

**USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY16 Final Performance Report
Due date: July 28, 2017**

Cover Page

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Fiscal Year:	2016
USDA-ARS Agreement ID:	59-0206-4-031
USDA-ARS Agreement Title:	Development of Wheat with Resistance to Scab Adapted to the Mid-Atlantic.
FY16 USDA-ARS Award Amount:	\$ 72,453
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:	558515
Project/Grant Reporting Period:	6/16/16 - 6/15/17
Reporting Period End Date:	06/15/17

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.	\$ 63,003
VDHR-SWW	Developing Double Haploids to Expedite Variety Development in SRWW.	\$ 9,450
	FY16 Total ARS Award Amount	\$ 72,453



Principal Investigator

7/13/2017

Date

* MGMT – FHB Management
 FST – Food Safety & Toxicology
 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

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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?

1) Increase and document acreage seeded to varieties with improved FHB resistance to increase grain yield and grain quality and reduce DON in the US grain supply. 2) Increase efficiency of coordinated project breeding programs to develop and release FHB resistant varieties. 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? *Address items 1-4) below for each goal or objective.*

Objective 1. Major Activities: Approximately 500 F₂ and F₃ bulks (combined) were advanced during 2016-17 utilizing mass selection. Most crosses contained one or more parents exhibiting moderate FHB resistance. Approximately 30,000 headrows in the F₄, F₅ and F₆ generations (combined) were selected using the pedigree method. The misted/inoculated nursery evaluated major cooperative uniform nurseries and in-house advanced lines. Five hundred ten new two- and three-way crosses were made and over 95 percent of the crosses had parents with FHB resistance. Twelve new crosses entered the doubled haploid program. Approximately 1,500 doubled haploid lines were produced in-house and will enter field evaluation in fall 2017.

Specific Objectives: evaluated 725 advanced generation lines at multiple locations for overall agronomic superiority, and specifically, FHB resistance.

Significant Results: Thirty of the 38 NCSU entries in the SUNPRE Late uniform nursery contain *Fhb1* plus Hessian fly, powdery mildew and leaf rust resistances. Forty-six percent of entries in our Wheat Prelim Test are doubled haploids containing *Fhb1* or other scab resistant QTL's and are Hessian fly, powdery mildew, and leaf rust resistant. All seven NCSU entries in the NC Official Variety Test have moderate levels of scab resistance plus overall good agronomic performance.

Key Outcomes or other achievements: Several lines with good overall agronomic performance and FHB resistance will be entered in NC, VA, AR and GA Official State Variety Trials in fall 2018.

Objective 2. Major Objectives: Coordinated the Southern Uniform Scab Nursery. Utilized marker assisted selection and doubled haploid technology to increase breeding efficiency.

Specific Objectives: Evaluated 42 advanced generation lines from six public and two private company breeding programs for resistance to FHB at 12 locations. Collated and summarized data and published online. In-house evaluation of approximately 1,200 conventional and doubled haploid lines for major QTL such as *Fhb1*, *Ning 5A*, *Wuhan 2D* and recently

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identified *Bess 2B*, *NC-Neuse 1A* and *6A*, and *Jamestown 1B* and *6A* QTL. Initiated another cycle of double haploid development involving 12 crosses.

Significant results: https://scabusa.org/pdfs_dbupload/suwwsn16_report.pdf. The results of the 2015-16 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 2016 Scab Forum. 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. The 12 F_1 crosses made in January 2017 are being pollinated by corn pollen to initiate the doubled haploid process. The doubled haploid seed from the 17 crosses initiated in summer 2016 is being harvested from plants in the greenhouse at this time.

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. Major Activities: Evaluate the use of genomic selection to improve FHB resistance in southeastern wheat breeding programs.

Specific Objectives: Used a training population based on the past five years of entries in the Southern Uniform Scab Nursery to predict scab resistance in entries in the 2016-17 Southern Uniform Scab Nursery.

Significant results: An FHB model has been developed based on a combination of nursery phenotypic data and genotyping by sequencing. This model was used to predict the resistance in lines entered in the 2016-17 Southern Uniform Scab Nursery. The correlations between the predicted and phenotypic field evaluations will be presented in the December 2017 Scab Forum. A similar training population was used to predict scab resistance of entries in the various SunGrains uniform nurseries grown in 2016-17.

Key outcomes or other achievements: The correlations between predicted and phenotypic means over locations in the 2015-16 Uniform Scab Nursery varied between 0.30 for FDK to 0.65 for DON.

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

Paul Murphy attended the Scab Forum in St. Louis in December 2016. Roshan Acharya and Steve Mulkey (PhD students) worked together organizing and conducting the Uniform Scab Nursery. Mulkey attended the Eastern Wheat Workers Meeting at Purdue, May 2017.

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 five field day presentations to growers and industry representatives in spring 2017. In addition the Southern Scab Nursery report can be found at this website:

https://scabusa.org/pdfs_dbupload/suwwsn16_report.pdf

Project 2: *Developing Double Haploids to Expedite Variety Development in SRWW.*

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

Increase efficiency of individual breeding programs to develop and release FHB resistant varieties through the use of doubled haploid technology. Use of doubled haploid technology for winter wheat reduces the time to develop a variety by approximately four years.

