USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY19 Final Performance Report
Due date: July 24, 2020

Cover Page

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Fiscal Year:	2019
USDA-ARS Agreement ID:	59-0206-8-188
USDA-ARS Agreement Title:	New Sources of Resistance to FHB and DON in Wheat
FY19 USDA-ARS Award Amount:	$ 24,250
Recipient Organization:	Kansas State University 10 Andrerson Hall Manhattan, KS 66506
DUNS Number:	929773554
EIN:	48-0771751
Recipient Identifying Number or Account Number:	AR9805 / GAPP005089
Project/Grant Reporting Period:	5/26/19 - 5/25/20
Reporting Period End Date:	5/25/2020

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
HWW-CP	New sources of Resistance to FHB and DON in Wheat	$ 24,250
	FY19 Total ARS Award Amount	**$ 24,250**

July 7, 2020

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: *New sources of Resistance to FHB and DON in Wheat*

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

There are only a few sources of resistance to FHB available for wheat improvement. The proposed research is aimed at identifying new sources of FHB resistance in wild relatives of wheat and using directed chromosome engineering to produce agronomically useful compensating wheat-alien translocations, which are then being transferred into adapted winter wheat cultivars. We have previously identified novel sources of FHB resistance derived from *Leymus racemosus, Fhb3, and Elymus tsukushiensis, Fhb6.* In addition, we are continuing to evaluate wheat-alien introgression lines for the presence of novel sources of FHB resistance.

Objective 1: Transfer of *Fhb6* present in WGRC61 into adapted winter wheat cultivars Everest, Lyman, and Overland, with native FHB resistance and use molecular markers, genomic in situ hybridization analysis, and field evaluations to recover the recurrent wheat genotype with the *Fhb6* gene

Objective 2: New sources of FHB resistance are constantly being sought. In cooperation with Dr. Yanming Zhang from the Laboratory of molecular cytogenetics and genetic breeding, Harbin Normal University, China, who was a visiting scholar at the Wheat Genetic Resources Center, we have identified a potential new source of type-2 FHB resistance derived from *Thinopyrum intermedium*, designated as HSD2-32 (TA5117). We are presently using molecular marker and in situ hybridization analyses to identify the *Th. intermedium* chromosome involved and once the homoeology and genomic affinity of this chromosome is identified we will initiate directed chromosome engineering to produce agronomically useful recombinants.

2. What was accomplished under these goals or objectives? *(For each major goal/objective, address items a-b) below.)*

Objective 1:

a) What were the major activities?

We have transferred *Fhb6* into adapted winter wheat cultivars Lyman and Overland (the transfer to Everest was unsuccessful because of marker inconsistencies).

b, c) What were the significant results and key outcomes or other achievements.

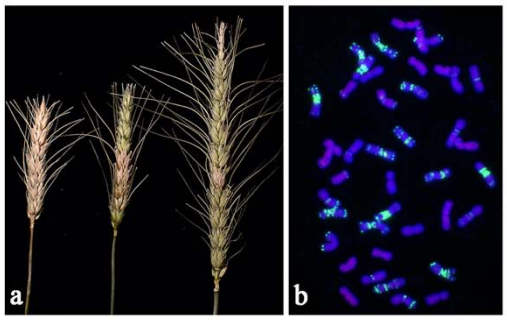
WGRC61 X Overland BC1F3 and WGRC61 X Lyman BC1F3 progenies were grown in the 2018/19 growing season in the Manhattan scab nursery and two of the two best FHB resistant lines were selected and their DON accumulation was determined. Both Overland selections RF19FH0010 and RF19FH001 showed highly improved seed characteristics and also showed about 50% DON reduction compared to Overland (Figure 1). Both

selections were verified for the presence of *Fhb6* using molecular marker (BE426771/*Rsa*I and AK357509/*Hae*III) and genomic in situ hybridization (GISH) analyses and were determined to be homozygous for the *Fhb6* carrier chromosome T1AL·1AS-1E^{ts}#1S. Both selections are being evaluated again for their FHB resistance and DON accumulation in the 2019/20 growing season and seeds will be available for distribution this fall.

