

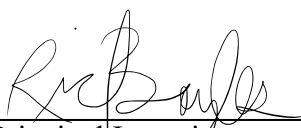
USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY18 Performance Report
Due date: September 23, 2019

Cover Page

Cooperating Principle Investigator (CPI):	Richard Boyles
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Phone:	843-661-0488
Fiscal Year:	2018
USDA-ARS Agreement ID:	58-6070-8-014
USDA-ARS Agreement Title:	Evaluation of Advanced and Diverse Wheat Germplasm for FHB Resistance in the Atlantic Coastal Plain.
FY18 USDA-ARS Award Amount:	\$ 16,697
Recipient Organization:	Clemson University Grants and Contracts Administration 230 Kappa Street, Suite 200 Clemson, SC 29634-5355
DUNS Number:	04-262-9816
EIN:	57-6000254
Recipient Identifying Number or Account Number:	20-207-xxxx-0185-207-2022776
Agency PI:	Gina Brown-Guedira
Project/Grant Reporting Period:	8/1/18 - 7/31/19
Reporting Period End Date:	07/31/19

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-SWW	Identifying Sources of FHB Resistance in Diverse Wheat Germplasm for the Southeast.	\$ 16,697
FY18 Total ARS Award Amount		\$ 16,697



 Principal Investigator

09/23/2019

 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: *Identifying Sources of FHB Resistance in Diverse Wheat Germplasm for the Southeast.*

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

The *goal of this project* was to evaluate wheat sources of Fusarium head blight (FHB; i.e., scab) resistance to identify new FHB resistant varieties adapted to South Carolina and other states in the southeastern US. To meet this goal, two objectives were proposed:

- 1) conduct a coordinated field trial in Florence, SC to screen elite varieties, advanced breeding lines, and diverse germplasm for FHB resistance, and
- 2) implement greenhouse crossing to intercross lines that exhibit FHB resistance.

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

OBJECTIVE 1: Conduct a coordinated field trial in Florence, SC to screen elite varieties, advanced breeding lines, and diverse germplasm for FHB resistance.

1) major activities

- Travelled to the NCSU wheat nursery located in Kinston, NC to meet with Paul Murphy and understand the requirements and logistics of a successful scab nursery
- Planted and harvested 1,000 individual headrows of entries from the following elite SRW wheat nurseries: Uniform Southern Scab Nursery, Uniform Southern SRW Wheat Nursery, Gulf Atlantic Wheat Nursery, and SunWheat Nursery
- Planted and harvested replicated yield plots of the USSRWWN, GAWN, and SunWheat
- Planted 336 wheat doubled haploids (sourced from Esten Mason at Univ of Arkansas)
- Planted 1,900 F₅ and 1,000 F₄ breeding lines surrounding the misted scab nursery
- Acquired and assembled irrigation equipment, including a sand media filter, to initiate a misted irrigation system
- Acquired locally-sourced FHB inoculum (sourced from Christina Cowger at ARS-Raleigh) and spread throughout the scab nursery using the maize kernel method
- Collected FHB index ratings at two different timepoints during grain fill
- Threshed harvested headrows and subsequently measured FDK for individual samples using the visual 0-100 nominal rating
- Measured agronomic traits for entries including grain yield, test weight, days to heading, and plant height

2) specific objectives

- Develop a scalable mist-irrigated scab nursery in South Carolina to screen elite lines from regional breeding programs and advanced breeding lines in the Clemson Small Grains Breeding program
- Determine the level of FHB resistance in advanced breeding lines

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- Evaluate the productivity and agronomic potential of entries in coordinated nurseries

3) significant results

- Moderate to severe scab pressure was observed throughout the nursery to demonstrate its initial success for evaluation of FHB resistance (Table 1; Figure 1)
- A wide range of phenotypic variation was observed for FHB index and FDK (Table 1), and susceptible checks (SS8641, Coker 9835) possessed significantly higher ratings than the resistant checks (Bess, Ernie) (Table 2)
- Four entries (13VTK434-89, ARFHBDH_72, NC12642-97T, VA17W-75) outperformed Bess and Ernie (5%) in respect to FDK. Meanwhile, 25 lines demonstrated a level of resistance equal to that of Bess and Ernie
- Of the 336 AR doubled haploid lines that were evaluated in the scab nursery, 49 demonstrated at least moderate FHB resistance and were advanced for preliminary yield testing and further resistance screening

4) key outcomes or other achievements

- This project provided information on scab resistance/susceptibility of cultivars and elite lines (near release) in a new production environment: South Carolina. SC farmers now have more reliable data on FHB to determine which varieties should be grown on their farm, which helps increase acreage sown with FHB resistant varieties
- Samples have yet to be sent for DON testing because they are being used for a FY19 USWBSI project that is working to identify a high-throughput phenotyping method for measuring FDK. These methods are currently being tested, and was complete, grain samples will immediately be shipped to the VT DON Testing Lab
- The only task not completed during project year 1 was the screening of the statewide variety trial entries (*i.e.* SC Small Grain Official Variety Trial). While the entries were prepared for planting, unusually wet conditions (Figure 2) during the fall inhibited sowing of this trial. Thus, data were collected for the statewide test to incorporate FHB data in the annual small grains factsheet. We will attempt to collect these data in the 2019-2020 field season

OBJECTIVE 2: Implement greenhouse crossing to intercross lines that exhibit FHB resistance.

