

**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:	59-0206-4-007
USDA-ARS Agreement Title:	Breeding and Genetics of FHB Resistant Soft Winter Wheat for the Northeastern U.S.
FY15 USDA-ARS Award Amount:	\$ 92,159
Recipient Organization:	Cornell University 341 Pine Tree Road Ithaca NY 14850
DUNS Number:	872612445
EIN:	15-0532082
Recipient Identifying Number or Account Number:	1498454 (OSP# 73066)
Project/Grant Reporting Period:	05/03/15-05/02/16
Reporting Period End Date:	05/02/16

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-NWW	Genetics & Breeding of FHB Resistant Soft White & Red Winter Wheat for Northeast.	\$ 46,951
VDHR-NWW	Male Sterile Facilitated Recurrent Selection for FHB Resistance (MPI-5).	\$ 680
VDHR-NWW	Coordinated Phenotyping of Uniform Nurseries and Official Variety Trials.	\$ 2,916
VDHR-NWW	Implementing Genomic Selection for FHB Resistance in Soft Winter Wheat (SWW) Adapted to the Corn Belt.	\$ 41,612
	FY15 Total ARS Award Amount	\$ 92,159



July 8, 2016

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: *Genetics & Breeding of FHB Resistant Soft White & Red Winter Wheat for Northeast.*

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

FHB resistant wheat cultivars are essential for wheat produced in the northeastern U.S. FHB is the single greatest threat to successful production of soft white winter wheat in New York. We successfully commercialized Jensen and Medina soft white winter wheat varieties. Because most of the DON is in the bran, FHB resistance in white wheat is more important than for red because white wheat bran is widely marketed to the food industry for use as an additive in high bran food products. We are also developing FHB resistant soft red winter wheat varieties for this region.

Our objectives are to:

1. Develop FHB resistant soft wheat cultivars for the northeastern U.S. in collaboration with Gary Bergstrom, Department of Plant Pathology. Evaluate our elite lines in the Cornell University FHB Advanced Line nursery.
2. Pyramid FHB resistance genes by hybridizing elite lines with native FHB resistance to new sources of FHB resistance, both Asian and other sources.
3. Evaluate FHB resistant lines in New York regional trials for release, farmer recommendations, and seed increase.
4. Participate in the coordinated sharing of information from the above activities to generate a comprehensive source of information that can be used in forward breeding strategies.

2. What was accomplished under these goals?

- 1) major activities:
- 2) Breeding – 40 New FHB crosses/backcrosses made with FHB resistant alien introgression lines, 28 new crosses made with 2B and 5A sources, 50 new general FHB crosses made from FHB nursery selections; 730 populations were screened for FHB resistance alleles at the 3B and 5A loci; 77 screening nursery plots were grown from the previous year selections. In our advanced trials, we have 2 new soft red FHB lines and 10 new soft white FHB lines selected by MAS. In our Master nursery, we have 125 FHB selected entries.
- 3) specific objectives – see above under question 1.
- 4) significant results – Our breeding program is the only public wheat breeding program in the northeastern U.S. that is releasing soft white and red winter wheat varieties that have been selected for FHB resistance.
- 5) key outcomes or other achievements - Over the past 8 years we have released of 6 new soft winter wheat varieties with FHB and preharvest sprouting resistance. Two of the varieties have *fhb1* from marker assisted backcrossing and four have native resistance. Except for branded varieties, all varieties marketed in NY have at least some moderate resistance to FHB.

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

We have trained 8 graduate students, 4 post docs and 5 undergraduates how to plan, set up, maintain, and score a misted, inoculated FHB nursery. They receive training on the significance of the disease, sources of inoculum, biology of fusarium, and implications of developing resistant varieties. The graduate students and post docs are also taught how to analyze the data and prepare summaries.

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

I presented results of FHB evaluation at three field days and at county agent training schools. I distribute the results of our FHB evaluations both electronically by email and on our web site (<http://small.grains.cals.cornell.edu>) and by hard copy to other wheat breeders and to stakeholders in New York and surrounding states.

Project 2: *Male Sterile Facilitated Recurrent Selection for FHB Resistance (MPI-5).*

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

The objective of this project is to advance male-sterile facilitated recurrent selection populations that have been developed to combine genes for FHB resistance from multiple sources in soft winter wheat backgrounds adapted to the eastern U.S. The goal is for this project to further develop several pools of adapted breeding lines with genes for FHB resistance derived from multiple sources.

2. What was accomplished under these goals?

- 1) major activities – Originally, the dominant male sterile population was allowed to intermate with entries in the NWWSN for two generations. The population was then intermated for a generation followed by half sib selection. Since then, the dominant male sterile population was planted as replicated half sib families in the misted, inoculated FHB nursery. Male sterile plants were tagged at anthesis and three weeks later each half sib family was scored for FHB incidence and severity. The most resistant 25% of the families were selected and within each family, male sterile plants that showed the fewest symptoms were selected and harvested. Those selected plants became the half sibs for the next generation. A bulk harvest of the selected half sibs were planted adjacent to the half sib families to serve as a pollen source for the male steriles. In addition, male fertile plants from the selected families were planted in a replicated trial to determine if there has been an increase in FHB resistance resulting from selection over the past 5 generations.
- 2) specific objectives – see above
- 3) significant results – We are currently analyzing the data from the fertile plants to determine if there has been genetic progress for FHB resistance. Casual observations indicate that this population has a high level of FHB resistance. A comprehensive analysis will be presented this winter at the Scab Forum.
- 4) key outcomes or other achievements – This population appears to have a high level of FHB resistance and is well adapted to northeastern growing conditions. These populations will be beneficial to regional and local breeding programs because they are an adapted source of FHB resistance in a soft winter genetic background. This project will provide breeding programs in the eastern region with germplasm from which to extract breeding lines that have the potential to have unique combinations of FHB resistance genes.

