USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY18 Performance Report
Due date: July 12, 2019

Cover Page

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Fiscal Year:	2018
USDA-ARS Agreement ID:	59-0206-8-209
USDA-ARS Agreement Title:	Enhancement of Fusarium Head Blight Resistance in the Southeastern U.S. Germplasm.
FY18 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:	6/16/18 - 6/15/19
Reporting Period End Date:	06/15/19

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
	FY18 Total ARS Award Amount	$ 111,777

(signature)

July 7 2019

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Principal Investigator   Date

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

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

   The objectives of this research are:

   1) Increased acreage planted to varieties with improved FHB resistance and low DON,

   2) Increased efficiency of Coordinated Project breeding programs to develop FHB resistant varieties, and

   3) Implement new breeding technologies and 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?**

   <u>Objective 1.</u>

   1) <u>Major activities</u>: Five hundred ninety three F_2 and F_3 bulks (combined) were advanced during 2018-19 utilizing mass selection. Almost all crosses contained one or more parents exhibiting moderate FHB resistance. Approximately 30,000 headrows in the F_4, F_5 and F_6 generations (combined) were selected using the pedigree method. The misted/inoculated nursery evaluated five cooperative uniform nurseries (USFHBN, GAWN, SPE, SPL, SUNWHEAT) and in-house advanced lines. Four hundred twenty three new two- and three-way crosses were made and over 95 percent of the crosses had parents with FHB resistance. Eight new crosses entered the doubled haploid program. Approximately 1,200 doubled haploid lines were produced in-house and will enter field evaluation in fall 2019. Approximately 2,400 doubled haploid lines were produced under contract for the University of Georgia, Virginia Tech, Louisiana State University, and University of Arkansas.

   2) <u>Specific objectives:</u> evaluated 679 advanced generation, in-house lines, at up to seven locations for overall agronomic superiority, and specifically, FHB resistance. FHB resistance, or lack thereof, trumps all other traits when a line is being considered for advancement in our breeding program.

   3) <u>Significant results:</u> All 40 NCSU entries in the SUNPRE Late Uniform Nursery had moderate resistance to FHB and 37 contained known major QTL for scab resistance, including, *Fhb1, Jamestown1B*, *Neuse1A*, *Neuse4A*, *Massey3B* plus Hessian fly, powdery mildew, leaf rust and soil borne virus resistances. The nineteen Advanced generation lines in second year of testing across the state had FHB ratings of 4 or below. Six NCSU entries

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in the NC Official Variety Test have moderate levels of scab resistance plus overall good agronomic performance.

4) Key outcomes or other achievements; Breeders Seed of three competitive lines with moderate FHB resistance, NC14-20985, NC15-21834 and NC15-21970 produced for possible release in 2020.

Objective 2.

1) Major Activities: Coordinated the Southern Uniform Scab Nursery. Participated in coordinated breeding activities with the six university SUNGRAINS cooperative breeding program.

2) Specific Objectives: The Southern Uniform Scab Nursery evaluated 44 advanced generation lines from five public and two private company breeding programs for resistance to FHB at up to seven locations. I called for entries and distributed seed to cooperators in September 2018. 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.

3) Significant results: https://scabusa.org/pdfs_dbupload/suwwsn18_report.pdf . The results of the 2017-18 Southern Uniform Scab Nursery was collected, analyzed and published online at the web address above. A poster and hard copy reports were presented at the December 2018 Scab Forum. The quantification of scab resistance of entries in the SUNGRAINS nurseries impacted the advancement decisions of six 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.

4) 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.

Objective 3

1) Major activities. Utilized marker assisted selection, genomic selection and doubled haploid technology to increase breeding efficiency in NC and other SUNGRAINS programs. Investigated the genetic control of FHB resistance in NC13-20076. This moderately resistant line contains no known resistance QTL.

2) Specific objectives. In-house evaluation of 489 conventional and doubled haploid lines for major QTL such as *Fhb1*, *Ning 5A*, *Wuhan 2D* and recently identified *Bess 2B*, *Bess 3B*, *NC-Neuse 1A* and *6A*, and *Jamestown 1B* QTL. Initiated another cycle of double haploid development involving 16 SUNGRAINS crosses. We coordinated the sequencing pipeline, data curation, updating of training populations, prediction estimation

for numerous traits including FDK and DON and investigated various techniques to improve prediction accuracies for 3,165 SUNGRAINS early generation lines. Evaluated 200 random DH lines from the cross NC13-20076 x GA06493-13LE6 at three misted and inoculated locations.

3) Significant results. Presence of major QTL was utilized in selection among 489 lines in first year yield testing. Genomic selection predictions correlated with observed data to investigate the utility of the methodology in wheat breeding in the southeast. PopVar identified optimum crosses to make and checked against what breeders themselves choose.

4) Key outcomes or other achievements. The highest correlations between observed and GS predicted performance was for FHB resistance traits (r= 0.50 (DON), 0.56 (FDK) and 0.59 (Severity). GS could be incorporated in breeding programs for FHB resistance selection. Another set of DH populations are four years ahead along the variety development conveyor belt. Three locations of good data obtained on NC13-20076 mapping population.

