USDA-ARS | U.S. Wheat and Barley Scab Initiative

FY21 Performance Progress Report

Due date: July 26, 2022

Cover Page

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Phone:	402-472-9643
Fiscal Year:	2021
USDA-ARS Agreement ID:	N/A
USDA-ARS Agreement Title:	Characterization of Resistance to Fusarium Head Blight in Wheat and its Relatives
FY20 USDA-ARS Award Amount:	$111,178
Recipient Organization:	USDA-ARS Wheat, Sorghum and Forage Research Unit 251 Filley Hall, 1625 Arbor Drive Lincoln, NE 68583-0937
DUNS Number:	N/A
EIN:	N/A
Project/Grant Period:	5/1/21 - 4/30/22
Reporting Period End Date:	4/30/2022

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
DUR-CP	Introgression and Characterization of Hexaploid-Derived FHB Resistance Genes in Durum	$56,527
VDHR-SPR	Enhancing Resistance of Spring Wheat to FHB using Alien Species	$54,651
	FY21 Total ARS Award Amount	$111,178

I am submitting this report as an: ☒ Annual Report ☐ Final Report

I certify to the best of my knowledge and belief that this report is correct and complete for performance of activities for the purposes set forth in the award documents.

Principal Investigator Signature

7/6/2022
Date Report Submitted

DUR-CP and VDHR-SPR

ǂ BAR-CP – Barley Coordinated Project
DUR-CP – Durum Coordinated Project
EC-HQ – Executive Committee-Headquarters
FST-R – Food Safety & Toxicology (Research)
FST-S – Food Safety & Toxicology (Service)
GDER – Gene Discovery & Engineering Resistance
HWW-CP – Hard Winter Wheat Coordinated Project
MGMT – FHB Management
MGMT-IM – FHB Management – Integrated Management Coordinated Project
PBG – Pathogen Biology & Genetics
TSCI – Transformational Science
VDHR – Variety Development & Uniform Nurseries
NWW –Northern Soft Winter Wheat Region
SPR – Spring Wheat Region
SWW – Southern Soft Red Winter Wheat Region

Project 1: Introgression and Characterization of Hexaploid-Derived FHB Resistance Genes in Durum

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1. **What are the major goals and objectives of the research project?**
   The major goals of this research project are to provide a better understanding of the effects of the durum genetic background and wheat D-genome chromosomes on the hexaploid-derived FHB resistance and to manipulate the genetic background to incorporate the hexaploid-derived FHB resistance genes into durum for germplasm development. The specific objectives of this project are to: 1) Characterize inheritance of the hexaploid-derived FHB resistance genes in durum background and understand the effect of D-genome chromosomes on FHB resistance; 2) Incorporate hexaploid wheat-derived FHB resistance genes into durum for germplasm development; and 3) Develop and validate the molecular markers tagging FHB resistance QTL in durum.

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?**
   - Increased two generations of the progeny from the crosses of adapted durum varieties with hexaploid FHB-resistant sources for RIL population development using a modified single-seed descent procedure.
   - Seed increase of six RIL populations.
   - Collected leaf tissues for genotyping of the three new RIL populations using wheat 90K SNP arrays.
   - FHB resistance evaluation of the resistant RILs and other durum introgression lines in the Lincoln FHB nursery.
   - Made new crosses for conventional *Fhb7* introgression toward germplasm development.
   - Developed *Fhb7*-specific STS and KASP markers for MAS.
   - Initiated chromosome substitution-mediated FHB resistance gene introgression from hexaploid into durum for epistatic analysis and germplasm development.

   b) **What were the significant results?**
   - Developed six FHB-resistant hexaploids x durum RIL populations.
   - Identified the RILs with improved FHB resistance from the previously developed RIL populations in the greenhouse and field nurseries.
   - Identified and incorporated a novel *Th. elongatum*-derived *Fhb7* allele into the wheat B genome.
   - *Fhb7*-specific STS and KASP markers useful for *Fhb7* introgression and pyramiding in durum.

   c) **List key outcomes or other achievements.**
   - The new *Th. elongatum*-derived *Fhb7* allele we integrated into the wheat B genome through a small 7B-7E translocation makes this novel resistance gene immediately

usable without obvious linkage drag in durum for germplasm and variety development.

- Early introgression materials with Fhb7 and other hexaploid-derived FHB resistance genes.
- The six RIL populations ideal for the characterization of epistatic effects and FHB-resistant germplasm development.
- User-friendly DNA markers specific for Fhb7. They are useful for MAS in the deployment of Fhb7 in adapted durum varieties.

