USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY18 Performance Report
Due date: July 12, 2019

Cover Page

Principle Investigator (PI):	Shaobin Zhong
Institution:	North Dakota State University
E-mail:	Shaobin.Zhong@ndsu.edu
Phone:	701-231-7427
Fiscal Year:	2018
USDA-ARS Agreement ID:	59-0206-7-153
USDA-ARS Agreement Title:	Genetic and Molecular Characterization of New Sources of FHB Resistance in Wheat.
FY18 USDA-ARS Award Amount:	$ 83,879
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:	FAR0028058
Project/Grant Reporting Period:	5/1/18 - 4/30/19
Reporting Period End Date:	04/30/19

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
DUR-CP	Identify and Map Novel QTL for FHB Resistance in Durum Wheat.	$ 36,008
VDHR-SPR	Genetic and Molecular Characterization of Novel FHB Resistance QTL in Spring Wheat.	$ 47,871
	FY18 Total ARS Award Amount	$ 83,879

Shaobin Zhong

July 9, 2019

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 in Durum Wheat.*

1. **What are the major goals and objectives of the project?**
   The major goal of this project was to identify, map, and deploy QTLs for FHB resistance in the emmer wheat (Triticum turgidum L. subsp. dicoccum) line PI 254188. Therefore, the specific objectives are:

   1) Develop a mapping population with recombinant inbred lines (RILs) derived from the cross between Divide and PI 254188;
   2) Phenotype FHB resistance and morphological traits of the mapping population from the Divide/PI 254188 cross in greenhouse and field;
   3) Construct a genetic linkage map of the population using 90k-SNP chips;
   4) Identify DNA markers linked to QTL for FHB resistance in PI 254188;
   5) 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
   We made the cross between durum wheat cultivar Divide and the emmer wheat line PI 254188 and raised recombinant inbred lines (RILs) by single seed descent. We evaluated the RILs for FHB resistance in one greenhouse season. We also used marker-assisted selection to pyramid FHB resistance QTL from different sources into durum wheat.

   2) specific objectives
   The specific objectives were to map novel QTL for FHB resistance in the emmer wheat line PI 254188, introgress the FHB resistance into durum wheat, and combine them with FHB resistance QTL derived from other sources into adapted durum wheat cultivars.

   3) significant results
   A mapping population with 268 recombinant inbred lines (RILs) (F7:8) derived from the cross between Divide and PI 254188 was developed; The mapping population segregated for FHB resistance in the greenhouse evaluation; Several durum lines with a high level of FHB resistance were obtained by pyramiding FHB resistance QTL from various sources via marker-assisted selection, although their agronomic traits remain to be improved.

   4) key outcomes or other achievements
   The mapping population developed is essential for mapping the FHB QTL in PI 254188. The FHB resistant durum wheat lines with a combination of QTL from different sources are very important germplasm for durum wheat breeding programs.

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

The project provided one research associate and three Ph.D. students with training on QTL mapping and marker development. The PI and the participants of this project have attended three seminars and three conferences.

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

Nothing to report

Project 2: *Genetic and Molecular Characterization of Novel FHB Resistance QTL in Spring Wheat.*

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

Our overall goal is to characterize novel FHB resistance quantitative trait loci (QTL) at both genetic and molecular levels in spring wheat. The specific objectives of this project are to:

1) Clone and characterize the major FHB resistance QTL on chromosome 5AL in wheat line PI 277012;
2) Identify novel QTL for FHB resistance in PI 185843, a Brazil wheat cultivar with a higher level of FHB resistance;
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

To clone the major QTL on 5AL for FHB resistance in the wheat line PI 277012, we genotyped three F_2 populations from the crosses between Grandin (susceptible to FHB) and PI 277012 (the 5AL QTL donor), GP112 and GP1004 (both carry the 5AL QTL derived from PI 277012) using DNA markers flanking the target QTL region. We also developed additional PCR-based SNP markers for the QTL, and constructed a non-gridded BAC library using high molecular weight DNA of PI 277012. To map the QTL in PI 185843, we phenotyped a mapping population consisting of 200 RILs derived from the Wheaton/PI 185843 cross for FHB reaction in two inoculation experiments, one in the 2018 Fargo FHB nursery and one in the greenhouse. DON data were also collected from the greenhouse inoculation experiment. We also genotyped this population using the genotyping by sequencing (GBS) approach. We identified additional SNP markers by genome sequencing of PI 277012 and comparison with the reference genome sequence of Chinese Spring. These SNP markers were converted into CAPS markers for fine mapping of the 5AL QTL.

2) specific objectives

The specific objectives were to further delimit the major FHB resistance QTL on chromosome 5AL in wheat line PI 277012, map novel QTL for FHB resistance in PI 185843, a Brazil wheat cultivar with a higher level of FHB resistance, and develop user-friendly DNA markers for the novel QTLs, and deploy FHB resistance in wheat breeding programs.

