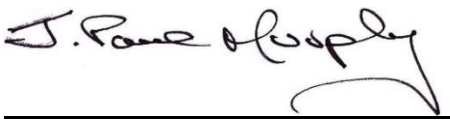
USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY19 Performance Report
Due date: July 24, 2020

Cover Page

Principle Investigator (PI):	Paul Murphy
Institution:	North Carolina State University
E-mail:	Paul_Murphy@ncsu.edu
Phone:	919-610-0100
Fiscal Year:	2019
USDA-ARS Agreement ID:	59-0206-7-009
USDA-ARS Agreement Title:	Genotyping Breeding Lines for FHB Resistance
FY19 USDA-ARS Award Amount:	$ 84,278
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:	572204
Project/Grant Reporting Period:	6/1/19 - 5/31/20
Reporting Period End Date:	5/31/2020

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-NWW	Genotyping FHB Nurseries - Northern	$ 59,569
VDHR-SWW	Genotyping FHB Nurseries- Southern	$ 24,709
	FY19 Total ARS Award Amount	**$ 84,278**



July 24, 2020
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: *Genotyping FHB Nurseries - Northern*

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

The overall goal of the project is to utilize the capacity of the genotyping lab to work cooperatively with breeding programs to identify genomic regions involved in disease resistance and develop GS models.

The specific objectives of this proposal are (1) to characterize entries in the Northern (NUWWSN and PNUWWSN) scab screening nurseries with markers linked to FHB QTL; (2) to characterize entries with diagnostic markers for genes having major effects on plant growth and development, as well as genes conferring resistance to other pests and for quality traits; (3) to use next generation sequencing (NGS) analysis to genotype SRWW to identify QTL associated with FHB resistance and perform genomic selection (GS). This project will provide breeders with genotypic data for loci linked to FHB resistance as well as genomic estimated breeding values for selecting lines for advancement and identification of FHB resistant parents for crossing.

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

Objective 1 Characterize entries in the Northern (NUWWSN and PNUWWSN) scab screening nurseries with markers linked to FHB QTL.

a) What were the major activities?

Genomic DNA was isolated from entries in the 2020 NUWWSN and PNUWWSN, in addition to samples from Uniform Eastern Winter Wheat Regional Nursery, Mason-Dixon, Six State and Soft White Winter Wheat nurseries and advanced lines provided by public and private breeding programs.

Agriplex Genomics was provided sequences for design of an amplicon sequencing genotyping platform targeting FHB resistance QTL. Sequences included those for markers linked to FHB resistance QTL from Asian sources (Fhb1, QTL on chromosome 5A and 2D) as well as six QTL identified from soft red winter wheat sources Bess, NC-Neuse and Jamestown. DNA of all eastern regional nursery samples was provided to Agriplex for genotyping.

b) What were the significant results?

This research has been significantly delayed due to the COVID-19 pandemic (see below).

c) List key outcomes or other achievements.

This research has been significantly delayed due to the COVID-19 pandemic (see below).

Objective 2: Characterize entries with diagnostic markers for genes having major effects on plant growth and development, as well as genes conferring resistance to other pests and for quality traits

a) What were the major activities?

Genomic DNA of entries in the 2020 NUWWSN and PNUWWSN was sent to Agriplex Genomics. Agriplex was provided DNA sequences for design of an amplicon sequencing genotyping platform targeting markers linked to genes for plant growth and development, disease resistance genes, and quality traits.

b) What were the significant results?

This research has been significantly delayed due to the COVID-19 pandemic (see below).

c) List key outcomes or other achievements.

This research has been significantly delayed due to the COVID-19 pandemic (see below).

Objective 3: To use next generation sequencing (NGS) analysis to genotype SRWW to identify QTL associated with FHB resistance and perform genomic selection.

a) What were the major activities?

Sequence based genotyping was performed on entries in the 2014 through 2019 NUWWSN and PNUWWSN. Phenotypic data were obtained from the nursery coordinator. These data were combined with the genotypic and phenotypic data available from the Northern SRWW Coordinated Multi-PI Project (MPI4) to develop a large training set.

b) What were the significant results?

