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

FY21 Performance Progress Report

Due date: July 26, 2022

Cover Page

Principle Investigator (PI):	Mark Sorrells
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Fiscal Year:	2021
USDA-ARS Agreement ID:	59-0206-0-119
USDA-ARS Agreement Title:	Development of FHB Resistant Wheat and Barley Varieties for the Northeastern U.S.
FY20 USDA-ARS Award Amount:	$128,512
Recipient Organization:	Cornell University Department of Plant Breeding 240 Emerson Hall, Ithaca, NY 14853
DUNS Number:	872612445
EIN:	15-0532082
Recipient Identifying Number or Account Number, if any:	1498135 (OSP135995)
Project/Grant Period:	5/3/21 - 5/2/23
Reporting Period End Date:	5/2/2022

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	$34,508
BAR-CP	Identification, Characterization, & Development of Widely-adapted FHB-resistant Germplasm	$4,620
BAR-CP	Genomics Selection for FHB Resistance and Malting Quality in Spring Malting Barley	$3,819
VDHR-NWW	Genetics and Breeding of FHB Resistant Soft White & Red Winter Wheat for the Northeastern U.S.	$82,116
VDHR-NWW	Coordinated Phenotypes of Soft Wheat Germplasm for the Midwest	$3,449
	FY21 Total ARS Award Amount	$128,512

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.

Mark E. Sorrells
Principal Investigator Signature

June 6, 2022
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?

Goal #1 - Increase and document the number of varieties with improved FHB resistance and high grain yield and grain quality, that are tested in statewide variety trials and available to farmers, to reduce DON in the US grain supply.

Goal #2: Increase efficiency of the CPs' funded projects to develop and release FHB resistant varieties and germplasm.

Goal #3: Evaluate and implement new breeding technologies and develop germplasm to further enhance short term and long term improvement of FHB resistance, and to efficiently introgress effective resistance genes into breeding germplasm.

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 our misted inoculated FHB nursery for malting barley varieties that are tested in both New York State Regional Spring and Winter Malting Barley testing programs. We are testing the FHB resistance in winter malting barley germplasm from Idaho and Nebraska. We collaborate with Tom Baldwin on evaluating Idaho spring malting barley.
2. We are evaluating FHB resistance in our misted inoculated nursery for spring malting barley varieties in a cooperative Uniform Eastern Spring Malting Barley nursery coordinated by Richard Horsley (North Dakota State University) and a Winter 2-row Malting Barley Trial coordinated by Kevin Smith (University of Minnesota). We are sharing seed of the elite winter and facultative barley DH lines developed in collaboration with Pat Hayes at Oregon State University with the barley community. 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. We are evaluating FHB resistance and agronomic traits in our NY spring 2-row elite line genomic selection training population, and we used genomic selection to develop spring 2-row malting barley varieties with FHB resistance and adaptation to the northeastern U.S. The genomic predictions were used to select lines for harvest in the off-season nursery in New Zealand. We have completed 2 cycles of genomic selection using an index that includes FHB resistance. The second season of evaluation for gain from selection was completed this past summer

b) What were the significant results?

1. Two spring malting barley lines showed moderate resistance to FHB.
2. Data were summarized for the ID and NE winter barley populations and sent to collaborators. The NE barley lines were nearly all susceptible, but the ID population

was segregating for FHB resistance and excellent data were summarized and sent to ID.

3. Genomic prediction identified spring malting barley breeding lines that had high genomic estimated breeding values. A severe spring drought limited the quality of the data from the spring malting barley evaluations

c) List key outcomes or other achievements.

1. The two lines, designated CU-31 (named Excelsior Gold) and CU-198 were grown commercially for the first time.
2. We continued the agronomic evaluation of over 500 DH lines developed in collaboration with Pat Hayes at Oregon State University. Seed of those lines have been sent back to the OSU program for evaluation and are available to the barley community.
3. Genomic selection was effective for identifying lines with good FHB breeding values.

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.

