

FY22 Performance Progress Report

Due date: July 26, 2023

Cover Page

USDA-ARS Agreement ID:	59-0206-2-130
USDA-ARS Agreement Title:	Developing Diverse Solutions for Fusarium Head Blight (FHB) in Wheat
Principle Investigator (PI):	Nidhi Rawat
Institution:	University of Maryland
Institution UEI:	NPU8ULVAAS23
Fiscal Year:	2022
FY22 USDA-ARS Award Amount:	\$113,291
PI Mailing Address:	4291 Field House Drive, Plant Science and Landscape Architecture Dept. University of Maryland, College Park, MD 21044
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Period of Performance:	May 1, 2022 – April 30, 2026
Reporting Period End Date:	April 30, 2023

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
BAR-CP	Evaluation of Winter Barley Commercial Cultivars and Breeding Lines for FHB	\$9,690
GDER	Manipulating a Conserved Susceptibility Factor for Developing FHB Resistant Wheat	\$59,996
MGMT IM-CP	Fungicide Combinations and Genetic Resistance for FHB and DON Management in Maryland	\$43,605
FY22 Total ARS Award Amount		\$113,291

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.



Principal Investigator Signature

7/26/2023

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: Evaluation of Winter Barley Commercial Cultivars and Breeding Lines for FHB

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

Project Goals: Evaluation of Fusarium head blight (FHB) reaction in local commercial varieties of barley is critical for growers. At the same time, barley breeders need to evaluate their breeding germplasm for FHB resistance and DON accumulation for developing resistant varieties. PI will conduct misted nursery to evaluate local commercial cultivars and breeding germplasm for their response to FHB and DON accumulation. Barley is most susceptible to FHB at heading stage. However, heading times of barley genotypes/cultivars vary in natural conditions due to differences in their genetic background. Moreover, weather conditions may not be favorable for FHB every year. The misted nursery will help to avoid these issues by consistently maintaining favorable conditions for FHB infection over a longer period. **The overall project goal is to analyze barley breeding germplasm and commercial cultivars for their genetic resistance to FHB and DON accumulation.**

Project Objectives:

1. Conduct misted nursery for evaluating FHB resistance and DON accumulation in NABSEN barley breeding lines
2. Evaluate local barley varieties from the Mid-Atlantic region in the misted nursery.

The misted nursery data generated will help: a)-breeders in selecting FHB resistant breeding germplasm, and b)- growers in the Mid-Atlantic region in selecting high-yielding barley varieties with moderate resistance to FHB and DON.

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?

Misted nursery was conducted at Beltsville Research station of the University of Maryland for screening NABSEN lines in headrows, and local barley varieties in small plots. FHB severity and incidence data were collected on the germplasm. Samples were prepared for their DON content analysis and shipped to Dr. Yanhong Dong at Minnesota. The proposed activities were conducted as per the proposed timelines in the project. The data was provided to the stakeholders and the NABSEN team in the FY 2022.

b) What were the significant results?

The FHB indices and DON data on barley commercial varieties were published as Factsheet for the year 2022. The results were disseminated to the growers and stakeholders in commodity board meetings and via emails. The NABSEN data was provided to the coordinator Dr. Tom Baldwin.

c) List key outcomes or other achievements.

Key outcomes were disease ratings and DON contamination measurement. Some lines in the barley trial and NABSEN head rows had lower FHB severity, indices and DON content as compared to others.

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

A master's student, one PostDoc, and two undergraduate students were involved in the field work. Two minority high school students were also trained in the project on field diseases. All the trainees worked with the PI to conduct the nursery, collect and analyze data. The graduate students and PostDocs also participated in conferences and commodity board meetings with their work.

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

The PI presented the results in oral presentations and disseminated updates on FHB in wheat and barley through emails. The graduate students in the team presented the results as posters and handouts to the stakeholders in commodity board meetings. The results were published as Barley disease Factsheets and was disseminated via emails and the UMD extension system to the broader grower community.