Genotyping of all entries in the 2014 to 2020 NUWWSN and PNUWWSN identified more than 15,000 polymorphic SNP markers. Genomic estimated breeding values were calculated for entries in the 2020 NUWWSN and PNUWWSN, using the remaining years and the MPI4 data as the training population. These data were provided to breeders and the nursery coordinator.

c) List key outcomes or other achievements.

Overall, our results suggest that GS for FHB resistance can be utilized to streamline variety selection and evaluation. This work is continuing to expand as the models developed can be used to predict FHB resistance in earlier generation breeding lines provided by breeders.

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

Genotyping of nursery entries via amplicon sequencing in Objectives 1 and 2 has been significantly delayed due to shutdown of the Agriplex lab. Shutdown of North Carolina State University and USDA-ARS labs has prevented us from collecting these data using KASP assays.

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

Project has provided training opportunities for a graduate student and post-doctoral scientist.

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

Genomic estimated breeding values (GEBVs) FHB traits have been provided to the nursery coordinator for inclusion in the NUWWSN and PNUWWSN reports. GEBVs were also sent directly to the breeders during the growing season (April, 2020).

Project 2: *Genotyping FHB Nurseries- Southern*

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

The overall goal of the project is to utilize the capacity of the genotyping lab to work cooperatively with breeding programs to identify genomic regions involved in disease resistance and develop GS models.

The specific objectives of this proposal are (1) to characterize entries in the Southern (SUWWSN) scab screening nursery with markers linked to FHB QTL; (2) to characterize entries with diagnostic markers for genes having major effects on plant growth and development, as well as genes conferring resistance to other pests and for quality traits; (3) to use next generation sequencing (NGS) analysis to genotype SRWW to identify QTL associated with FHB resistance and perform genomic selection (GS). This project will provide breeders with genotypic data for loci linked to FHB resistance as well as genomic estimated breeding values for selecting lines for advancement and identification of FHB resistant parents for crossing.

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

Objective 1. Characterize entries in the Southern scab screening nurseries with markers linked to FHB QTL.

a) What were the major activities?

Genomic DNA was isolated from entries in the 2020 SUWWSN, in addition to samples from Uniform Southern Winter Wheat Regional Nursery, Gulf Atlantic Wheat Nursery, and Uniform Bread Wheat Trial, as well as advanced lines provided by public and private breeding programs.

Agriplex Genomics was provided sequences for design of an amplicon sequencing genotyping platform targeting FHB resistance genes. Sequences included those for markers linked to FHB resistance QTL from Asian sources (Fhb1, QTL on chromosome 5A and 2D) as well as six QTL identified from soft red winter wheat sources Bess, NC-Neuse and Jamestown. DNA of all eastern regional nursery samples was provided to Agriplex for genotyping.

b) What were the significant results?

This research has been significantly delayed due to the COVID-19 pandemic (see below).

c) List key outcomes or other achievements.

This research has been significantly delayed due to the COVID-19 pandemic (see below).

Objective 2. Characterize entries with diagnostic markers for genes having major effects on plant growth and development, as well as genes conferring resistance to other pests and for quality traits

a) What were the major activities?

Genomic DNA of entries in the 2020 SUWWSN, Uniform Southern Winter Wheat Regional Nursery, Gulf Atlantic Wheat Nursery, and Uniform Bread Wheat Trial was sent to Agriplex Genomics. Agriplex was provided DNA sequences for design of an amplicon sequencing genotyping platform targeting sequences for markers linked to genes for plant growth and development, disease resistance genes, and quality traits.

b) What were the significant results?

This research has been significantly delayed due to the COVID-19 pandemic (see below).

c) List key outcomes or other achievements.

This research has been significantly delayed due to the COVID-19 pandemic (see below).

Objective 3. To use next generation sequencing (NGS) analysis to genotype SRWW to identify QTL associated with FHB resistance and perform genomic selection.

a) What were the major activities?

Sequence based genotyping was performed on entries in the 2020 Uniform Southern Soft Red Winter Wheat Scab Nursery.

b) What were the significant results?

