USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY19 Performance Progress Report
Due date: December 30, 2021

Cover Page

Agency PI:	Deven See
Cooperating Principle Investigator (PI):	Jan Dvorak
Institution:	University of California, Davis
E-mail:	jdvorak@ucdavis.edu
Phone:	530-752-6549
Fiscal Year:	2019
USDA-ARS Agreement ID:	58-2090-9-023
USDA-ARS Agreement Title:	FHB Resistance Candidate Genes from Wheatgrass
FY20 USDA-ARS Award Amount:	$ 21,073
Recipient Organization:	The Regents of the University of California Office of Research Sponsored Programs 1850 Research Park Drive Suite 300 University of California Davis, CA 95618-6153
DUNS Number:	04-712-0084
EIN:	94-6036494
Recipient Identifying Number or Account Number:	3-APSF765
Project/Grant Reporting Period:	8/1/20 - 7/31/21
Reporting Period End Date:	7/31/2021

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-SPR	Introgression to Wheat and Candidate Gene Discovery for Resistance Gene *Fhb7*	$ 21,073
	FY19 Total ARS Award Amount	**$ 21,073**

Jan Dvorak

January 24, 2022

Principal Investigator Date

* MGMT – FHB Management
FST – Food Safety & Toxicology
R – Research
S – Service (DON Testing Lab)
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: *Introgression to Wheat and Candidate Gene Discovery for Resistance Gene Fhb7*

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

1) Map the FHB resistance on chromosome 7E and develop introgression lines (IL) for wheat FHB resistance breeding.
2) Introgress the 7E FHB resistance into the MN-Washburn, Wheaton, and Rollag spring wheat genetic backgrounds, compare expression, and assess synergy with the *Fhb1* gene.

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

Obj. 1. Map the FHB resistance on chromosome 7E and develop introgression lines for wheat FHB resistance breeding.

a) What were the major activities?

The published sequence of *Fhb7* gene was used to developed PCR markers for selection of the *Fhb7* gene.

b) What were the significant results?

Four PCR primers were designed in the exons of *Fhb7* gene and were tested on progeny from crosses Rollag × IL 45497 and MN-Washburn × IL 45497 segregating for markers we developed previously.

c) List key outcomes or other achievements.

The Chinese publication of the *Lophopyrum elongatum* acc. PI 531718 genome sequence and the discovery of the *Fhb7* gene (Wang et al. 2020, Horizontal gene transfer of *Fhb7* from fungus underlies Fusarium head blight resistance in wheat, Science, DOI 10.1126/science.aba5435) made our effort to map the *Fhb7* gene superfluous. We therefore re-focused our work on the development of markers based on the *Fhb7* gene sequence (below).

Obj. 2. Introgress the 7E FHB resistance into the Wheaton, MN-Washburn and Rollag spring wheat genetic backgrounds, compare expression, and assess synergy with the *Fhb1* gene.

a) What were the major activities?

Backcrossing of IL 45497 to Wheaton, MN-Washburn, and Rollag was continued using PCR primers we developed for the *Fhb7* gene (Obj. 1). Meiotic analyses were performed on BC_1 and BC_2 plants to select those with the desired chromosomal constitution.

b) What were the significant results?

We are testing the following null hypothesis: The combined expression of *FHb7* and *Fhb1* will provide greater protection against fusarium infection than only *Fhb1.* If the null hypothesis is true, both genes should be simultaneously deployed in new varieties but if it is false there will be little point on introgressing *Fhb7* into wheat, except as safety against *Fhb1* breaking down. To evaluate this hypothesis, we continued backcrossing the *Fhb7* from IL 45497 to Wheaton, MN-Washburn, and Rollag using *Fhb7* PCR primers we developed (objective 1). The former variety is devoid of *Fhb1* and is FHB susceptible, whereas the latter two varieties are FHB resistant due to the presence of the *Fhb1* gene. Segregating MN-Washburn backcross progeny showed that *Fhb7* was located on a chromosome that originated by Robertsonian translocation of *L. elongatum* chromosome arms 2ES and 7EL in IL 45497. Robertsonian translocation is joining of two unrelated chromosome arms at the centromere. The translocation of 7EL with 2ES was broken in the backcross to MN-Washburn, but not in the backcross to Rollag, in which the *Fhb7* remained located on the translocated 2ES::7EL chromosome. A F*hb7* homozygous MN-Washburn plant GH59041 with added pair of 7EL telosomes to the 21 wheat chromosomes was obtained. Our attempt to develop Rollag homozygous for Fhb7 was also successful, as we obtained a BC_2F_3 plant (GH60246) with a pair of 2ES::7EL chromosomes. The attempt to backcross Fhb7 to the susceptible Wheaton failed. FHB resistance of the MN-Washburn and Rollag lines is currently being evaluated.

c) List key outcomes or other achievements.

The key outcome for this objective was the development of MN-Washburn and Rollag plants which harbor both *Fhb1* and *Fhb7* genes. In the backcross to MN-Washburn, the *Fhb7* gene is on a pair of telocentric chromosomes 7EL added to the standard 21 wheat chromosome pairs. In the backcross to Rollag, the gene in on a pair of translocated 2ES::7EL chromosomes added to the standard 21 wheat chromosome pairs.

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.

If your research was impacted in any way as a result of state and/or federal mandates/regulations put in place to address the COVID-19 pandemic, we want to know how it was impacted. Please be as detailed as possible.

This research was delayed by about 4 months, primarily because of unavailability of technical assistance and inability to genotype plants with Sequenom markers in the UC Davis Veterinary Genetics Laboratory, which provides the Sequenom SNP genotyping. In response, we designed and validate new PCR primers, which resulted in loss of funds and time for unnecessary work. Moreover, we missed genotyping of BC_2F_1 progeny involving Wheaton, which made the plants of that generation of no value for the project. In addition

to these problems, due to unavailability of student assistance, PI had to do all of the greenhouse work. That also slowed down the rate of progress.

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

A PhD student, Jiale Xu, who worked on this project graduated and assumed a postdoctoral position at Medical School, University of California, San Francisco. No new student replaced him since funding was inadequate to support another student.

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

The materials represent work in progress and have not been disseminated.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY20 award period (8/1/20 - 7/31/21). 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 FY19 award period?**
   ☐Yes ☒No ☐ Not Applicable
   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 FY19 award period?**
   ☒Yes ☐No ☐ Not Applicable
   If yes, how many? One student.

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?**
   ☐Yes ☒No ☐ Not Applicable
   If yes, how many? Click to enter number here.

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?**
   ☐Yes ☒No ☐ Not Applicable
   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 **FY19 award period (8/1/20 - 7/31/21)**. 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
Nothing to report.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year

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 (8/1/20 - 7/31/21**) should be included. If you did not publish/submit or present anything, state 'Nothing to report' below each 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:

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

Journal publications.

Xu J, Wang L, Deal KR, Zhu T, Luo M-C, Malvick J, You FM, McGuire PE, Dvorak J (2020) Genome-wide introgression from a bread wheat × *Lophopyrum elongatum* amphiploid into wheat. Theor Appl Genet. DOI: 10.1007/s00122-020-03544-w.
Status: Published
Acknowledgement of Federal Support: Yes

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

None

Other publications, conference papers and presentations.

None