3) significant results

From the three F_2 populations derived from the crosses between Grandin (susceptible to FHB) and PI 277012, GP112 and GP1004, homozygous recombinants carrying different

lengths of the PI 277012-derived chromosome in the target QTL region were identified. These recombinants will be evaluated for FHB resistance to determine the fine location of the QTL. From the BAC library constructed from PI 277012, sixteen BACs were identified around the 5AL genomic region containing the QTL. These BACs will be sequenced to construct a sequence contig for identification of candidate gene(s) for the QTL. A genetic linkage map was constructed for the mapping population derived from the cross between Wheaton and PI 185843, which will be used in combination with the phenotype data to identify the QTL for FHB resistance in PI 185843. Ten additional PCR-based SNP markers were developed in the 5AL QTL region of PI 277012 and have used in selection of the QTL in the process of introgression of the FHB resistance into adapted wheat cultivars.

4) key outcomes or other achievements

The non-gridded BAC library constructed for PI 277012 are very useful for identification of BACs to cover the target region for candidate gene identification. Novel QTL identified from PI 185843 will be used to develop FHB resistant wheat varieties. The SNP markers developed will facilitate the quick transfer of the FHB resistance into adapted wheat breeding lines.

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

The project provided one research associate and three Ph.D. students with training on QTL mapping and marker development as well as map-based gene cloning. The PI and the participants of this project have attended three seminars and three conferences.

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

The FHB resistant wheat lines developed and DNA markers associated with the FHB resistance have been provided to and used by other wheat researchers and breeders.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY18 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 FY18 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 FY18 award period?**

   yes

   If yes, how many? One

3. **Have any post docs who worked for you during the FY18 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?**

   No

   If yes, how many?

4. **Have any post docs who worked for you during the FY18 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

   If yes, how many?

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 FY18 award period. All columns must be completed for each listed germplasm/cultivar. Use the key below the table for Grain Class abbreviations.

NOTE: 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 FY18-FPR_Instructions for detailed instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY18 grant. Only include citations for publications submitted or presentations given during your award period (5/1/18 - 4/30/19). If you did not have any publications or presentations, state 'Nothing to Report' directly above the Journal publications section.

NOTE: Directly below each reference/citation, you must indicate the Status (i.e. published, submitted, etc.) and whether acknowledgement of Federal support was indicated in publication/ presentation. See example below for a poster presentation with an abstract:

> Conley, E.J., and J.A. Anderson. 2018. Accuracy of Genome-Wide Prediction for Fusarium Head Blight Associated Traits in a Spring Wheat Breeding Program. In: Proceedings of the XXIV International Plant & Animal Genome Conference, San Diego, CA.
> Status: Abstract Published and Poster Presented
> Acknowledgement of Federal Support: YES (poster), NO (abstract)

Journal publications.

Wu, D., Wan, J., Lu, J., Wang, X., Zhong, S., Schwarz, P., Chen, B., Rao, J. 2018. Chitosan coatings on lecithin stabilized emulsions inhibit mycotoxin production by Fusarium pathogens. Food Control 92: 276-285.
Status: Published
Acknowledgement of Federal Support: Yes

Zhao, M., Leng, Y., Chao, S., Xu, S. S., and Zhong, S. 2018. Molecular mapping of QTL for FHB resistance introgressed into durum wheat. Theor. Applied. Genet. 131:1939-1951.
Status: Published
Acknowledgement of Federal Support: Yes

Wan, J., Zhong, S., Schwarz, P., Chen, B., and Rao, J. 2018. Influence of oil phase composition on antifungal and mycotoxin inhibitory activity of clove oil nanoemulsions. Food & Function 9: 2872-2882.
Status: Published
Acknowledgement of Federal Support: Yes

Zhao, M., Wang, G., Leng, Y., Wanjugi, H., Xi, P., Grosz, M. D., Pitkin, J., Mergoum, M., and Zhong, S. 2018. Molecular mapping of Fusarium head blight resistance in ND2710. Phytopathology 108: 972-979.
Status: Published
Acknowledgement of Federal Support: Yes

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

None

Other publications, conference papers and presentations.

Wu, D., Lu, J., Zhong, S., Schwarz, P., Chen, B., and Rao, J. 2018. Physical Stability, Antifungal Properties, and Mycotoxin Inhibitory Activities of Chitosan Stabilized Cinnamon Oil-in-Water Emulsion. 2nd Mycokey International Conference - Integrated Solutions for Mycotoxin Management, September 16-18, 2018, Wuhan, China (Oral presentation)
Status: Abstract Published and Oral Presentation made
Acknowledgement of Federal Support: No

Karmacharya, A., and Zhong, S. 2018. Establishment of a CRISPR-Cas9 system for targeting genes in wheat. 2018 North Central Division Meeting, Fargo, North Dakota. P37 (Poster#26)
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: No