

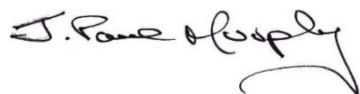
USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY20 Annual Performance Progress Report
Due date: August 31, 2021

Cover Page

Principle Investigator (PI):	J. Paul Murphy
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Fiscal Year:	2020
USDA-ARS Agreement ID:	59-0206-0-145
USDA-ARS Agreement Title:	Enhancement of Fusarium Head Blight Resistance in the Southeastern U.S. Germplasm
FY20 USDA-ARS Award Amount:	\$ 112,686
Recipient Organization:	North Carolina State University Office of Contracts & Grants Box 7214 Raleigh, NC 27695-7214
DUNS Number:	04-209-2122
EIN:	56-6000756
Recipient Identifying Number or Account Number:	567134
Project/Grant Reporting Period:	6/16/20 - 6/15/21
Reporting Period End Date:	6/15/2021

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-SWW	Enhancement of Fusarium Head Blight Resistance in the Southeastern U.S. Wheat Breeding Programs	\$ 112,686
FY20 Total ARS Award Amount		\$ 112,686



August 22, 2021

Principal Investigator

Date

* MGMT – FHB Management
FST – Food Safety & Toxicology
R- Research
S – Service (DON Testing Labs)
GDER – Gene Discovery & Engineering Resistance
PBG – Pathogen Biology & Genetics
EC-HQ – Executive Committee-Headquarters
BAR-CP – Barley Coordinated Project
DUR-CP – Durum Coordinated Project
HWW-CP – Hard Winter Wheat Coordinated Project
VDHR – Variety Development & Uniform Nurseries – Sub categories are below:
SPR – Spring Wheat Region
NWW – Northern Soft Winter Wheat Region
SWW – Southern Soft Red Winter Wheat Region

Project 1: *Enhancement of Fusarium Head Blight Resistance in the Southeastern U.S. Wheat Breeding Programs*

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

- 1) Increase the number of varieties with improved FHB resistance and high grain yield and grain quality tested in statewide variety trials.
- 2) Increase efficiency of the CPs' funded projects to develop and release FHB resistant varieties and germplasm.
- 3) Evaluate and implement new breeding technologies and develop germplasm to further enhance short term and long-term improvement of FHB resistance.

2. What was accomplished under these goals or objectives? *(For each major goal/objective, address these three items below.)*

Objective 1.

a) What were the major activities?

Six hundred sixty five F₂ and F₃ bulks (combined) were advanced during 2020-21 utilizing mass selection. Almost all crosses contained one or more parents exhibiting moderate FHB resistance. Approximately 26,000 headrows in the F₄, F₅ and F₆ generations (combined) underwent selection using the pedigree method. The misted/inoculated nursery evaluated five cooperative uniform nurseries (USFHBN, GAWN, SPE, SPL, SUNWHEAT) and in-house advanced lines and state Official Variety Test). Five hundred thirty six new two- and three-way crosses were made and over 95 percent of the crosses had parents with FHB resistance. Five hundred and eight doubled haploid lines underwent selection.

b) What were the significant results?

All but one of 40 NCSU entries in the SUNPRE Late Uniform Nursery had moderate resistance to FHB and 32 contained known major QTL for scab resistance, including, *Fhb1 (15)*, *Jamestown1B (22)*, *Neuse1A (18)*, *Neuse4A (18)*, plus Hessian fly, powdery mildew, leaf rust and soil borne virus resistances. All 43 Advanced generation lines in second and third years of testing across the state had FHB ratings of 4 or below and 34 had previously identified major *Fhb* resistance QTL. Eight of 10 NCSU entries in the NC Official Variety Test had moderate levels of scab resistance plus overall good agronomic performance.

c) List key outcomes or other achievements.

Breeders Seed of three competitive lines with moderate FHB resistance, NC12164-200T, NC16-19288 produced for possible release in 2022.

Objective 2.

a) What were the major activities?

Coordinated the Southern Uniform Scab Nursery. Participated in coordinated breeding activities with the seven-university SUNGRAINS cooperative breeding program. The Southern Uniform Winter Wheat Scab Nursery evaluated 42 advanced generation lines from five public and one private company breeding programs for resistance to FHB at up to eight locations. I called for entries and distributed seed to cooperators in September 2020. I collated and summarized data and published report on the USWBSI website. Examples of coordinated SUNGRAINS activities included growing early and later generation uniform nurseries, many of which I screened for FHB resistance in an inoculated and misted nursery. In cooperation with my Research Associate, Jeanette Lyerly and Dr. Gina Brown-Guedira USDA-ARS, we ran the Genomic Selection activities in the CP.

b) What were the significant results?

https://scabusa.org/pdfs_dbupload/suwwsn20_report.pdf. The results of the 2019-20 Southern Uniform Scab Nursery was collected, analyzed and published online at the web address above. A poster was presented at the December 2020 Scab Forum. The quantification of scab resistance of entries in the SUNGRAINS nurseries influenced the advancement decisions of seven university breeding programs. MAS for major FHB QTL and *H13* among $F_{5:7}$, $F_{5:8}$, $F_{5:9}$ and doubled haploid lines greatly enhanced selection efficiency. Genomic predictions for scab resistance in addition to yield, test weight, powdery mildew, leaf and stripe rust resistances were distributed to breeders for over 3,000 advanced lines in March 2021 prior to field selection.

c) List key outcomes or other achievements.

The Southern Uniform Scab Nursery provides public and private sector breeders with multi-environment evaluations of FHB resistance in advanced generation breeding lines compared with the resistant check varieties. Correlations between predicted and observed measures for scab resistance ranged as high as 0.67. Our five years of applied experience with genomic predictions for scab resistance and yield strongly suggest that the initial selection for both these key traits can be made based on genomic predictions rather than field evaluations without detrimental impact on a program.

