USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY19 Final Performance Progress Report
Due date: August 31, 2021

Cover Page

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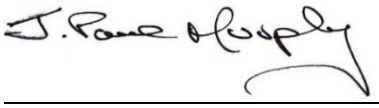
Fiscal Year:	2019
USDA-ARS Agreement ID:	59-0206-8-209
USDA-ARS Agreement Title:	Enhancement of Fusarium Head Blight Resistance in the Southeastern U.S. Germplasm
FY19 USDA-ARS Award Amount:	$ 111,777
Recipient Organization:	North Carolina State University Office of Contracts & Grants Box 7214 Raleigh, NC 27695-7214
DUNS Number:	04-209-2122
EIN:	56-6000756
Recipient Identifying Number or Account Number:	583042-06050
Project/Grant Reporting Period:	6/16/19 - 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. Germplasm	$ 111,777
	FY19 Total ARS Award Amount	**$ 111,777**



August 27th, 2021

Principal Investigator Date

* MGMT – FHB Management
FST – Food Safety & Toxicology
R – Research
S – Service (DON Testing Lab)
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. Germplasm*

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?

Objective 1.

a) What were the major activities?

Almost 1,300 F_2 and F_3 bulks (combined) advanced utilizing mass selection. Almost all crosses contained one or more parents exhibiting moderate FHB resistance. Approximately 50,000 headrows in the F_4, F_5 and F_6 generations (combined) underwent selection using the pedigree method. Approximately 600 doubled haploid lines produced in-house and approximately 1,500 doubled haploid lines produced under contract for UGA, Virginia Tech, LSU, and UAR. The misted/inoculated nursery evaluated five cooperative uniform nurseries annually (USFHBN, GAWN, SPE, SPL, SUNWHEAT) and in-house advanced lines and state Official Variety Test. Nine hundred fifty three new two- and three-way crosses 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?

Eight of the highest yielding lines in the NC Official Variety Test 2020 were NC State bred with moderate scab resistance and overall good agronomic performance. Eight of 10 NCSU entries in the NC Official Variety Test 2021 had moderate levels of scab resistance plus overall good agronomic performance. 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.

c) List key outcomes or other achievements.

Breeders Seed of three lines with moderate FHB resistance, NC15-21835, NC11546-14, NC11363-25, produced for possible release in 2021. 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 annual Southern Uniform Scab Nursery for five public and one private breeding programs. I collated and summarized data and published a report on the USWBSI website. Participated in coordinated breeding activities with the seven-university SUNGRAINS cooperative breeding program. We ran the Genomic Selection activities in the CP. Participated in coordinated breeding activities with the six university SUNGRAINS cooperative breeding programs.

b) **What were the significant results?**

Two annual Uniform Nursery reports published online at https://scabusa.org/publications#pubs_uniform-reports. Posters presented at the annual Scab Forums. The quantification of scab resistance of entries in the SUNGRAINS nurseries influenced the advancement decisions of seven university breeding programs. Genomic predictions for scab resistance in addition to yield, test weight, powdery mildew, leaf and stripe rust resistances were distributed to breeders for over 4,500 advanced lines in March of each year prior to field selection.

c) **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. Investigated the genetic control of FHB resistance in NC13-20076, and began validation of important QTL for scab resistance identified in NC13-20076. Working on forward prediction of scab QTL from sequence data alone.

b) What were the significant results?

Genomic predictions correlated with observed data to investigate the utility of the methodology in wheat breeding in the southeast. PopVar identified optimum crosses to make. We identified major QTL associated with FDK and DON in NC13-20076 with LOD scores up to 10. 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 to validate the utility of QTL previously identified.

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. Forward prediction of scab resistance QTL was successful using sequence data only. The highest correlations between observed and GS predicted performance was for FHB resistance traits (r= 0.77 (DON), 0.67 (FDK) and 0.71 (Severity).

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 Impact in 2020-21. In 2019-20 our doubled haploid production was down 50 percent because we were unable to hire undergraduates to assist in greenhouse and lab activities. Other research aspects completed as planned.

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

Four undergraduate students worked part-time on the laboratory, greenhouse and field aspects of the DH effort. In addition, ten undergraduate students 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. Zachary Winn (PhD Student) attended the Scab Forum in December 2019 and the virtual Forum in 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 annually. In addition the Southern Scab Nursery reports for both years can be found at can be found at this website: https://scabusa.org/publications#pubs_uniform-reports

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the **FY19 award period (6/16/19 - 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.

