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

FY22 Performance Progress Report

Due date: July 26, 2023

Cover Page

USDA-ARS Agreement ID:	N/A
USDA-ARS Agreement Title:	Genetic Improvement of FHB Resistance in Barley
Principle Investigator (PI):	Shengming Yang
Institution:	USDA-Agricultural Research Service
Institution UEI:	N/A
Fiscal Year:	2022
FY22 USDA-ARS Award Amount:	$67,260
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Period of Performance:	May 1, 2022 - April 30, 2023
Reporting Period End Date:	April 30, 2023

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
BAR-CP	Functional Validation of the Barley Fhb1 Ortholog in Susceptibility to FHB	$37,260
GDER	Genotype-independent Transformation in Barley	$30,000
	FY22 Total ARS Award Amount	$67,260

I am submitting this report as an: ☒ Annual 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.

SHENGMING YANG Digitally signed by SHENGMING YANG Date: 2023.07.24 15:50:28 -05'00'

Principal Investigator Signature

07/24/2023

Date Report Submitted

‡ 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: Functional Validation of the Barley Fhb1 Ortholog in Susceptibility to FHB

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1. **What are the major goals and objectives of the research project?**
   1) To develop targeted gene knockouts in barley using CRISPR-mediated mutagenesis;
   2) To obtain the transgene-free barley mutants with resistance to FHB.

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?
   1) Barley transformation using the amenable genotype Gold Promise;
   2) Barley transformation using recalcitrant genotypes, such as Bowman and Conlon;
   3) CRISPR-mediated mutagenesis in Golden Promise and Bowman;
   4) Testing the mutants under field conditions.

   b) What were the significant results?
   1) We developed a stable protocol for barley transformation in Golden Promise and Bowman.
   2) We improved barley transformation efficiency in recalcitrant genotypes.
   3) The barley ortholog of *FHB1* (*HvHRC*) in Golden Promise and Bowman was knocked out.
   4) Homozygous mutant plants were obtained.

   c) List key outcomes or other achievements.

   1) We developed a genotype-independent transformation protocol in barley.
   2) We set up an efficient CRISPR protocol in barley.

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

   This project provided a Ph. D student and an undergraduate student with training on barley transformation and gene editing.

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

   We presented our preliminary results at the 2022 National FHB Forum.

Project 2: Genotype-independent Transformation in Barley

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

1) To obtain transgenic barley plants using recalcitrant varieties other than Golden Promise.
2) To obtain transgenic barley plants using the GRF-GIF chimera.
3) To transfer the *FHB7* gene to Bowman.
4) To test FHB severity with the *FHB7*-transgenic plants in both greenhouse and field conditions.

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?

1) Cloned the CRF-GIF chimera to the destination vector.
2) Transfer *FHB7* to Bowman.
3) Evaluation of *FHB7*-transgenic plants under field conditions.

b) What were the significant results?

1) We developed *Agrobacterium*-mediated stable transformation protocol using various barley genotypes, including some transformation-recalcitrant ones, such as Bowman and Conlon.
2) We introduced a mutated GRF4-GIF1 complex to upgrade our constructs and improve transformation efficiency.
3) We transferred the wheat *FHB7* gene to Golden Promise and Bowman using the transformation protocol we developed.
4) Homozygous FHB7-transgenic plants were obtained.
5) Homozygous FHB7-transgenic plants were grown in the FHB nursery for evaluation.

c) List key outcomes or other achievements.

1) Mutated GRF4-GIF1 fusion protein significantly improved barley transformation efficiency.
2) The *FHB7* gene in wheat with effective FHB resistance was successfully transferred to barley.
3) Genotype-independent transformation protocol was developed.

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

This project provided a Ph. D student and an undergraduate student with training on barley transformation and gene editing.

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

We presented our preliminary results at the 2022 National FHB Forum.

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 FY22 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 May 1, 2022 – April 30, 2023?

☒ Yes, I've included the citation reference in listing(s) below.

☐ No, I have nothing to report.

Journal publications as a result of FY22 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).

Books or other non-periodical, one-time publications as a result of FY22 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 FY22 award

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

Abdullah F Alhashel, Sandesh Dangi, Abbeah Navasca, Shaobin Zhong, Thomas Baldwin, Shengming Yang. (2022). Host-induced gene silencing of the fungal gene *FgGCN5* in barley for improving resistance to Fusarium head blight. Proceedings of the 2022 National Fusarium Head Blight Forum; Tampa, FL. December 4-6, 2022. Retrieved from: https://scabusa.org/forum/2022/2022NFHBForumProceedings.pdf