Objective 3

a) What were the major activities?

Continued to examine ways to improve the genomic selection approach to trait improvement. Began validation of important QTL for scab resistance previously identified in NC13-20076. Working on forward prediction of scab QTL from sequence data alone.

b) What were the significant results?

Only utilization of SNPs at the 0.10 level of significance in a training population usually increased prediction accuracy over using the entire SNP set. Machine learning algorithms had accuracies of over ninety percent for four scab resistant QTL's, Four populations containing NC13-20076 as one parent were evaluated in three misted and inoculated nurseries.

c) List key outcomes or other achievements.

Pursuing a limited SNP set in a training population as a way to increase prediction accuracy is warranted. Significant variation in scab resistance was identified in the verification populations. Forward prediction of scab resistance QTL was successful using sequence data only.

3. Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns and/or restrictions, reduced or lack of support personnel, etc.)? If yes, please explain how this research was impacted or is continuing to be impacted.

No

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

Primary opportunities for training involved five undergraduate students who worked in scab nurseries and on post-harvest processing of materials harvested from the scab nurseries. They worked with the project leader and PhD graduate student on these activities.

Paul Murphy and Zachary Winn (PhD Student) attended the virtual Scab Forum in December 2020. Zachary Winn organized and conducted the NC Uniform Scab Nursery.

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

Results have been disseminated through poster presentations at scientific meetings, and presentations to growers and industry representatives in winter 2020 / spring 2021. In addition the Southern Scab Nursery report can be found at this website:
https://scabusa.org/pdfs_dbupload/suwwsn18_report.pdf.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY20 award period (6/16/20 - 6/15/21). The term “support” below includes any level of benefit to the student, ranging from full stipend plus tuition to the situation where the student’s stipend was paid from other funds, but who learned how to rate scab in a misted nursery paid for by the USWBSI, and anything in between.

1. Did any graduate students in your research program supported by funding from your USWBSI grant earn their MS degree during the FY19 award period?

Yes No Not Applicable

If yes, how many? [Click to enter number here.](#)

2. Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY19 award period?

Yes No Not Applicable

If yes, how many? [Click to enter number here.](#)

3. Have any post docs who worked for you during the FY19 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?

Yes No Not Applicable

If yes, how many? [Click to enter number here.](#)

4. Have any post docs who worked for you during the FY19 award period and were supported by funding from your USWBSI grant gone on to take positions with private ag-related companies or federal agencies?

Yes No Not Applicable

If yes, how many? [Click to enter number here.](#)

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Release of Germplasm/Cultivars

Instructions: In the table below, list all germplasm and/or cultivars released with full or partial support through the USWBSI during the FY20 award period (6/16/20 - 6/15/21). All columns must be completed for each listed germplasm/cultivar. Use the key below the table for Grain Class abbreviations.

NOTE: Leave blank if you have nothing to report or if your grant did NOT include any VDHR-related projects.

Name of Germplasm/Cultivar	Grain Class	FHB Resistance	FHB Rating (0-9)	Year Released
Nothing to report.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year

NOTE: List the associated release notice or publication under the appropriate sub-section in the 'Publications' section of the FPR.

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Publications, Conference Papers, and Presentations

Instructions: Refer to the PR_Instructions for detailed more instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY20 grant award. Only citations for publications published (submitted or accepted) or presentations presented during the **award period (6/16/20 - 6/15/21)** should be included. If you did not publish/submit or present anything, state 'Nothing to Report' directly above the Journal publications section.

NOTE: Directly below each citation, you **must** indicate the Status (i.e. published, submitted, etc.) and whether acknowledgement of Federal support was indicated in the publication/presentation. See example below for a poster presentation with an abstract:

Winn, Z.J., Acharya, R., Lyerly, J., Brown-Guedira, G., Cowger, C., Griffey, C., Fitzgerald, J., Mason R.E., and Murphy, J.P. (2020, Dec 7-11). Mapping of Fusarium Head Blight Resistance in NC13-20076 Soft Red Winter Wheat (p. 12). In: Canty, S., Hoffstetter, A. and Dill-Macky, R. (Eds.), *Proceedings of the 2020 National Fusarium Head Blight Forum*. https://scabusa.org/pdfs/NFHBF20_Proceedings.pdf.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: YES (Abstract and Poster)

Journal publications.

Carpenter, N. R., E. Wright, S. Malla, L. Singh, D. Van Sanford, A. Clark, S. Harrison, J. P. Murphy, J. Costa, S. Chao, G.L. Brown-Guedira, N. McMaster, D.G. Schmale III, C. A. Griffey and N. Rawat. 2020. Identification and validation of Fusarium head blight resistance QTL in the U.S. soft red winter wheat cultivar 'Jamestown'. *Crop Sci.* 60: 2919-2930. DOI: 10.1002/csc2.20307.

Status: Published

Acknowledgement of Federal Support: YES

Books or other non-periodical, one-time publications.

Nothing to report.

Other publications, conference papers and presentations.

Murphy, J. P., J. H. Lyerly, Z. Winn and G. Brown-Guedira. (2020, Dec. 7-11). The 2000 Uniform Southern Soft Red Winter Wheat Scab Nursery (p. 108). In: Canty, S., A. Hoffstetter and R. Dill-Macky (Eds), *Proceedings of the 2020 National Fusarium Head Blight Forum*, https://scabusa.org/pdfs/NFHBF20_Proceedings.pdf.

Status: Abstract Published and Poster Presented.

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