# USDA-ARS
# U.S. Wheat and Barley Scab Initiative
# FY20 Annual Performance Progress Report
**Due date:** July 29, 2021

## Cover Page

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|---:|---|
| **Principle Investigator (PI):** | Bernd Friebe |
| **Institution:** | Kansas State University |
| **E-mail:** | friebe@ksu.edu |
| **Phone:** | 785-532-2364 |
| **Fiscal Year:** | 2020 |
| **USDA-ARS Agreement ID:** | 59-0206-0-136 |
| **USDA-ARS Agreement Title:** | New Sources of Resistance to FHB and DON in Wheat |
| **FY20 USDA-ARS Award Amount:** | $ 33,763 |
| **Recipient Organization:** | Kansas State University<br>10 Andrerson Hall<br>Manhattan, KS 66506 |
| **DUNS Number:** | 929773554 |
| **EIN:** | 48-0771751 |
| **Recipient Identifying Number or Account Number:** | AR9754 / GAPP006614 |
| **Project/Grant Reporting Period:** | 5/26/20 - 5/25/21 |
| **Reporting Period End Date:** | 5/25/2021 |

## USWBSI Individual Project(s)

| USWBSI Research Category[*] | Project Title | ARS Award Amount |
|---|---|---:|
| HWW-CP | New Sources of Resistance to FHB and DON | $ 33,763 |
| | **FY20 Total ARS Award Amount** | **$ 33,763** |

June 30, 2021

Principal Investigator Date

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[*] MGMT – FHB Management
FST – Food Safety & Toxicology
    R- Research
    S – Service (DON Testing Labs)
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

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**Project 1:** *New Sources of Resistance to FHB and DON*

## 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 (GISH) 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 Genetics Resource Center, we have identified a potential new source of type-2 FHB resistance derived from *Thinopyrum intermedium,* designated as HSD2-32 (TA5117) and we are characterizing this new source of resistance using GISH and molecular markers. Once the homoeology and genomic affinity of the introgressed chromosomes have been determined we will used directed chromosome engineering to develop agronomically useful wheat-alien recombinant chromosomes and introgress them into hard winter wheat cultivars.

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

### a) What were the major activities?

Objective 1: We have transferred *Fhb6* into adapted winter wheat cultivars Lyman and Overland (the transfer to Everest was unsuccessful because of marker inconsistencies). Homozygous Fhb6/Overland and Fhb6/Lyman derivatives were further analyzed for their FHB incidence and DON accumulation under field condition.

Objective 2): We have further characterized line HSD2-32 using molecular cytogenetic and molecular analyses but failed to detect any alien segment in this material. We also crossed this line with Chinese Spring and Everest wheat to produce segregating populations, which can be used to identify the introgressed material conferring FHB resistance.

**b) What were the significant results?**

Objective 1: Fhb6/Overland and Fhb6/Lyman derivatives were evaluated for their FHB resistance and DON accumulation under field condition in the 2019 and 2020 growing seasons. The transfer of *Fhb6* into Overland significantly reduced FHB incidence and DON content whereas only minor effects were observed in Lyman background.

Objective 2: Molecular cytogenetic analysis failed to detect any alien chromatin in germplasm HSD2-32, suggesting that the introgression may be either cryptic and smaller than the detectability of GISH (30 Mbp) or that the introgression was not derived from *Th. intermedium*. We are continuing using molecular marker analysis to further characterize this germplasm.

**c) List key outcomes or other achievements.**

Objective 1: The transfer of *Fhb6* into Overland significantly reduced FHB incidence and DON content in both growing seasons whereas only minor effects of Fhb6 were observed in Lyman background (see attached table). Fhb6/Overland and Fhb6/Lyman selections with superior FHB resistance and reduced DON accumulation have been distributed to national wheat breeding programs together with molecular marker information to monitor the transfer into regional breeding programs.