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 **FY19 award period (6/16/19 - 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
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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.

Publications, Conference Papers, and Presentations

Instructions: Refer to the FPR_Instructions for detailed more instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY19 grant award. Only citations for publications published (submitted or accepted) or presentations presented during the **award period (6/16/19 - 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.

Nothing to report.

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

Nothing to report.

Other publications, conference papers and presentations.

Fitzgerald, J., C. Griffey, W. Brooks, N. Meier, D. Van Sanford, J.P. Murphy, N. McMaster and D. Schmale III. 2019. Evaluation of Winter Barley Cultivar Nomini for Resistance to Fusarium Head Blight. Proceedings of the 2019 National Fusarium Head Blight Forum. In: Canty, S., A. Hoffstetter, B. Wiermer and R. Dill-Macky (Eds.), Proceedings of the 2019 National Fusarium Head Blight Forum (p. 90). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: Yes (poster), Yes (Abstract)

Mergoum, M., J. Johnson, J. Buck, Z. Chen, S. A. Harrison, R. E. Mason, J. P. Murphy, G. L. Brown-Guedira, A. M.H. Ibrahim, R. L. Sutton, B. E. Simoneaux and Md A. Babar. 2019. GA09129-16E55 (AGS 3015), A New Soft Red Winter Wheat Cultivar Adapted to the US

Southeast with Improved FHB Resistance. Proceedings of the 2019 National Fusarium Head Blight Forum. In: Canty, S., A. Hoffstetter, B. Wiermer and R. Dill-Macky (Eds.), Proceedings of the 2019 National Fusarium Head Blight Forum (p. 101). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: Yes (poster), Yes (Abstract)

Z.J. Winn, Z. L., R. Acharya, J. Lyerly, G. Brown-Guedira, C. Cowger, C. Griffey, J. Fitzgerald and J.P. Murphy. 2019. Preliminary Mapping of Fusarium Head Blight Resistance in NC13-20076 Soft Red Winter Wheat. Proceedings of the 2019 National Fusarium Head Blight Forum. In: Canty, S., A. Hoffstetter, B. Wiermer and R. Dill-Macky (Eds.), Proceedings of the 2019 National Fusarium Head Blight Forum (p. 125). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: Yes (poster), Yes (Abstract)

Murphy, J. P., J.H. Lyerly, R. Acharya, B. Ward and G. Brown-Guedira. 2019. The 2019 Uniform Southern Soft Red Winter Wheat Scab Nursery The 2019 Uniform Southern Soft Red Winter Wheat Scab Nursery. Proceedings of the 2019 National Fusarium Head Blight Forum. In: Canty, S., A. Hoffstetter, B. Wiermer and R. Dill-Macky (Eds.), Proceedings of the 2019 National Fusarium Head Blight Forum (p. 104). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: Yes (poster), Yes (Abstract)

Mason, R. E., G. Brown-Guedira, J. Lyerly, D. Van Sanford, J. P. Murphy, B. Ward, J. Johnson, M. Mergoum, S. Harrison, A. Babar, A. Ibrahim and R. Sutton. 2019. Partnering to predict: centralized genomic selection in southeastern wheat breeding programs. In: Murphy, J. P. (Ed.), Proceedings of the Eastern Wheat Workers / Southern Small Grain Workers Conference. Department of Crop and Soil Sciences, North Carolina State University, Raleigh, NC 27695.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: Yes (poster), Yes (Abstract)

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. In: Canty, S., A. Hoffstetter and R. Dill-Macky (Eds*), Proceedings of the 2020 National Fusarium Head Blight Forum (p108*.), https://scabusa.org/pdfs/NFHBF20_Proceedings.pdf.
Status: Abstract Published and Poster Presented.
Acknowledgement of Federal Support: Yes

Winn, Z. J., R. Acharya, J. Lyerly, G. Brown-Guedira, C. Griffey, J. Fitzgerald, R. E. Mason and J. P. Murphy. (2020, Dec. 7-11). Mapping of Fusarium head blight resistance in NC13-20076 soft red winter wheat. In: Canty, S., A. Hoffstetter and R. Dill-Macky (Eds*), Proceedings of the 2020 National Fusarium Head Blight Forum (p111)*. https://scabusa.org/pdfs/NFHBF20_Proceedings.pdf.

Status: Abstract Published and Poster Presented.

Acknowledgement of Federal Support: Yes