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

FY22 Performance Progress Report

Due date: July 26, 2023

Cover Page

USDA-ARS Agreement ID:	59-0206-2-148
USDA-ARS Agreement Title:	Development of Fusarium Head Blight (FHB) Resistant Wheat and Barley for the NE U.S.
Principle Investigator (PI):	Mark Sorrells
Institution:	Cornell University
Institution UEI:	G56PUALJ3KT5
Fiscal Year:	2022
FY22 USDA-ARS Award Amount:	$125,837
PI Mailing Address:	Cornell University, Department of Plant Breeding 240 Emerson Hall, Ithaca, NY 14853
PI E-mail:	mes12@cornell.edu
PI Phone:	607-255-1665
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	Breeding Spring and Winter 2-rowed Malting Barley for FHB Resistance and Reduced DON	$32,814
VDHR-NWW	Genetics and Breeding of FHB Resistant Soft White & Red Winter Wheat for the NE U.S.	$93,023
	FY22 Total ARS Award Amount	$125,837

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.

Mark E. Sorrells

Principal Investigator Signature — June 6, 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: Breeding Spring and Winter 2-rowed Malting Barley for FHB Resistance and Reduced DON

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

1. Evaluate FHB resistance in spring malting barley varieties in a Uniform Eastern Spring Malting Barley nursery coordinated by Richard Horsley at North Dakota State University, a Winter 2-row Malting Barley Trial coordinated by Kevin Smith at the University of Minnesota and the winter NABSEN coordinated by Eric Stockinger at Ohio State University.
2. Evaluate FHB resistance in spring and winter malting barley varieties and lines that are tested in New York State Regional Barley Trials.
3. Evaluate FHB resistance in winter malting barley germplasm from Idaho and Nebraska.
4. Evaluate FHB resistance and agronomic traits in our NY winter 2-row elite line training population and use genomic selection to develop winter 2-row malting barley varieties with FHB resistance and adaptation to the northeastern U.S.

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. We are evaluating FHB resistance in the Winter 2-row Malting Barley Trial coordinated by Kevin Smith at the University of Minnesota and the winter NABSEN coordinated by Eric Stockinger at Ohio State University. The Eastern Spring Malting Barley nursery coordinated by Richard Horsley was discontinued by the coordinator citing a lack of funding.
2. We are evaluating FHB resistance in our misted inoculated FHB nursery for malting barley varieties that are tested in New York State Regional Spring and Winter Malting Barley testing programs. All of our data are published and distributed to the barley community and the public at large through print, web, field days and workshops.
3. Evaluate FHB resistance in winter malting barley germplasm from Idaho and Nebraska as needed.
4. We are evaluating FHB resistance and agronomic traits in our NY winter 2-row elite line training population and those data are used for genomic selection to develop winter 2-row malting barley varieties with FHB resistance and adaptation to the northeastern U.S.

b) What were the significant results?

1. We scored all entries in the Winter Malting Barley Trial and the NABSEN for incidence, severity, fusarium damaged kernels and DON in three replicates. Data were submitted to T3 and the nursery coordinators.
2. We scored all entries in spring and winter malting barley State-Wide Regional Trials for incidence, severity, fusarium damaged kernels and DON in three replicates. Those data were summarized and reported in our annual performance trial publication.

3. Our collaborators in Idaho and Nebraska did not submit entries for evaluation this past year.
4. Phenotypic data were recorded for FHB and agronomic traits in our NY winter 2-row malting barley genomic selection training population. The phenotypic and genotypic data were used to train genomic prediction models to generate breeding values for our preliminary yield trial entries.

c) List key outcomes or other achievements.

1. Several entries in the Winter Malting Barley Trial and the NABSEN had above average resistance to FHB.
2. Almost half of the entries in our State-Wide trial had above average resistance to FHB.
3. Our collaborators in Idaho and Nebraska did not submit entries for evaluation this past year.
4. Breeding values for FHB resistance were used to select lines in our preliminary yield trial for advancement.

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

All of our graduate and undergraduate students participate in the collection and analysis of data from our FHB nurseries. Two new technicians received training in FHB data collection.

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

Each year we publish the results of our state regional trials for both spring and winter malting barley including malting quality through mail or email and online. Data for cooperative nurseries were sent to coordinators.

Cornell Small Grains Performance Trials:
https://bpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/5/8858/files/2022/11/SG-Performance-Rpt-10Nov2022.pdf

We also present the results at three fields days and two workshops for extension agents.

Project 2: Genetics and Breeding of FHB Resistant Soft White & Red Winter Wheat for the NE U.S.

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

1. Develop FHB resistant soft white and red winter wheat cultivars for the northeastern U.S. in collaboration with Gary Bergstrom, Department of Plant Pathology. Evaluate our elite lines in the Cornell University FHB Advanced Line nursery.
2. Pyramid FHB resistance genes by hybridizing elite lines with native FHB resistance to exotic sources of FHB resistance both Asian and other sources.
3. Evaluate FHB resistant lines in New York regional and state trials for release, farmer recommendations, and seed increase.
4. Participate in the coordinated evaluation of cooperative nurseries for FHB resistance.
5. Implement recurrent mass selection in dominant male sterile populations in soft winter wheat backgrounds adapted to the eastern US.
6. Participate in the coordinated sharing of information from the above activities to generate a comprehensive source of information that can be used in forward breeding strategies.

