USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY15 Final Performance Report
Due date: July 15, 2016

Cover Page

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Fiscal Year:	2015
USDA-ARS Agreement ID:	59-0206-4-031
USDA-ARS Agreement Title:	Development of Wheat with Resistance to Scab Adapted to the Mid-Atlantic.
FY15 USDA-ARS Award Amount:	$ 65,225
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:	06/16/15-06/15/16
Reporting Period End Date:	06/15/16

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.	$ 60,161
VDHR-SWW	Developing Doubled Haploids to Expedite Variety Development in SRWW.	$ 5,064
	FY15 Total ARS Award Amount	**$ 65,225**

Principal Investigator 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

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 project 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) Develop new breeding technologies 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?

Objective 1.

1) Major Activities: Approximately 600 F_2 and F_3 bulks (combined) were advanced during 2015-16 utilizing mass selection. Most of these crosses contained one or more parents exhibiting partial FHB resistance. Approximately 30,000 headrows in the F_4, F_5 and F_6 generations (combined) were advanced using the pedigree method. The misted/inoculated nursery evaluated 3200 headrows. As a member of SUNGRAINS (Southeastern University Grains), I partnered closely in a collaborative cultivar development program by public small grain programs in NC, GA, FL, LA, AR and TX. During the 2015-16 crossing season, 610 new two- and three-way crosses were made and over 95 percent of the crosses had one or more parents with FHB resistance. Nineteen new crosses entered the doubled haploid program, all with FHB resistant parents. Approximately 3,000 doubled haploid lines were produced in-house during 2015-16 and will enter field evaluation in fall 2016.

2) Specific Objectives: evaluated 142 advanced generation lines at multiple locations for overall agronomic superiority, and specifically, FHB resistance. These are the closest to release of materials in the program.

3) Significant Results: Four of 75 lines in the Wheat Advanced Test with good FHB resistance had yields of 20 percent or greater than the check cultivar Shirley. Eleven of 95 lines with known QTL for FHB resistance in the Wheat Preliminary Test outperformed the check cultivar Shirley for important agronomic traits. A late spring freeze did not permit evaluation for FHB in inoculated misted nursery as planned.

4) Key Outcomes or other achievements: Several lines with good overall agronomic traits and FHB resistance will be entered in NC, VA and GA Official State Variety Trials in fall 2016.

Objective 2.

1) Major Objectives: Coordinate the Southern Uniform Scab Nursery, Utilize marker assisted selection and doubled haploid technology to increase breeding efficiency.

2) Specific Objectives: Evaluate 50 advanced generation lines from six public and two private company breeding programs for resistance to FHB at 14 locations. Collate and summarize data and publish online. In-house evaluation of approximately 1,500 conventional and doubled haploid lines for major QTL such as Fhb1, Ning 5A, Wuhan 2D and recently identified Bess 2B, NC-Neuse 1A and 6A, and Jamestown 1B and 6A. Initiate another cycle of double haploid development involving 19 crosses.

3) Significant results: http://scabusa.org/pdfs_dbupload/suwwsn15_report.pdf . The results of the 2014-15 Southern Uniform Scab Nursery was collected, analyzed and published online at the web address above. In addition a poster was presented on the results at the December 2015 Scab Forum. A hard copy report was distributed at that venue also. MAS for major FHB QTL and *H13* among $F_{5:7}$, $F_{5:8}$ and $F_{5:9}$ and doubled haploid lines greatly enhanced selection efficiency. The lines advanced based on MAS and field based agronomic evaluations, will display better FHB and Hessian fly resistances as a result of this approach. The 19 F_1 crosses made in January 2016 are just starting to be pollinated by corn pollen to initiate the doubled haploid process. The doubled haploid seed from the 22 crosses initiated in summer 2015 is being harvested from plants in the greenhouse at this time. Selected populations of DH lines will undergo MAS for major QTL's prior to fall planting.

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 Ernie, Bess and Jamestown.

Objective 3.

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

2) Specific Objectives: Use a training population based on the past four years of entries in the Southern Uniform Scab Nursery to estimate Genotype Estimated Breeding Values for entries in the 2015-16 Southern Uniform Scab Nursery.

3) Significant results: An FHB model has been developed based on a combination of nursery phenotypic data and genotyping by sequencing. This model has been used to predict the resistance in lines entered in the 2015-16 Southern Uniform Scab Nursery. The correlations between the predicted and actual resistances from field evaluations will be presented in the December 2016 Scab Forum.

4) Key outcomes or other achievements: Too early to say, but it is hoped that the results will illustrate to researchers the utility of this approach for FHB improvement in the region. This is the first time breeders will be able to judge the effectiveness of Genomic Selection to enhance breeding for FHB resistance in southeastern US germplasm.

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

Matt Granberry and Steve Mulkey both attended the American Society of Agronomy Meetings in Minnesota in November 2015. Paul Murphy attended the Scab Forum in St. Louis in December 2015.

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 2016. In addition the Southern Scab Nursery report can be found at this website: http://scabusa.org/pdfs_dbupload/suwwsn15_report.pdf

Project 2: *Developing Doubled 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?

1) Major Activities: Selection in one cross and increase of seed in a second cross.