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

Summary tables and reports (annual and cumulative) are prepared and distributed to more than 400 agents, farmers, scientists, and administrators by regular mail and email. All reports are made available online at two web sites. We also deposit our data in T3.
https://cpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/5/8858/files/2022/03/SG-Performance-Rpt-19Mar2022.pdf

Project 2: Identification, Characterization, & Development of Widely-adapted FHB-resistant Germplasm

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1. **What are the major goals and objectives of the research project?**
   1) Identify resistant lines in elite winter barley germplasm;
   2) Cross resistant spring lines to a) create mapping populations and b) broaden the adaptability of Aberdeen FHB-resistant malting barley germplasm by introducing broad-spectrum disease resistance.
   3) Investigate fungal biomass estimated qPCR as a screening tool for selection of low-DON lines.

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. For the past 2 years we have evaluated breeding lines in two different nurseries from Univ of Nebraska and both winter and spring mapping populations from the Univ of ID.
      2. Parents were chosen for crossing.
      3. Samples were sent to Tom Baldwin for analyses.

   b) **What were the significant results?**
      1. Excellent data were collected and analyzed for all three winter nurseries from both years. Data for the spring population from ID were of sufficient quality from one year. It was noted that there was very little evidence of resistance in the NE materials. The ID winter population was especially useful for mapping FHB resistance.
      2. Crosses were made.
      3. Samples were sent to NDSU.

   c) **List key outcomes or other achievements.**
   Collaborators were able to obtain useful data from our location.

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.

4. **How have the results been disseminated to communities of interest?**
   All data were collected, analyzed and sent to our collaborators in ID and NE.

Project 3: Genomic Selection for FHB Resistance and Malting Quality in Spring Malting Barley

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1. **What are the major goals and objectives of the research project?**
    1. Evaluate FHB resistance and malt quality of lines in a training population selected to represent the Aberdeen, ID spring malting barley breeding program.
    2. Develop and apply a genomic selection prediction model for FHB resistance in the Aberdeen spring malting barley germplasm, accounting for the need to maintain acceptable malt quality

3. **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. From a founder population of ~700 lines, 248 lines were selected as a training population (TP) representative of the Aberdeen spring barley breeding program and genotyped.
    2. Our collaborators at the Univ of ID have used our data as well as data from other locations for genomic prediction

    b) **What were the significant results?**
    High quality data were collected and analyzed for the ID spring barley training population from one of the two years. 2020 was lost to drought but it was grown again in 2021.

    c) **List key outcomes or other achievements.**
    Data was collected and sent to our collaborators for genomic prediction.

4. **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.

5. **How have the results been disseminated to communities of interest?**
Data was collected and sent to our collaborators for genomic prediction.

Project 4: Genetics and Breeding of FHB Resistant Soft White & Red Winter Wheat for the Northeastern 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 sharing of information from the above activities to generate a comprehensive source of information that can be used in forward breeding strategies.
5. Implement recurrent mass selection in dominant male sterile populations in soft winter wheat backgrounds adapted to the eastern US.

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 continued breeding and selection of elite winter wheat lines and varieties with native and/or exotic sources of resistance to FHB.
2. We created elite populations segregating for multiple FHB resistance loci that were used with marker assisted selection in variety development.
3. Our FHB trials generated information on which varieties have FHB resistance that was usd for making recommendations for farmers and other stakeholders
4. We distributed information to collaborators and stakeholders.
5. We evaluated our dominant male sterile selections for resistance to FHB.

b) What were the significant results?

1. We developed 393 early generation plots and half involved FHB parents in crosses. Our screening nursery had 213 plots and all were from FHB crosses. Our Preliminary Yield Trial had 296 entries with one or more FHB parents. Our state-wide trial had 12 soft red and 15 soft white winter entries with below average FHB index and low DON.
2. We evaluated 180 new FHB selected lines in our misted, inoculated FHB nursery.
3. We have evaluated 60 lines extracted from our Half-Sib. We have evaluated 60 lines extracted from our Half-Sib Recurrent Selection population for 3 years and will prepare a germplasm release next year.

c) List key outcomes or other achievements.

1. We grew purified Breeder seed of a new soft white winter wheat that has excellent resistance to FHB and has been approved for release.