*Fhb6 introgressions into Overland and Lyman*

| Line | 2020 ID | 2019 ID | FHB Incidence | | Heading | | Height | 1000 tkw | DON | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2020 | 2019 | 2020 | 2019 | 2020 | 2020 | 2019 | 2020 |
| Everest | RF20FH0017, B6 | RF19FH0091, D11 | 100 | 80 | 5/12 | 5/29 | 81 | - | 34.8 | not tested |
| Lyman | RF20FH0011, B4 | RF19FH0041, B14 | 80 | 80 | 5/20 | 5/30 | 101 | 23.4 | 12.7 | 9.5 |
| Overland | RF20FH0034, A12 | RF19FH0013, A5 | 80 | 80 | 5/21 | 5/30 | 91 | 19.6 | 22.7 | 24.5 |
| | | | | | | | | | | |
| Lyman/*Fhb6* | RF20Fh0010, A4 | RF19FH0032, B11 | 80 | 60 | 5/17 | 5/26 | 114 | 23.9 | 11.7 | 20.9 |
| | | | | | | | | | | |
| Overland/*Fhb6* | RF20FH0006, C2 | RF19FH0014, B5 | 50 | 40 | 5/21 | 5/31 | 104 | 26.3 | not tested. | 12.5 |
| Overland/*Fhb6* | RF20FH0009, C3 | RF19FH0014, B5 | 60 | 40 | 5/18 | 5/31 | 108 | 24.8 | not tested. | 14.8 |
| Overland/*Fhb6* | RF20FH0033, C11 | RF19FH0014, B5 | 60 | 40 | 5/21 | 5/31 | 98 | 24.1 | not tested. | 4.7 |
| Overland/*Fhb6* | RF20FH0004, A2 | RF19FH0010, A4 | 60 | 50 | 5/16 | 5/29 | 114 | 28.3 | 10.2 | 14.1 |
| Overland/*Fhb6* | RF20FH0035, B12 | RF19FH0011, B4 | 70 | 30 | 5/19 | 5/29 | 109 | 26.3 | 12.6 | 16.8 |

Objective 2: We have identified a novel source of type-2 FHB resistance that was assumed to be derived from *Th. intermedium* and have confirmed the level of resistance after point inoculation under greenhouse conditions. Molecular cytogenetic and marker analyses both failed to detect any *Th. intermedium* segment in HSD2-32 suggesting that the source of this resistance was not derived from *Th. intermedium*. We also used gene-specific marker (TaHRC-GSM) to determine that FHB resistance was not caused by the presence of

*Fhb1* gene. We have crossed this germplasm with Chinese Spring and Everest wheat and have obtained $BC_1F_2$ progenies that will be evaluated for their FHB resistance and DON accumulation under field condition. Further molecular cytogenetic analysis and Skim-sequencing will be performed to determine the homoeology and genomic affinity of the introgressed alien segment.

3. **Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns and/or restrictions, 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 Genetics Resource 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 2020 National Fusarium Head Blight Forum and will be published in peer-reviewed international scientific journals. Fhb6/Overland and Fhb6/Lyman selections with superior FHB resistance and reduced DON accumulation have been distributed to national wheat breeding programs together with molecular marker information to monitor the transfer into regional breeding programs.

## Training of Next Generation Scientists

**Instructions:** Please answer the following questions as it pertains to the FY20 award period (5/26/20 - 5/25/21). 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 FY20 award period?**
   ☐Yes ☒No
   **If yes, how many?** Click to enter number here.

2. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY20 award period?**
   ☐Yes ☒No
   **If yes, how many?** Click to enter number here.

3. **Have any post docs who worked for you during the FY20 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?**
   ☐Yes ☒No
   **If yes, how many?** Click to enter number here.

4. **Have any post docs who worked for you during the FY20 award period and were supported by funding from your USWBSI grant gone on to take positions with private ag-related companies or federal agencies?**
   ☐Yes ☒No
   **If yes, how many?** Click to enter number here.

## 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 FY20 award period (5/26/20 - 5/25/21). 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** | **FHB Rating** (0-9) | **Year Released** |
|---|---|---|---|---|
| Click here to enter text. | Select Grain Class | Select what represents your most resistant check | Enter as text 0-9 rating | Select Year |
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**NOTE:** List the associated release notice or publication under the appropriate sub-section in the 'Publications' section of the FPR.

## Publications, Conference Papers, and Presentations

**Instructions:** Refer to the PR_Instructions for detailed more instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY20 grant award. Only citations for publications published (submitted or accepted) or presentations presented during the **award period (5/26/20 - 5/25/21**) 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:

> Z.J. Winn, R. Acharya, J. Lyerly, G. Brown-Guedira, C. Cowger, C. Griffey, J. Fitzgerald, R.E. Mason and J.P. Murphy. 2020. "Mapping of Fusarium Head Blight Resistance in NC13-20076 Soft Red Winter Wheat." In: S. Canty, A. Hoffstetter, and R. Dill-Macky (Eds.), *Proceedings of the 2020 National Fusarium Head Blight Forum (*p. 12.), Virtual; December 7-11. Online: https://scabusa.org/pdfs/NFHBF20_Proceedings.pdf.
>
> Status: Abstract Published and Poster Presented
>
> Acknowledgement of Federal Support: YES (Abstract and Poster)

**Journal publications.**

Nothing to report

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

Nothing to report

**Other publications, conference papers and presentations**.

Nothing to report