Project 2: Manipulating a Conserved Susceptibility Factor for Developing FHB Resistant Wheat

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

Project Goals: Genetic resistance is the most sustainable approach for managing Fusarium Head Blight (FHB) in wheat and barley. As most of the resistance genes are sourced from un-adapted germplasm, linkage drag and variable penetrance in different genetic backgrounds limits their deployment in cultivars. The goal of this project is to characterize and manipulate a conserved susceptibility factor present in wheat cultivars for enhancing their FHB resistance. The project builds-up on three-years of work done by PI Rawat (Chhabra et al. 2021), which mapped a susceptibility factor in the peri-centromeric region of wheat chromosome 7AS. In this project, we will fine-map and isolate the susceptibility factor using Radiation Hybrid (RH) mapping. Collaborator Vijay Tiwari is an expert on RH mapping and will be vital in the SF-7AS fine mapping. After fine mapping we will perform VIGS, TILLING, and genome editing to validate the gene function and utilize the loss-of-function variants to enhance the FHB resistance in wheat cultivars. In the fourth year, PI will test the lines in field conditions for yield evaluation and FHB resistance.

Specific objectives of this project over a 4-year period are:

1. Fine mapping and isolation of 7AS susceptibility factor using RH mapping.
2. Validation of candidate genes using TILLING and Genome-editing.
3. Transfer of FHB resistant variants in wheat cultivars
4. Field Testing of the variant lines for yield evaluation.

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?

Chinese Spring radiation panels were developed using 35kRad gamma radiation. As the deletion of the susceptibility factor is expected to provide resistance in homozygous condition, generation advancement was done for the irradiation panel. Considering R7 generation to have majority of deletions in homozygous state, we have been able to advance the population upto R6 generation so far. A total of 700 individual strong population at R6 generation has been developed. Work on characterizing the deletions in the targeted interval progress using genome-specific markers from Chhabra et al. and using GBS is in. In the meanwhile, phenotyping of the whole population at R6 generation was performed with 3 spikes per plant data points. We have obtained ~20 lines that showed resistance response. Molecular analysis of the lines is being conducted to characterize the status of deletions in these lines. In case, the deletions are still not in homozygous state, we will conduct the phenotypic and molecular analysis of the panel in the Fall 2023 season.

Additionally, a panel of 700 irradiated lines was also developed in the HRW cultivar Jagger. The panel has been sequenced using GBS and is being currently analyzed for deletions in the chromosome 7A target interval.

b) What were the significant results?

Development of populations and Genotyping based sequencing of the panels is the most significant result. Extensive phenotyping of the panels, identifying some resistant lines is also significant toward the progress of the project.

c) List key outcomes or other achievements.

Key outcomes include: Development of irradiated panels, and generation advancement up to R6, Phenotyping of the plants at this generation, as well as GBS of the deletion panel in Chinese spring and Jagger.

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

The project has enabled training of 1 PhD student and a PostDoc, plus two undergrad students and 3 high school students.

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

The results have been disseminated via oral and poster presentations at National FHB forum, Mid-Atlantic ASPB meeting, and University level presentations by the graduate student and PostDoc involved in the project.

Project 3: Fungicide Combinations and Genetic Resistance for FHB and DON Management in Maryland

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

Overall project goal(s)

FHB has been a major challenge to small grain farmers in the state of Maryland due to several compounding factors. Maryland has wet spring seasons, which is the time of highest susceptibility to *Fusarium graminearum* infections. Farmers practice No-Tillage agriculture, and often follow corn: wheat or corn: barley rotations. The overall project goal is to analyze and compare different chemistries, their combinations, and timings, as well as the effect of genetic resistance on the overall efficacy of FHB and DON management in wheat and barley.

Project Objectives:

- 1) Evaluate the integrated effects of fungicide treatment and genetic resistance on FHB and DON in soft red winter wheat and barley, with emphasis on new combination fungicides, Prosaro Pro and Sphaerex.
- 2) Compare the efficacy of Prosaro Pro and Sphaerex to that of Prosaro, Caramba, and Miravis Ace.
- 3) Generate data to further quantify the economic benefit of FHB and DON management programs.

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?