3. **What opportunities for training and professional development has the project provided?**
One undergraduate student and one postdoc have been hired to work on this research project. This research project has provided them an opportunity to learn the procedure and principles underlying FHB inoculum preparation, inoculation, and disease development and evaluation. In addition, the postdoc has received trainings in genetic analysis, chromosome engineering, genomics, and bioinformatics. These learning and research experience have facilitated their career preparation in plant genetics and breeding.

4. **How have the results been disseminated to communities of interest?**
Research results from this project have been presented in the FHB Forum and published in the peer-reviewed journal.

Project 2: Enhancing Resistance of Spring Wheat to FHB using Alien Species

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1. **What are the major goals and objectives of the research project?**
   The major goals/objectives of this project are to strengthen and diversify FHB resistance by alien introgression in spring wheat and to characterize and manipulate alien chromatin containing FHB resistance genes for a better understanding and utilization of the resistance genes in spring wheat.

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?**
   - Performed Fhb7 introgression from an FHB-resistant 7B-7E translocation line containing Fhb7 into adapted FHB-susceptible spring wheat breeding lines.
   - Performed DON testing of 400 samples.
   - Developed Fhb7-specific markers for Fhb7 introgression in spring wheat.

   b) **What were the significant results?**
   - Marker-assisted selection (MAS) of Fhb7 till BC2F1. The Th. elongatum 7E chromosome segment containing Fhb7 exhibits a monogenic inheritance pattern, making the DNA marker specific for the segment and MAS for Fhb7 highly effective.

   c) **List key outcomes or other achievements.**
   - KASP and STS markers specific for the Th. elongatum 7E chromosome segment containing Fhb7 and Fhb7 itself. They are highly diagnostic and user-friendly and can be routinely used in the wheat breeding programs.

3. **What opportunities for training and professional development has the project provided?**
   One undergraduate student and one postdoc have been hired to work on this research project. This research project has provided them an opportunity to learn the procedure and principles underlying FHB inoculum preparation, inoculation, and disease development and evaluation. In addition, the postdoc has received trainings in genetic analysis, chromosome engineering, genomics, and bioinformatics. These learning and research experience have facilitated their career preparation in plant genetics and breeding.

4. **How have the results been disseminated to communities of interest?**
   Research results from this project have been shared through personal communication in the spring wheat research community.

Publications, Conference Papers, and Presentations

Please include a listing of all your publications/presentations about your FHB work that were a result of funding from your FY21 grant award. Only citations for publications published (submitted or accepted) or presentations presented during the **award period** should be included.

Did you publish/submit or present anything during this award period?

☒ Yes, I've included the citation reference in listing(s) below.
☐ No, I have nothing to report.

Journal publications as a result of FY21 grant award

List peer-reviewed articles or papers appearing in scientific, technical, or professional journals. Include any peer-reviewed publication in the periodically published proceedings of a scientific society, a conference, or the like.

Identify for each publication: Author(s); title; journal; volume: year; page numbers; status of publication (published [include DOI#]; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).

Zhu, X, Boehm, J.D. Jr, Zhong, S., Cai, X. 2022. Genomic compatibility and inheritance of hexaploid-derived Fusarium head blight resistance genes in durum wheat. The Plant Genome. 2022 Mar 1:e20183. doi: 10.1002/tpg2.20183. Epub ahead of print. PMID: 35229982, acknowledgment of federal support - yes.

Books or other non-periodical, one-time publications as a result of FY21 grant award

Report any book, monograph, dissertation, abstract, or the like published as or in a separate publication, rather than a periodical or series. Include any significant publication in the proceedings of a one-time conference or in the report of a one-time study, commission, or the like.

Identify for each one-time publication: Author(s); title; editor; title of collection, if applicable; bibliographic information; year; type of publication (book, thesis or dissertation, other); status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).

Other publications, conference papers and presentations as a result of FY21 grant award

Identify any other publications, conference papers and/or presentations not reported above. Specify the status of the publication.

Zhang, W., Danilova, T., Zhang, M., Ren, S., Zhu, X., Zhang, Q., Zhong, S., Dykes, L., Fiedler, J., Xu, S., Boehm Jr. J., and Cai, X. 2021. A diploid tall wheatgrass-derived *Fhb7* allele integrated into wheat B genome conditions FHB resistance in wheat. 2021 *Proceedings of the 2021 National Fusarium Head Blight Forum;* Virtual Forum via Zoom, December 6-7, 2021. Retrieved from: https://scabusa.org/forum/2021/2021NFHBForumProceedings.pdf