The *Fhb6* Lyman selections RF19FH0032 and RF19FH0067 also showed improved seed characteristics. RF19FH0032 had a similar DON content compared to Lyman, whereas RF19FH0076 had a 50% reduction in DON content compared to Lyman. Molecular marker and GISH analyses confirmed that RF19FH0032 was homozygous for *Fhb6*, however, surprisingly no *E. tsukushiensis* chromatin was detected in RF19FH0067, which needs to be further analyzed. Both selections are also again being evaluated for their FHB resistance and DON accumulation in the 2019/20 growing season and seeds will be available for distribution this fall.

Figure 1:Seed characteristics and DON content of Fhb6 introgressions into Overland and Lyman

Figure 2: (a) FHB resistance after point innoculation of Chinese Spring, Everest, and HSD2-32 (from left to right) (b) GISH using total genomic Th. intermedium DNA (red) and GAA (green) for chromosome identification



Objective 2.

a) What were the major activities?

We have identified a novel source of FHB resistance derived from *Th. intermedium* and have confirmed the level of resistance after point inoculation under greenhouse conditions (Figure 2a).

b, c) What were the significant results and key outcomes or other achievements.

We have used in situ hybridization to further characterize this germplasm. GISH analysis using total genomic *Th. intermedium* DNA as a probe failed to detect *Th. intermedium* chromatin (Fig. 2b). GISH analysis using total genomic A-genome and B-genome DNA as probes further revealed that this germplasm has 7 pairs of A-, B-, and D-genome chromosomes, and FISH using GAA as a probe also could not detect any chromosome abnormalities. Summarizing, molecular cytogenetic analysis failed to detect any alien chromatin in this germplasm, suggesting that the introgression may be either cryptic and smaller than the detectability of GISH (30Mbp), or that the introgression was not derived from *Th. intermedium*. We are now using molecular marker analysis to further characterize this germplasm. We have also crossed this germplasm with Chinese Spring and Everest wheat and have obtained BC1F2 progenies that will be evaluated for their FHB resistance and characterized using molecular marker analysis.

3. Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns, reduced or lack of support personnel, etc.)? If yes, please explain how this research was impacted or is continuing to be impacted.

Yes, because of the covid-19 pandemic the laboratories were closed and, thus, the molecular cytogenetic analyses were halted but luckily the greenhouse and field evaluations could be accomplished.

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

Dr. Dr. Yanming Zhang was visiting the Wheat Genetic Resources Center for one year and received training in state-of-the-art molecular cytogenetic techniques.

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

The results were presented at the National Fusarium Head Blight Forum and will be published in peer-reviewed international scientific journals. The germplasms with novel sources of FHB resistance will be distributed to public and private wheat breeding programs.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY19 award period (5/26/19 - 5/25/20). 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 FY19 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 FY19 award period?**
   No
   If yes, how many?

3. **Have any post docs who worked for you during the FY19 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 FY19 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 FY19 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 FY19-FPR_Instructions for detailed more instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY19 grant award. Only citations for publications published (submitted or accepted) or presentations presented during the **award period (5/26/19 - 5/25/20**) should be included. If you did not publish/submit or present anything, state 'Nothing to Report' directly above the Journal publications section.

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

De Wolf, E., D. Shah, P. Paul, L. Madden, S. Crawford, D. Hane, S. Canty, R. Dill-Macky, D. Van Sanford, K. Imhoff and D. Miller. 2019. "Impact of Prediction Tools for Fusarium Head Blight in the US, 2009-2019." In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum*, Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY. p. 12.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (Abstract and Poster)

Nothing to report

Journal publications.

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

Other publications, conference papers and presentations.