Field evaluation of efficacy of Prosaro-Pro and Spaherex and a standard fungicide with different genetic resistance levels of wheat and barley cultivars was performed in 2022 at two locations, one with artificial misted nursery and the other in natural inoculation conditions. The experiments were conducted in randomized complete block design (RCBD), with a split-plot arrangement having moderately resistant and a susceptible cultivar as the whole-plot, and fungicide treatment in wheat and barley as the sub-plot. The other experiment was done with different combinations and timings of these new fungicides as compared to the standard fungicides on a susceptible variety as RCBD in 5 reps. All treatments were applied with NIS @ 0.125 v/v. Experiments were done in five replicate blocks following corn with No-Till. The data on FHB incidence, severity, DON content, yields and grain weight was collected and presented to the regional stakeholders. The results were also shared with the IMCP coordinator Dr. Pierce Paul as part of the network for his overarching analysis.

b) What were the significant results?

The new fungicides Prosaro-Pro and Sphaerex were found to be effective in reducing FHB severity, incidence as well as DON contamination significantly as compared to the untreated control. The new test fungicides performed equally good as the standard FHB fungicides.

c) List key outcomes or other achievements.

We were able to provide recommendations to Maryland wheat and barley farmers about the efficacy of Sphaerex and Prosaro-Pro, and the effect of different genetic resistance levels on the fungicide efficacy. In addition, the results were also shared with IM team led by Dr. Pierce Paul, who will be able to determine the degree to which baseline FHB and DON levels influence the efficacy of the tested fungicide treatments and treatment x cultivar combinations across locations and grain classes.

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

Two graduate students (1 PhD and 1 Masters students) plus 5 undergraduate students were involved in the field work in 2022. All the trainees worked with the PI to conduct the nursery, collect and analyze data. The graduate students also presented the results to the stakeholders in commodity board meetings.

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

The PI presented the results in oral presentations. The graduate students in the team presented the results as posters and handouts to the stakeholders in commodity board meetings. The results were also disseminated via the UMD extension system to the broader grower 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 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).

Chhabra, B. Livesay, J., Thrasu, S., Cheng, V., Crank, J., Thorne, L., Koehler, A., Dong, Y., and Rawat, N. Evaluating the efficacy of a newly released fungicide, Sphaerex, for control of Fusarium Head Blight in soft red winter wheat. In preparation for Plant Health Progress.

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).

Rawat et al. Factsheet: Disease Data Maryland Barley Varieties-2022. Published and distributed.
Acknowledgement of federal support: Yes

Rawat et al. Factsheet: Disease Data Maryland Barley Varieties-2022. Published and distributed.
Acknowledgement of federal support: Yes

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.

1. Rawat, N. Mapping of susceptibility factor Sf-Fhb-7AS from Chinese Spring. U.S. Wheat and Barley Scab Initiative GDER and PBG Joint Mid-year meeting. Virtual. April 27, 2023
2. Rawat, N. Making sense of non-sense: Using mutations for wheat and barley improvement. Plant and Animal Genome Conference, San Diego, CA. Jan 16, 2023.
3. Chhabra, B et al. Discovery of a susceptibility factor for Fusarium head blight on chromosome 7A of wheat. Proceedings of the 2022 National FHB Forum: Tampa, FL. Dec 4-6, 2022. Retrieved from: <https://scabusa.org/forum/2022/2022NFHBForumProceedings.pdf>
4. Rawat, N. Fighting the fungal foes of wheat. Punjab Agricultural University, Ludhiana, India. Aug 4, 2022.
5. Rawat, N. Fighting the fungal foes of wheat. Regional Center for Biotechnology, Faridabad, India. Aug 2, 2022.
6. Rawat, N. Determine the best systems approach to managing Fusarium head blight and vomitoxin levels in wheat and barley. Maryland Grain Producers and Utilization Board. Virtual. Jan 5, 2023
7. Helping crop plants fight diseases. Congressional representative panel. College of Agricultural and Natural Resources. University of Maryland, College Park, MD. Oct 27, 2022
8. Small grain pathology program's activities in the 2021-2022 season. Maryland Grain Producers and Utilization Board. Wye, Queenstown Maryland, Dec 15, 2022.