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. Lines in our preliminary trial and state-wide regional trials were evaluated in our Cornell University FHB Advanced Line FHB nursery.
2. Diverse sources of FHB resistance were grown in the winter greenhouse to generate new crosses for pyramiding FHB resistance genes.
3. FHB resistance of all wheat varieties grown in NY state were evaluated in our misted, inoculated FHB nursery.
4. We evaluated the NUWWSN in our FHB nursery and reported the data to the coordinator and loaded the data into T3.
5. For this objective, we have extracted lines from the half-sib recurrent selection population and evaluated them in our FHB nursery.
6. All data were summarized and distributed to coordinators and stakeholders.

b) What were the significant results?

1. High quality data on FHB resistance in our soft winter wheat breeding program were recorded and analyzed.
2. About 150 crosses were made between diverse sources of FHB resistance.
3. Entries in our state-wide trials were evaluated in our misted, inoculated FHB nursery. Data were summarized and distributed to stakeholders.
4. The NUWWSN was evaluated for resistance in our FHB nursery and the data were reported to the coordinator and uploaded to T3.
5. Lines extracted from our half-sib recurrent selection population showed very high levels of FHB resistance.
6. Data from all lines and varieties evaluated in our FHB nursery were reported to collaborators and stakeholders.

c) List key outcomes or other achievements.

1. Single year and multiple year summaries of our advanced lines demonstrated that we are making progress in developing lines with above average FHB resistance. Our new soft white winter wheat variety named 'Towpath' has the highest level of FHB resistance compared to all other varieties grown in NY.
2. All of our soft wheat parents used in crosses now have some level of FHB resistance leading to a high frequency of moderately resistant lines in our testing program.
3. Only lines and varieties that have at least moderate resistance to FHB are recommended for NY growers.
4. Many of the NUWWSN entries continue to show good FHB resistance.
5. We are planning a germplasm release for the lines extracted from the half-sib recurrent selection population.
6. Data summaries from our FHB nursery and regional trials are distributed to stakeholders on our web site, by email and at field days and extension workshops.

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

All of our graduate and undergraduate students participate in the collection and analysis of data from our FHB nurseries. Two new field technicians received training in FHB data collection.

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

Each year we publish the results of our state regional trials for both soft red and soft white winter wheat including FHB and milling and baking quality hard copy through mail or email and online. Data for cooperative nurseries were sent to coordinators.
Cornell Small Grains Performance Trials:
https://bpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/5/8858/files/2022/11/SG-Performance-Rpt-10Nov2022.pdf
We also present the results at three fields days and two workshops for extension agents.

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?

X 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).

Gaire, R., C. Sneller, G. Brown-Guedira, D. Van Sanford, M. Mohammadi, F.L. Kolb, E. Olson, M.E. Sorrells, J. Rutkoski. 2022. Genetic Trends in Fusarium Head Blight Resistance from 20 Years of Winter Wheat Breeding and Cooperative Testing in the Northern U.S.A. Plant Disease. 106:2, 364-372.

Published. Acknowledgement of federal support: Yes

Rooney, T. E., Kunze, K. H., Sorrells, M. E. 2022. Genome-wide marker effect heterogeneity is associated with a large effect dormancy locus in winter malting barley. The Plant Genome, 00, e20247. https://doi.org/10.1002/tpg2.20247

Published. Acknowledgement of federal support: Yes

Rooney, T.E., Sweeney, D.W., Sorrells, M.E. 2022. Time series barley germination is predictable using functional principal component analysis or logistic regression and associated with known seed dormancy loci. Crop Science 62:100–119. https://doi.org/10.1002/csc2.20638

Published. Acknowledgement of federal support: Yes

Sandro, P., Kucek, L.K., Sorrells, M.E., Dawson J., Gutierrez L. 2022. Developing high-quality value-added cereals for organic systems in the US Upper Midwest: hard red winter wheat (*Triticum aestivum* L.) breeding. Theor Appl Genet https://doi.org/10.1007/s00122-022-04112-0

Published. Acknowledgement of federal support: Yes

Sweeney, D.W., Kunze, K.H. Sorrells, M.E. 2022. QTL x environment modeling of malting barley preharvest sprouting. Theor Appl Genet 135, 217–232. https://doi.org/10.1007/s00122-021-03961-5

Published. Acknowledgement of federal support: Yes

Sweeney, D.W., Rooney, T.E., Walling, J.G., Sorrells, M.E. 2022. Interactions of the barley *SD1* and *SD2* seed dormancy loci influence preharvest sprouting, seed dormancy, and malting quality. Crop Science, 62, 120– 138. https://doi.org/10.1002/csc2.20641.

Published. Acknowledgement of federal support: Yes

Taagen, E., K. Jordan, E. Akhunov, M.E. Sorrells, J-L. Jannink. 2022. If it ain't broke, don't fix it: evaluating the effect of increased recombination on response to selection for wheat breeding, *G3 Genes|Genomes|Genetics*, Volume 12, Issue 12, jkac291, https://doi.org/10.1093/g3journal/jkac291

Published. Acknowledgement of federal support: Yes

Massman, C., B. Meints, J. Hernandez, K. Kunze, K.P. Smith, M.E. Sorrells, P.M. Hayes, and L. Gutierrez. 2023. Genomic prediction of threshability in naked barley. Crop Science 63: 674–689. https://doi.org/10.1002/csc2.20907.

Published. Acknowledgement of federal support: Yes

Rooney, T.E., D.W. Sweeney, K.H., Kunze, M.E. and J.G. Walling. 2023. Malting quality and preharvest sprouting traits are genetically correlated in spring malting barley. Theor Appl Genet. **136**, 59. https://doi.org/10.1007/s00122-023-04257-6.

Published. Acknowledgement of federal support: Yes

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).

None

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.

2022 Cornell Small Grains Performance Trials:
https://bpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/5/8858/files/2022/11/SG-Performance-Rpt-10Nov2022.pdf
Published. Acknowledgement of federal support: Yes