USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY18 Performance Report
Due date: September 23, 2019

Cover Page

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Fiscal Year:	2018
USDA-ARS Agreement ID:	58-2090-8-071
USDA-ARS Agreement Title:	FHB Resistance Candidate Genes from Wheatgrass
FY18 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:	8/1/18 - 7/31/19
Reporting Period End Date:	07/31/19

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
	FY18 Total ARS Award Amount	$ 21,073

Sept. 23, 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: *Introgression to Wheat and Candidate Gene Discovery for Resistance Gene Fhb7.*

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

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

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

2. **What was accomplished under these goals?** *Address items 1-4) below for each goal or objective.*

   Goal 1.

   (1) Major activities Markers specific to the *Lophopyrum elongatum* (E genome) were developed. A total of 554 recombinant inbred lines (RILs) were screened to identify introgression lines harboring *L. elongatum* chromosome 7E. To introgress *Fhb7* resistance into wheat on a small segment that can be deployed in breeding, an introgression line (IL 44530) homozygous for the *ph1b* deletion was crossed with a wheat line homozygous for *ph1b* to target chromosome 7E for recombination with wheat chromosome 7D.

   (2) Specific objectives (a) Develop *L. elongatum* genome-specific markers, (b) map *Fhb7*, and (3) introgress *Fhb7* into wheat on a short interstitial segment.

   (3) Significant results The sequences of high-confidence genes in the recently sequenced genome of *Aegilops tauschii* (http://aegilops.wheat.ucdavis.edu/ATGSP/index.php), the donor of the wheat D subgenome, were aligned against Illumina reads of *L. elongatum*. Genes present only once in each genome and harboring an SNP were selected and the sequences were aligned against sequences of *Triticum aestivum* cv. Chinese Spring (CS, $2n=6x=42$, genomes AABBDD, https://wheat-urgi.versailles.inra.fr/Seq-Repository) to identify genes present only once in the *L. elongatum* genome and each of the three wheat subgenomes. Two PCR primers and one extension primer were designed for each SNP using the Sequenom MassARRAY Designer software. Sequences were then modified to have distinct mass, multiplexed, and validated on the Sequenom MassARRAY platform (Veterinary Genetics Lab, UC Davis) by genotyping a panel of control lines including CS, *Ae. tauschii*, amphiploid CS x *L. elongatum* acc. D (AgCS), and 19 *L. elongatum* disomic substitution (DS) lines. A total of 106 markers was validated and 97 were successfully multiplexed into seven pools corresponding to the seven *L. elongatum* chromosomes. A total of 554 recombinant inbred lines (RILs) were genotyped with the 97 Sequenom MassARRAY SNPs markers and 130 introgression lines (ILs) with complete or recombined *L. elongatum* chromosomes were identified. Of them, 36 harbored a *L. elongatum* chromosome 7E; 9 ILs harbored a recombined chromosome and 27 a complete chromosome 7E. To identify wheat chromosomes recombined or replaced by a *L. elongatum* chromosome in the 130 ILs, the ILs

and 19 *L. elongatum* DS lines were genotyped with the wheat 90-K Illumina Infinium SNP assay (UC Davis Genome Center).

ILs 44457, 44546, and 45497 were selected based on preliminary FHB screening and twice evaluated for resistance. All were FHB resistant, showing a level of resistance comparable to that conferred on wheat by *Fhb1*. The plants of 44457 had either 41 or 42 chromosomes and contained only arm 7EL. The line segregated resistant and susceptible plants. The plants of 44546 had 44 chromosomes and contained arm 7ES and the tip of arm 2ES. The line was homozygous and highly resistant. The plants of IL 45497 had 46 chromosomes and contained 7EL, complete chromosome 5E, and arm 2ES, and were homozygous, and highly resistant. Mapping of 44457 and 45497 generated results consistent with the location of *Fh7* on arm 7EL, but mapping of 44546 was not, since the line had arm 7ES, not 7EL.

(4) Key outcomes or other achievements

(a) *L. elongatum*-specific SNP markers were developed and validated.
(b) *Fhb7* gene was mapped in ILs 44457 and 45497.
(c) Another gene for FHB resistance was likely discovered in IL 44546.

Goal 2.

(1) Major activities Resistant ILs 44457, 44546, and 45497 were crossed with resistant cultuvars MN-Washburn and Rollag and the highly susceptible cultivar Wheaton.

(2) Specific objective Resistance present in the three ILs will be backcrossed into MN-Washburn, Rollag, and Wheaton.

(3) Significant results The ILs were crossed to *Fhb1*-containing spring wheat cultivars MN-Washburn and Rollag and the highly susceptible cultivar Wheaton. The progeny will be screened for the presence of the expected *L. elongatum* chromosome segments and recurrently backcrossed to the three wheat cultivars.

(4) Key outcomes Crosses between the ILs and the three spring wheat varieties were made. F_1 progeny is grown and will be screened for the presence of the expected *L. elongatum* chromosome segment.

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

Much of the work accomplished in this review period contributed to the PhD thesis project of a UC Davis graduate student supervised by PI Jan Dvorak.

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

By submission for publication in a refereed journal.

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?
   1

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?**
   None
   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?**
   None
   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 (8/1/18 - 7/31/19). 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 Blit 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.

J. Xu, L. Wang, K.R. Deal, T. Zhu, M.-C. Luo, J. Malvick, F.M. You, P.E. McGuire, J. Dvorak. 2019. Genome-wide introgression from a bread wheat × *Lophopyrum elongatum* amphiploid into wheat. *Theoretical and Applied Genetics*.
Status: Submitted and under revision
Acknowledgement of Federal Support: YES

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

Other publications, conference papers and presentations.