2) Specific Objectives: 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 will be evaluated for agronomic and disease resistance traits in VA and NC in 2016-17. Approximately 200 DH lines from MD08-26-H2-7-12-9 / VA11W-278 // VA11W-108 underwent increase in GA during 2015-16 and will be evaluated in VA and NC during 2016-17.

3) Significant Results: A small percentage of lines in MDC07027-12-24 / Hilliard are suitable for wide scale evaluations over locations. Seed increase of DH lines of MD08-26-H2-7-12-9 / VA11W-278 // VA11W-108 was successful and is being readied for distribution.

4) Key outcomes or other achievements: Nothing to report.

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

Nothing to Report

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

This is a work in progress, so nothing to report.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY15 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 FY15 award period?**

   If yes, how many? None

2. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY15 award period?**

   If yes, how many? One, Stine Petersen

3. **Have any post docs who worked for you during the FY15 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?**

   If yes, how many? None

4. **Have any post docs who worked for you during the FY15 award period and were supported by funding from your USWBSI grant gone on to take positions with private ag-related companies or federal agencies?**

   If yes, how many? None

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 FY15 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

Publications, Conference Papers, and Presentations

Refer to the FY15-FPR_Instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY15 grant. If you did not have any publications or presentations, state 'Nothing to Report' directly above the Journal publications section.

Journal publications.

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

Other publications, conference papers and presentations.

Merrill, K., G. Brown-Guedira, N. Subramanian, E. Mason, P. Bulli, M. Pumphrey, J. Kolmer, M. Guedira, D. Marshall, S. Chao and J. P. Murphy. 2015. Population structure and association analysis in Eastern Soft Winter Wheat. In: C. A. Griffey, J. E. Seago, and N. R. Carpenter (Eds.), Proceedings of the 2015 Eastern Wheat and Southern Small Grain Workers Conference (p 18). Crop and Soil Environmental Sciences Department, Virginia Tech, Blacksburg VA.
Status: Abstract Published and poster presented
Acknowledgement of Federal Support: YES

Petersen, S., J. H. Lyerly, G. Brown-Guedira, C. Cowger, Y. Dong, and J. Paul Murphy. 2015. Native FHB resiatance QTL in recent Uniform Southern Winter Wheat Scab Nurseries. Poster 14. In: C. A. Griffey, J. E. Seago, and N. R. Carpenter (Eds.), Proceedings of the 2015 Eastern Wheat and Southern Small Grain Workers Conference (p 38). Crop and Soil Environmental Sciences Department, Virginia Tech, Blacksburg VA.
Status: Abstract Published and poster presented
Acknowledgement of Federal Support: YES

Wright, E., C. Griffey, S. Malla, D. Van Sanford, S. Harrison, J. P. Murphy, J. Costa, E. Milus, J. Johnson, A. McKendry, D. Schmale III, A. Clark, N. McMaster, S. Chao, G. Brown-Guedira, H. Wanjugi, and M. Grosz. 2015. Identification of QTL for FHB resistance in SRW what 'Jamestown'. Poster 19. In: C. A. Griffey, J. E. Seago, and N. R. Carpenter (Eds.), Proceedings of the 2015 Eastern Wheat and Southern Small Grain Workers Conference (p 43). Crop and Soil Environmental Sciences Department, Virginia Tech, Blacksburg VA.
Status: Abstract Published and poster presented
Acknowledgement of Federal Support: YES

Malla, S., C. Griffey, J.P. Murphy, E. Milus, A. Clark, D. Van Sanford, J. Costa, N. McMaster, D. Schmale III, S. Chao and G. Brown-Guedira. 2015. Characterization of FHB resistance QTL in SRW wheat cultivar Tribute. In: S. Canty, A. Clark, S. Vukasovich and D. Van Sanford (Eds.), Proceedings of the 2015 National Fusarium Head Blight Forum (p. 94). East Lansing, MI/Lexington, KY: U.S.
Status: Abstract Published.
Acknowledgement of Federal Support: YES

Murphy, J. P., S. Petersen, J.H. Lyerly and B. Poole. 2015. The 2014-15 Southern Uniform Soft Red Winter Wheat scab nursery. In: S. Canty, A. Clark, S. Vukasovich and D. Van Sanford (Eds.), Proceedings of the 2015 National Fusarium Head Blight Forum (pp. 96-98). East Lansing, MI/Lexington, KY: U.S.
Status: Abstract Published and poster presented
Acknowledgement of Federal Support: YES

Ullrich, J., S. Malla, C. Griffey, W. Brooks, D. Van Sanford, A. Clark, P. Murphy, R. Brueggeman, C. Cowger, N. McMaster, D. Schmale III, S. Chao, and G. Brown-Guedira. 2015. Identification of quantitative trait loci for resistance to Fusarium head blight in winter barley cultivar Eve. In: S. Canty, A. Clark, S. Vukasovich and D. Van Sanford (Eds.), Proceedings of the 2015 National Fusarium Head Blight Forum (p. 113). East Lansing, MI/Lexington, KY: U.S.
Status: Abstract Published and poster presented
Acknowledgement of Federal Support: YES

Reports: (1)

Murphy, J. P, S. Petersen, J. H. Lyerly and B. Poole. 2015. The 2014-2015 Southern Uniform Winter Wheat Scab Nursery. Also available at http://scabusa.org//
Status: Abstract Published and poster presented
Acknowledgement of Federal Support: YES