2. What was accomplished under these goals? *Address items 1-4) below for each goal or objective.*

Major activities Selection in one DH cross, increase of seed in a second DH cross, and developing new DH lines in a third cross.

Specific Objectives: Cross 1) Approximately 200 double haploid lines from the cross of MDC07027-12-24 / Hilliard were evaluated for agronomic traits in Warsaw VA in 2015-16. Selected lines were evaluated for agronomic and disease resistance traits in VA and NC in 2016-17. Cross 2) Sixty six DH lines from MD08-26-H2-7-12-9 / VA11W-278 // VA11W-108 underwent increase in GA during 2015-16 and were evaluated in NC during 2016-17. Eleven were harvested based on visual selection and two were subsequently dropped based on Test Weight. Nine will enter Wheat Observation yield test in 2017-18. Cross 3) F₁ seed of NC11331-6 / VA11W-279 is undergoing DH production. NC11331-6 is a DH line with *Fhb1*, *H13* and *Bdv2*. VA11W-279, a high yielding line, containing the *3BL Massey QTL* and *H13*

Significant Results:

**Percentage of North Carolina Lines that are
 Double Haploids at four stages of Advanced
 Generation Yield Testing**

Three Years pre-OVT	63%
Two Years pre-OVT	53%
One Year pre-OVT	23%
OVT	25%

We have been producing in-house DH as well as contracting Heartland-produced DH for over five years. The table above shows the impact of DH on the cultivar pipeline in the three
 (Form – FPR16)

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generations leading to Official Variety Test evaluations. DH lines are over represented relative to their frequency in all crosses made.

4) Key outcomes or other achievements: Sixty three percent of lines entering our Observation Yield Nursery (first yield trial) are DH lines, many previously genotyped for major QTL.

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

Primary opportunities for training involve three to four undergraduate students who work part-time on the lab, greenhouse and field aspects of the DH effort.

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

Results have been disseminated to NC growers at field days where we discuss experimental cultivars.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY16 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 FY16 award period?**

Yes

If yes, how many? One

- 2. Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY16 award period?**

No.

If yes, how many?

- 3. Have any post docs who worked for you during the FY16 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 FY16 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?

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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 FY16 award period. All columns must be completed for each listed germplasm/cultivar. Use the key below the table for Grain Class abbreviations. *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

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Publications, Conference Papers, and Presentations

Instructions: Refer to the FY16-FPR_Instructions for detailed instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY16 grant. Only include citations for publications submitted or presentations given during your award period (6/16/16 - 6/15/17). If you did not have any publications or presentations, state ‘Nothing to Report’ directly above the Journal publications section.

Journal publications.

Petersen, S., J. H. Lyerly, P. V. Maloney, G. Brown-Guedira, C. Cowger, J. M. Costa, Y. Dong, and J. P. Murphy. 2016. Mapping of Head Blight Resistance Quantitative Trait Loci in Winter Wheat Cultivar NC-Neuse. *Crop Sci.* 56:1473-1483.

Status: Published.

Acknowledgement of Federal Support: YES

Cowger, C., R. Weisz, C. Arellano, and J. P. Murphy. 2016. Profitability of Integrated Management of Fusarium Head Blight in North Carolina Winter Wheat. *Phytopathology.* 106: 814-823.

Status: Published.

Acknowledgement of Federal Support: YES

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

Nothing to report

Other publications, conference papers and presentations.

Brown-Guedira, G., J. M. Sarinelli, P. Tyagi, J. H. Lyerly, R. Acharya, and J. P. Murphy. 2016. “Genomic selection for FHB resistance using the Uniform Scab Screening Nurseries.” In S. Canty, K. Wolfe and D. Van Sanford (eds), *Proceedings of the 2016 National Fusarium Head Blight Forum.* East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative. p. 75.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: YES (poster), NO (abstract)

Murphy, J. P., Lyerly, J. H., Sarinelli, J. M., Tyagi, P., Brown-Guedira, G. 2016. “The 2016 Uniform Southern Soft Red Winter Wheat Scab Nursery.” In: S. Canty, A. Clark, K. Wolfe and D. Van Sanford (Eds.), *Proceedings of the 2016 National Fusarium Head Blight Forum,* East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative. pp. 83-85.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: YES (poster), NO (abstract)

Ullrich, J., Malla, S., Griffey, C., Carpenter, N., Brooks, W., Van Sanford, D., Clark, A., Murphy, J. P., Brueggeman, R., Cowger, C., McMaster, N., Schmale III, D., Chao, S., Brown-Guedira, G. 2016. “Evaluation of Winter Barley Cultivar Eve for Quantitative Resistance to

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Fusarium Head Blight.” In: S. Canty, A. Clark, K. Wolfe and D. Van Sanford (Eds.), *Proceedings of the 2016 National Fusarium Head Blight Forum*, East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative. p. 101.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: YES (poster), Yes (abstract)

Published Report

Murphy, J. P. Lyerly, J. H., Sarinelli, J. M., Brown-Guedira, G., Tyagi, P. 2016. The 2016 Unifrom Soft Red Winter Wheat Scab Nursery Report. Posted online at

https://scabusa.org/pdfs_dbupload/suwwsn16_report.pdf.

Status: Published

Acknowledgement of Federal Support: Not in report, but in Abstract and Poster.