1) major activities

- Selected wheat lines based on FHB, leaf rust, powdery mildew, and height QTLs
- Vernalized and transplanted imbibed wheat seed of parents for crossing
- Managed wheat parent plants in the greenhouse and organized their positioning to enable efficient crossing among lines
- Emasculated and crossed greenhouse parent lines with various known FHB QTL
- Sent F₁ seed of selected crosses to Aberdeen, ID for summer 2019 increase to generate enough F₂ seed for F₂ bulk segregating plots for 2019-2020 selection in SC

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2) specific objectives

- Intercross wheat lines with superior FHB resistance to develop segregating populations for evaluation and selection in the Clemson Small Grains Breeding program
- Maintain F₁ seed of select crosses for doubled haploid production and distribution to collaborators
- Generate F₂ seed for planting in the SC 2019-2020 winter small grains nursery

3) significant results

- A total of 538 unique F₁ crosses were made, of which 326 (61%) contained at least one known FHB QTL
- Of the 538 crosses, 205 were successfully increased in the F₁ summer growout nursery in Aberdeen, ID
- Of the 538 crosses, 110 F₁s had one or both parents with Fhb1

4) key outcomes or other achievements

- As a result of funding from the USWBSI, this was the first time the reestablished Clemson small grains breeding program made a concerted effort toward incorporating increased FHB resistance in the crossing design.

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

The PI was able to attend the National FHB Forum in December 2018 for the first time to gain experience in variety development for improved scab resistance as well as develop a stronger collaborative network to coordinate large-scale genetics and breeding projects targeted toward increasing FHB resistance in SRW wheat. Additionally, this project has given the opportunity for the PI to work more targeted on scab resistance by developing the knowledge and acquiring the equipment required to perform a robust field screening nursery.

The PI had the opportunity to train a research technician in the small grains breeding program on how to effectively coordinate a scab nursery and evaluate headrows for FHB-related traits. This included methods to develop inoculum, rate FHB in the field, and screen for FDK post-harvest. Also, a graduate student (funded outside of the USWBSI) working on a pathology project in sorghum was involved in this process to gain knowledge of how to screen for disease resistance in a wheat breeding program.

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

A list of moderately resistant FHB varieties currently available for SC growers were published on the ScabSmart website (https://scabsmart.org/South_Carolina_SWW).

All FHB data (FHB index and FDK) generated in the SC scab nursery have been shared via email with the VDHR-SWW breeders. When DON results are received, these will be shared among the small grains community as well to further inform breeding decisions. This

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dataset will be provided to Paul Murphy, USSN coordinator, for publication of the final annual USSN report.

Seed of the F₁ crosses and F₂ segregating populations will be maintained by the Clemson Small Grains Breeding Program and seed (as available) will be disseminated upon request. A list of the crosses made in the 2019 greenhouse nursery has been circulated throughout the VDHR-SWW programs so pedigrees can be observed to make decisions on which crosses will be useful.

Table 1. Summary statistics for the 2018-2019 SC scab nursery.

	Unit	Mean	Max	Min
Days to heading	Julian days	111	122	99
FHB index 1 (04/30/19)	0-9 scale	2.17	7	0
FHB index 2 (05/09/19)	0-9 scale	5.39	9	0
FDK rating	0-100 scale	20.7	95	0

Table 2. The top 5 lines in the USSN for FHB resistance along with comparative checks.

Entry	Line	Heading Date	FHB Index 1	FHB Index 2	FDK Rating
1	Ernie (res)	107	1	3	5
2	Coker 9835 (susc)	107	6	8	50
3	Bess (res)	109.7	0.5	3.5	7.5
4	Jamestown (res)	103.5	2	3.5	5
5	SS 8641 (susc)	109.3	6.5	7.5	71.3
43	13VTK434-89	120	0	1	0
10	NC11331-38	120	0	2	5
17	AR11289-8-1	111.5	0	3	5
21	ARFHBDH2_72	108	0	1	5
31	KWS219	117.5	0	1.5	5



Fig 1. Scab nursery field design in Florence, South Carolina (29 March 2019).



Fig 2. Waterlogged field conditions (20 December 2018).

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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?

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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 FY18 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

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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 (8/1/18 - 7/31/19). 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.

Boyles R.E., Marshall D., Bockelman H.E. Yield data from the Uniform Southern Soft Red Winter Wheat Nursery emphasize importance of selection location and environment for cultivar development. Crop Sci. 59:1887-1898. doi:10.2135/cropsci2018.11.0685.

Status: Published

Acknowledgment of Federal Support: No

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

N/A

Other publications, conference papers and presentations.

Invited talk: Ackerman A., **Boyles R.E.** The Reestablished Small Grains Breeding Program. South Carolina Annual Seedsmen Meeting, Hilton Head, SC. July 2019

Status: Published

Acknowledgment of Federal Support: Yes

Online publication: **Boyles R.E.**, Gunter D. South Carolina Soft Winter Wheat — 2018 MR Soft Red Winter Wheat Varieties. 21 February 2019. https://scabsmart.org/South_Carolina_SWW

Status: Published

Acknowledgment of Federal Support: Yes