-5A* and *Qfhb.NDWP-7A* respectively) were identified in 10Ae564 and one FHB resistance QTL on chromosome 2A (designated as *Qfhb.NDWP-2A*) was detected in Joppa. *Qfhb.NDWP-5A* was localized at the same region as the 5AL QTL previously mapped in PI 277012.
      C. Four DNA markers closely linked with the 5AL QTL in PI 277012 were polymorphic between Joppa and 10Ae564, and were mapped to the genetic map constructed with the mapping population from the Joppa/10Ae564 cross. They were closely linked to *Qfhb.NDWP-5A,* confirming that this QTL is derived from PI 277012.

4) Key outcomes or other achievements
   A. Major QTL (*Qfhb.NDWP-5A*) from 10Ae564 with resistance source coming from PI 277012 and minor QTL (*Qfhb.NDWP-2A and Qfhb.NDWP-7A*) in durum wheat cultivars were detected in the mapping population, suggesting that FHB resistance can be improved by accumulation of existing and new FHB resistance QTL in durum wheat breeding program.
   B. Some of the RILs in the mapping population showed better resistance than their parents, suggesting that they may contain QTL from both parents.

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

1) One Ph.D. students is working on this project and has been trained for FHB phenotyping.

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

Nothing to report

Project 2: *Identification and Deployment of Novel FHB Resistance QTL in Spring Wheat.*

1. **What are the major goals and objectives of the project?**
   The major goal of this project is to identify and map novel QTL for FHB resistance in PI 277012 and PI 185843. The specific objectives are to: 1) Introgress and pyramid the two major QTL for FHB resistance derived from PI 277012 into adapted spring wheat varieties through backcrosses and marker assisted selection; 2) Identify novel QTL for FHB resistance in PI 185843 by genotyping and phenotyping a population consisting of 200 recombinant inbred lines from the cross between PI 185843 and Wheaton; 3) Develop user-friendly DNA markers for the novel QTLs and deploy them in selection of FHB resistance in wheat breeding programs.

2. **What was accomplished under these goals?** *Address items 1-4) below for each goal or objective.*

   1) Major activities
      A. We phenotyped 958 recombinant inbred lines (RILs) derived from the Grandin/PI277012 cross for FHB reaction in two more inoculation experiments, both in the 2016 Fargo FHB nursery.
      B. We also phenotyped 200 recombinant inbred lines (RILs) derived from the Wheaton/PI 185843 for FHB reaction in two inoculation experiments, one in the 2016 Fargo FHB nursery and one in the greenhouse.
      C. We continued to develop PCR-based SNP for the 5AL QTL in PI 277012 using the 958 RILs, and delimited the QTL in a 1.2 Mb genomic interval based on the reference genome sequence of Chinese Spring.
      D. We obtained BC4F1 plants with FHB resistance from PI 277012 using Grandin and Wheaton as recurrent parents.

   2) Specific objectives
      A. Develop additional PCR-based SNP markers for map-based cloning of the 5AL FHB resistance QTL in PI 277012.
      B. Develop near-isogenic lines with the FHB resistance QTL in the two adapted spring wheat varieties Grandin and Wheaton.
      C. Mapped QTL for FHB resistance in PI 185843.

   3) Significant results
      A. Additional DNA markers have been developed for the 5AL QTL region and the two markers flanking the QTL were narrow down to a 1.2 Mb genomic interval of the 5AL chromosome.
      B. BC5F1 plants were obtained from the backcrosses of PI 277012 to Grandin and Wheaton. FHB evaluation of individual backcrossed plants indicated that some of the BC5F1 plants were much more resistant than their susceptible parents although not as resistant as their resistant parent PI 277012.
      C. RILs of the Wheaton/PI 185843 population segregated in FHB severity in the two inoculation experiments, with disease severity ranging from 8.6% to 100%.

4) Key outcomes or other achievements
   A. DNA markers for the 5AL QTL from PI 277012 are available for marker-assisted selection in the wheat breeding programs. They will facilitate the use of the FHB resistance in this wheat line.
   B. These near-isogenic lines with the FHB resistance from PI 277012 are useful sources for wheat breeding programs and for genetic studies.

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

1) Two Ph.D. students are working on this project and received one on one training for marker development and QTL mapping.
2) A postdoctoral research associate is working on the project and received one on one training for FHB phenotyping and marker development.

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

1) The SNP markers associated with the 5AL QTL for FHB resistance in PI 277012 have been provided to other labs for marker-assisted selection.
2) The results have been presented in professional conferences

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY16 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 FY16 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 FY16 award period?**

   If yes, how many? Yes, One

3. **Have any post docs who worked for you during the FY16 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 FY16 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

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 FY16 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

Instructions: Refer to the FY16-FPR_Instructions for detailed instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY16 grant. Only include citations for publications submitted or presentations given during your award period (5/1/16 - 4/30/17). If you did not have any publications or presentations, state 'Nothing to Report' directly above the Journal publications section.

Journal publications.

Puri, K. D., Yan, C., Leng, Y., *Zhong, S. 2016. RNA-Seq revealed differences in transcriptomes between 3ADON and 15ADON populations of *Fusarium graminearum* in vitro and in planta. PLoS ONE 11(10): e0163803. doi:10.1371/journal.pone.0163803
Status: Published
Acknowledgement of Federal Support: YES

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

None

Other publications, conference papers and presentations.

Szabo-Hever, A., Zhang, Q., Zhong, S., Friesen, T. L., Elias, E. M., Xu, S. S., and Chao, S. 2016. Association mapping for Fusarium head blight resistance in synthetic hexaploid wheat. In: *Proceedings of the 2016 National Fusarium Head Blight Forum.* S. Canty, K. Wolfe, D. Van Sanford (eds.). December 4-6, 2016. Hyatt Regency St. Louis, MO.P97. (Poster)
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (Poster) Yes (Abstract)

Zhao, M., Leng, Y., Chao, S., Xu, S. S., and **Zhong, S.** 2016. Molecular mapping of QTL for FHB resistance introgressed into durum wheat. . In: *Proceedings of the 2016 National Fusarium Head Blight Forum.* S. Canty, K. Wolfe, D. Van Sanford (eds.). December 4-6, 2016. Hyatt Regency St. Louis, MO. P105. (Poster)
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (Poster) Yes (Abstract)