Pedigrees of 10 DH populations produced during 2018-19

Parent 1	Parent 2	Parent 1	Parent 2
ARLA06146E-1-4	NC13-20076	NC13-20076	NC13-21213
ARLA06146E-1-4	NC15-21787	NC13-21213	NC14-23372
GA061471-15LE38	NC13-20076	NC14-23372	NC15-21834
Hilliard	NC11331-6	NC14-23372	VA09MAS1-12-8-4
Hilliard	NC15-21787	NC15-21787	VA09MAS1-12-8-4

Pedigrees of nine DH populations to be produced during 2019-20

Parent 1	Parent 2	Parent 1	Parent 2
ARLA06146E-1-4	NC11546-14	NC11546-14	NC113210-58
ARLA06146E-1-4	VATK429-3	NC11546-14	VA16W-202
GA15-MAS23-18LE43	VATK429-3	NC13217-35	NC13210-58
Hilliard	NC13210-58	NC14-20373	NC11546-14
Hilliard	NC11564-14		

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

Primary opportunities for training involved four undergraduate students who worked part-time on the laboratory, greenhouse and field aspects of the DH effort. In addition, five undergraduate students worked in scab nurseries and on post-harvest processing of materials harvested from the scab nurseries.

Paul Murphy and Roshan Acharya (PhD Student) attended the Scab Forum in St Louis in December 2018. Roshan Acharya organized and conducted the NC Uniform Scab Nursery.

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

Results have been disseminated through poster presentations at scientific meetings, scientific journal publications, and presentations to growers and industry representatives in winter 2018 / spring 2019. 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 FY18 award period. 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 FY18 award period?**

    No

    If yes, how many?

2. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY18 award period?**

    No.

    If yes, how many?

3. **Have any post docs who worked for you during the FY18 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?**

    No.

    If yes, how many?

4. **Have any post docs who worked for you during the FY18 award period and were supported by funding from your USWBSI grant gone on to take positions with private ag-related companies or federal agencies?**

    No.

    If yes, how many?

(Form – PR18)

Release of Germplasm/Cultivars

Instructions: In the table below, list all germplasm and/or cultivars released with <u>full or partial</u> support through the USWBSI during the <u>FY18 award period</u>. 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 (S, MS, MR, R, where R represents your most resistant check)	FHB Rating (0-9)	Year Released

Add rows if needed.

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

Abbreviations for Grain Classes
　Barley - BAR
　Durum - DUR
　Hard Red Winter - HRW
　Hard White Winter - HWW
　Hard Red Spring - HRS
　Soft Red Winter - SRW
　Soft White Winter - SWW

Publications, Conference Papers, and Presentations

Instructions: Refer to the FY18-FPR_Instructions for detailed instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY18 grant. Only include citations for publications submitted or presentations given during your award period (6/16/18 - 6/15/19). If you did not have any publications or presentations, state 'Nothing to Report' directly above the Journal publications section.

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

> Conley, E.J., and J.A. Anderson. 2018. Accuracy of Genome-Wide Prediction for Fusarium Head Blight Associated Traits in a Spring Wheat Breeding Program. In: Proceedings of the XXIV International Plant & Animal Genome Conference, San Diego, CA.
> Status: Abstract Published and Poster Presented
> Acknowledgement of Federal Support: YES (poster), NO (abstract)

Journal publications.

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

Other publications, conference papers and presentations.

Ward, B. P., G. Brown-Guedira and J. P. Murphy. 2018. Genotyping-by-sequencing markers for detecting alleles of the Fhb1 quantitative trait locus in soft winter wheat. In: S. Canty, A. Hoffstetter, B. Weirmer and R. Dill-Macky (Eds.), Proceedings of the 2018 National Fusarium Head Blight Forum (p 141). East Lansing, MI/Lexington, KY: U.S.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (poster), NO (abstract)

Murphy, J. P., J. H. Lyerly, R. K. Acharya, B. Ward, and G. Brown-Guedira. 2018. The 2018 Uniform Southern Soft Red Winter Wheat Scab Nursery. In: S. Canty, A. Hoffstetter, B. Weirmer and R. Dill-Macky (Eds.), Proceedings of the 2018 National Fusarium Head Blight Forum (p 126-128). East Lansing, MI/Lexington, KY: U.S.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (poster), NO (abstract)

Acharya, R. K., J. M. Sarinelli, J. H. Lyerly, P Tyagi, G. Brown-Guedira and J.P. Murphy. 2018. Influence of Environmental Selection on Prediction Accuracy of Training Population in the Uniform Southern Soft Red Winter Wheat Scab Nursery. In: S. Canty, A. Hoffstetter, B. Weirmer and R. Dill-Macky (Eds.), Proceedings of the 2018 National Fusarium Head Blight Forum (p 97-98). East Lansing, MI/Lexington, KY: U.S.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (poster), NO (abstract)