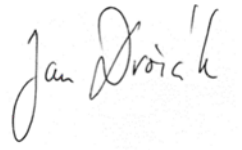
USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY19 Performance Report
Due date: September 30, 2020

Cover Page

Cooperating Principle Investigator (CPI):	Jan Dvorak
Institution:	University of California, Davis
E-mail:	jdvorak@ucdavis.edu
Phone:	530-752-6549
Fiscal Year:	2019
USDA-ARS Agreement ID:	58-2090-8-071
USDA-ARS Agreement Title:	FHB Resistance Candidate Genes from Wheatgrass
FY19 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-APSF719
Agency PI:	Deven See
Project/Grant Reporting Period:	8/1/19 - 7/31/20
Reporting Period End Date:	07/31/20

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



Sept. 30, 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

FY19 Performance Report
CPI: Dvorak, Jan
NACA Agreement #: 58-2090-9-023
Reporting Period: 8/1/19 - 7/31/20

Project 1: *Introgression to Wheat and Candidate Gene Discovery for Resistance Gene Fhb7.*

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

1) Map the FHB resistance on chromosome 7E and develop introgression lines 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 items a-b) 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 alternative 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 to IL 45497 to Wheaton, MN-Washburn, and Rollag was continued using new PCR primers we developed for the *Fhb7* gene (Obj. 1).

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. The former variety is devoid of *Fhb1* and is fusarium-susceptible, whereas the latter two varieties are resistant due to the presence of the *Fhb1* gene. The backcross into MN-Washburn was advanced most. Four BC_2F_1 plants with *Fhb7* were backcrossed and BC_3F_1 progeny are being grown in September, 2020. In three BC_2F_1 plants, *Fhb7*, which is located on chromosome arm 7EL, was accompanied by the *Lophopyrum elongatum* chromosome arm 2ES, as in IL 45497, but this association was broken in plant GH58138. Backcrossing to Rollag is in the BC_2F_1 stage, with four plants having *Fhb7*. They will be backcrossed to Rollag once more and then selfed.

c) List key outcomes or other achievements.
The key outcome for this objective is the development of BC_3F_1 MN-Washburn plants which harbor both *Fhb1* and *Fhb7* genes. A concern is the association of *L. elongatum* chromosome arm 7EL, on which *Fhb7* resides, with *L. elongatum* chromosome arm 2ES in three of the four BC_2F_1 plants. This association of the two arms could just be a coincidence, but it could also indicate that the chromosome introgressed into MN-Washburn from IL 45497 is a 2ES::7EL Robertsonian translocation. In that case, plant GH58138 could harbor a 7EL isochromosome. Analyses of meiotic pairing in BC_3F_1 progeny will answer these concerns.

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.

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 FY19 award period (8/1/19 - 7/31/20). 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?

   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.

   If yes, how many? One student.

2. **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?

3. **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 (8/1/19 - 7/31/20**) 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* (p. 12), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.
> 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:
ARS/USWBSI 58-2090-8-071 was acknowledged.

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

None

Other publications, conference papers and presentations.

None