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

Eight graduate students and four post docs were instructed on how to conduct modified half – sib selection. They also received education on the biology of male sterility and FHB.

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

We have reported the results of this project to other members of the Northern Winter Wheat FHB community.

Project 3: *Coordinated Phenotyping of Uniform Nurseries and Official Variety Trials.*

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

Fusarium head blight resistance must be combined with high yield to impact the Eastern U.S. wheat industry. Our breeding program generates breeding lines each year for advanced stages of development and testing. Multi-location testing is needed to determine the FHB resistance of these lines, as well as their yield, quality, agronomic value, and resistance to other diseases. Objectives: 1) Phenotype advanced breeding lines that are candidates for release: 2) place FHB and other agronomic, disease resistance, and quality data in database: 3) report on purification and seed increase of the best lines.

2. What was accomplished under these goals?

- 1) major activities – Each year we have collected incidence, severity, FDK, and DON data on the NUWWSN by evaluating it in a misted inoculated FHB nursery. We normally enter four experimental lines each year and enter the results of the NUWWSN in a coordinated database.
- 2) specific objectives – see above
- 3) significant results – Advanced lines that perform well in this nursery are entered into our state regional trials to determine if they are suitable for variety release.
- 4) key outcomes or other achievements - The data have been used in our regional trial summaries that are distributed to extension personnel, farmers, and seed companies and published on the Internet. We also contribute to the T3 public database.

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

We have trained 8 graduate students, 4 post docs and 5 undergraduates how to plan, set up, maintain, and score a misted, inoculated FHB nursery and this is one of the nurseries they score. They were also educated on the significance of the disease, natural sources of inoculum, biology of fusarium, and implications of developing resistant varieties.

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

For this nursery we have reported the results of this project to other members of the Northern Winter Wheat FHB community and uploaded the data into the FHB database.

Project 4: *Implementing Genomic Selection for FHB Resistance in Soft Winter Wheat (SWW)
Adapted to the Corn Belt.*

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

Genomic selection uses a training population of lines that is phenotyped and genotyped. A prediction model is built using the phenotypic and genotypic data from the training population. That model can then be used to predict the value of other genotyped individuals that are related to the training population even without phenotyping those individuals.

Objectives:

- 1) To implement GS for FHB resistance in soft winter wheat by completing two cycles of GS.
- 2) Initiate evaluation of the effectiveness of GS for FHB resistance in soft winter wheat lines.

2. What was accomplished under these goals?

- 1) major activities - We planted the best lines from the training population and have made crosses among them in 2014. The F2 seed was planted in October 2014 and vernalized. They were genotyped using genotyping by sequencing and prediction models were used to select the genotypes with the highest breeding values. We selected plants and made 41 crosses to generate the population for the third cycle. All 285 plants were selfed to produce F2:3 for comparison with selected genotypes. This was repeated for another cycle and are being evaluated in the 2015-16 FHB nursery.
- 2) specific objectives – see above
- 3) significant results – The results of the second cycle of selection are currently being analyzed and will be reported this winter and in a publication.
- 4) key outcomes or other achievements - Over the past three years we have phenotyped a training population of 649 lines. This includes 600 RILs (100 from each of six breeding programs, each phenotyped at the breeder's location) and 49 checks that were phenotyped by all six breeders at all locations and years. The lines selected using GS are currently being evaluated to measure gain from selection.

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

We have trained 8 graduate students, 4 post docs and 5 undergraduates how to plan, set up, maintain, and score a misted, inoculated FHB nursery and this is one of the nurseries they score. They were also educated on the significance of the disease, sources of inoculum, biology of fusarium, and benefits of developing resistant varieties.

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

The results of the second cycle of selection are currently being analyzed and will be reported this winter at the Scab Forum and in a publication.

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? Yes**

If yes, how many? 1

- 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? Yes**

If yes, how many? 2

- 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? Yes**

If yes, how many? 2

- 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? Yes**

If yes, how many? 1

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
Erie	SRW	MS-MR	?	2015

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

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.

None

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

None

Other publications, conference papers and presentations.

Field days and Public Presentations Reporting FHB Information:

Extension Agent Training School – November 3, 2015

Wheat Management Field Day – June 7, 2015

Hudson Valley Field Day – June 2, 2015

Seed Growers' Field Day – July 7, 2015

NY State Legislature presentation – February 9, 2015

Status: Presented

Acknowledgement of Funding Support: Not applicable for type of presentation

Extension Publications

Cornell Small Grains Performance Trials - 2015 Soft White Winter Wheat

<http://plbrgen.cals.cornell.edu/sites/plbrgen.cals.cornell.edu/files/shared/SWWW%20Reg15%20table%20corrected.pdf>

Status: Published

Acknowledgement of Funding Support: Not applicable for type of publication

Cornell Small Grains Performance Trials - 2015 Red Winter Wheat

<http://plbrgen.cals.cornell.edu/sites/plbrgen.cals.cornell.edu/files/shared/SRW%20Reg15%20Table23Feb2016.pdf>

Status: Published

Acknowledgement of Funding Support: Not applicable for type of publication