2. Nearly all the lines from the recurrent selection project have better FHB resistance than the most resistant check.

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

All of my grad students receive training in plant breeding methods and evaluation of FHB in our misted, inoculated nursery. Also, our undergraduate summer field assistants receive training and background information on our winter wheat FHB nurseries. We trained another new field assistant this year.

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

Each year we publish the results of our state regional trials for both sft red and soft white winter wheat including FHB and milling and baking quality hard copy through mail or email and online.

Cornell Small Grains Performance Trials:
https://cpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/5/8858/files/2022/03/SG-Performance-Rpt-19Mar2022.pdf

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

Project 5: Coordinated Phenotypes of Soft Wheat Germplasm for the Midwest

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

Specific objectives are:

1) Phenotype advanced breeding lines that are candidates for release;
2) Place FHB and other agronomic, disease resistance, and quality data in database and
3) Report on purification and seed increase of the best lines.

6. 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. The coordinated testing of advanced lines in the various uniform and state-wide trials plus the data summaries for lines that are candidates for release was used to determine the FHB resistance of nearly all germplasm that is currently released, or likely to be released in the near future.
2. Data were uploaded to T3.
3. None to report for 2021.

b) What were the significant results?

1. Data on severity, incidence, Fusarium damaged kernels and DON.
2. Data and summaries were made available to collaborators, stakeholders and uploaded to the T3 database.
3. None in 2021.

c) List key outcomes or other achievements.

1. The results were used to select parents for crossing and for advancement in our trials.
2. Data were uploaded to T3
3. None for 2021.

d) What opportunities for training and professional development has the project provided?

All of my grad students receive training in plant breeding methods and evaluation of FHB in our misted, inoculated nursery. Also, our undergraduate summer field assistants receive training and background information on our winter wheat FHB nurseries. We trained another new field assistant this year.

e) 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.

Cornell Small Grains Performance Trials:

https://cpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/5/8858/files/2022/03/SG-Performance-Rpt-19Mar2022.pdf

We also present the results at three field 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 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).

Fulcher, M.R., J.B. Winans, D., Benscher, M.E. Sorrells and G.C. Bergstrom. 2021. Triticum varieties grown as 'ancient grains' in New York differ in susceptibility to Fusarium head blight and harbor diverse Fusarium flora. European Journal of Plant Pathology, 1–7. https://doi.org/10.1007/s10658-020-02183-7.

Status: Published

Acknowledgement of Federal Support: Yes

Hayes, P., D.R. Carrijo, T. Filichkin, S. Fisk, L. Helgerson, J. Hernandez, B. Meints, M.E. Sorrells. 2021. Registration of 'Lightning' barley. J. Plant Registrations. 3:407-414. DOI: 10.1002/plr2.20129.

Status: Published

Acknowledgement of Federal Support: Yes

Lugo-Torres, A., G.C. Bergstrom, D. Benscher, and M.E. Sorrells. 2021. Evaluation of Fusarium head blight and foliar diseases in spring malting barley varieties in New York, 2020. Plant Disease Management Reports 15: CF150.

Status: Published

Acknowledgement of Federal Support: Yes

Lugo-Torres, A., G.C. Bergstrom, D. Benscher, and M.E. Sorrells. 2021. Evaluation of Fusarium head blight and foliar diseases in winter malting barley varieties in New York, 2020. Plant Disease Management Reports 15: CF149.

Status: Published

Acknowledgement of Federal Support: Yes

Sweeney, D.W., T.E. Rooney, M.E. Sorrells. 2021. Gain from genomic selection for a selection index in two-row spring barley. The Plant Genome. DOI: 10.1002/tpg2.20138.

Status: Published

Acknowledgement 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).

Korzun, V., M. L. Ponomareva and M.E. Sorrells. 2021. Economic and academic importance of rye. In: The Rye Genome. N. Stein Ed., Springer
Status: Published
Acknowledgement of Federal Support: 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.

2021 Small Grains Performance Trials for New York.
Status: Published
Acknowledgement of Federal Support: Yes

Description and Proposal for Release of NY99056-161 Soft White Winter Wheat – Cornell Cooperative Extension Publication.
Status: Published
Acknowledgement of Federal Support: Yes