All entries in the 2011 to 2020 SUWWSN have been genotyped and more 15,000 polymorphic markers identified. These data are provided to Jeanette Lyerly, who coordinates the southeastern genomic selection in wheat project. Genomic estimated breeding values were calculated for entries in the 2020 SUWWSN using the previous nursery years as the training population. These data were provided to breeders and the nursery coordinator.

c) List key outcomes or other achievements.

Overall, our results suggest that GS for FHB resistance can be utilized to streamline variety selection and evaluation. This work is continuing to expand as the models

developed can be used to predict FHB resistance in earlier generation breeding lines provided by breeders. During 2020, models were used to predict FHB traits for approximately 4,000 breeding lines provided by programs at North Carolina State University, University of Arkansas, Clemson University, Louisiana State University, University of Georgia, University of Kentucky and Texas A&M University.

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

Genotyping of nursery entries via amplicon sequencing in Objectives 1 and 2 has been significantly delayed due to shutdown of the Agriplex lab. Shutdown of North Carolina State University and USDA-ARS labs has prevented us from collecting these data using KASP assays.

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

Project has provided training opportunities for a graduate student and post-doctoral scientist.

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

Genomic estimated breeding values (GEBVs) FHB traits have been provided to the nursery coordinator for inclusion in the NUWWSN and PNUWWSN reports. GEBVs were also sent directly to the breeders by Jeanette Lyerly during the growing season (March, 2020).

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY19 award period (6/1/19 - 5/31/20). 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?**
   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 FY19 award period?**
   No

   If yes, how many?

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?**
   No

   If yes, how many?

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?**
   No

   If yes, how many?

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. 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 FY19-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 (6/1/19 - 5/31/20**) 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:

De Wolf, E., D. Shah, P. Paul, L. Madden, S. Crawford, D. Hane, S. Canty, R. Dill-Macky, D. Van Sanford, K. Imhoff and D. Miller. 2019. "Impact of Prediction Tools for Fusarium Head Blight in the US, 2009-2019." In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (p. 12), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (Abstract and Poster)

Journal publications.

Larkin, D. L., Holder, A. L., Mason, R. E., Moon, D.E., Brown-Guedira, G., Price, P., Harrison, S. A., Dong, Y. 2020. Genome Wide Analysis and Prediction of Fusarium Head Blight Resistance in Soft Red Winter Wheat. **https://doi.org/10.1002/csc2.20273**
Status: Accepted and published online first
Acknowledgement of Federal Support: YES

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

Other publications, conference papers and presentations.

Gaire, R., Brown-Guedira, G., Ohm, H. and Mohammadi, M. 2019. Genome-wide association studies of Fusarium head blight disease resistance in soft red winter wheat population. In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (p. 91), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (Abstract and Poster)

Larkin, D.L., Mason, R.E., Holder, A.L., Moon, D.E., Brown-Guedira, G., Harrison, S.A. 2019. Genome-wide analyses and predication of Fusarium head blight resistance in soft red winter wheat. In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (p.100), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (Abstract and Poster)

Mergoum, M., Johnson, J., Buck, J., Chen, Z., Harrison, S.A., Mason, R.E., Murphy, J.P., Brown-Guedira, G., Ibrahim, A.M.H., Sutton, R.L., Simoneaux, B.E., Babar, M.A. 2019. GA09129-16E55 (AGS 3015), A new soft red winter wheat cultivar adapated to the U.S. Southeast with improved FHB resistances. In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (p. 101), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (Abstract and Poster)

Murphy, J.P., Lyerly, J.H., Acharya, R., Ward, B., Brown-Guedira, G. 2019. 2 The 2019 Uniform Southern Soft Red Winter Wheat Scab Nursery. In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (p. 104), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (Abstract and Poster)

Ward, B.P., Brown-Guedira, G., Cowger, C., Marshall, D., Dong, Y. Machine learning models for predicting deoxynivalenol concentration from grain imaging data. In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (p. 124), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (Abstract and Poster)

Winn, Z.J., Acharya, R., Lyerly, J., Brown-Guedira, G., Cowger, C., Griffey, C., Fitzgerald, J., Murphy, J.P. 2019. Preliminary mapping of Fusarium head blight resistance in NC13-20076 soft red winter wheat. 2019. In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (p. 125), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (Abstract and Poster)