

**USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY14 Final Performance Report
July 15, 2015**

Cover Page

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Fiscal Year:	FY14
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.
FY14 USDA-ARS Award Amount:	\$ 91,795

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.	\$ 46,543
VDHR-NWW	Male Sterile Facilitated Recurrent Selection for FHB Resistance (MPI-5).	\$ 681
VDHR-NWW	Coordinated Phenotyping of Uniform Nurseries and Official Variety Trials.	\$ 2,918
VDHR-NWW	Implementing Genomic Selection for FHB Resistance in Soft Winter Wheat (SWW) Adapted to the Corn Belt.	\$ 41,653
	FY14 Total ARS Award Amount	\$ 91,795



16 June 2015

Principal Investigator

Date

* MGMT – FHB Management
 FSTU – Food Safety, Toxicology, & Utilization of Mycotoxin-contaminated Grain
 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
 WES-CP – Western 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 major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?

We have been developing FHB resistant varieties for the northeastern U.S. for more than 10 years. In recent years, our FHB screening and evaluation nurseries have been refined so that our FHB testing is very efficient and accurate. Currently we have sufficient irrigation capacity to cover approximately 3000 plots and this will cover all of our evaluation activities.

This project has provided financial support resulting in the release of 6 soft winter wheat varieties (4 white and 2 red) that have moderate resistance to FHB. The soft white wheat acreage in NY has declined in recent years and consequently, our white wheat varieties are having less impact. However, through collaboration with Ohio State, we have co-released two soft red winter wheat varieties named Otsego and Erie. Otsego has been produced commercially for four years and Erie is going into commercial production this year. Branded varieties continue to cause problems for us because FHB resistance is unknown before their sale to farmers. By the time we have adequate FHB data on them, they are gone and replaced with a new branded variety, often susceptible to FHB or other diseases in our region.

2. List the most important accomplishments and their impact (i.e. how are they being used) to minimize the threat of Fusarium Head Blight or to reduce mycotoxins. Complete both sections; repeat sections for each major accomplishment:

Accomplishment:

This year we made 94 crosses involving FHB resistant parents. This includes 40 crosses producing 285 F2s made for the Cooperative Genomic Selection project (CP). We grew 75 screening nursery plots that were selected using markers for FHB resistance loci. In our misted nursery, we have 260 selections under evaluation. We also screened 20 F2 individuals from each of 73 crosses that were segregating for *fhb1* or 5A resistance loci. In our advanced trials, we have 3 new soft red FHB lines and 13 new soft white FHB lines selected by MAS. In our Master nursery, we have 281 FHB selected entries. In our screening nursery, we have 75 FHB selected lines. We have 130 new populations that have been selected for FHB loci using MAS.

Of course our most important accomplishment has been the release 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 the branded varieties all varieties marketed in NY have at least moderate resistance to FHB.

Impact:

Soft white winter wheat acreage has been declining and consequently, our new varieties have only limited acceptance but certified seed is available for our most recent varieties. Soft white and soft red soft winter wheat varieties with moderate resistance to FHB are widely available in the northeastern U.S. Un-tested, branded varieties continue to reduce the impact of our FHB resistant varieties. We are promoting the use of FHB resistant varieties and specifically identify susceptible varieties and do not recommend them. It seems we are making progress in eliminating susceptible varieties but because there is no variety survey in NY, it is difficult to assess the impact of our varieties and companies do not release sales records.

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

1. What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?

Because FHB resistance is a complex trait, breeding methods are required that improve quantitative traits. These breeding methodologies include genomic selection and recurrent selection. These methods can improve the efficiency of introgressing effective resistance genes into breeding germplasm. Recurrent selection is a proven method for accumulating favorable alleles and raising their frequency in a population. We have a dominant MS population that has been selected for FHB resistance for four generations. This population was intermated with FHB resistant entries in the NUWWSN in the first two years to incorporate multiple sources of resistance. Subsequently, they were grown as half sib families for FHB evaluation and identification of male steriles. This summer we again have 360 half-sib families in our misted, inoculated nursery. Those families have been evaluated for FHB and male sterility and the best 25-30% of the families have been tagged for harvest and planting back this fall. The MSFRS populations flowered later than most of the entries in our FHB nurseries because they have to be space planted but we added an additional spray inoculation to catch the later flowering types. The objective of the MSFRS is to develop a soft winter wheat population with a high frequency of FHB resistant segregates that can be used directly in breeding programs.

2. List the most important accomplishments and their impact (i.e. how are they being used) to minimize the threat of Fusarium Head Blight or to reduce mycotoxins. Complete both sections; repeat sections for each major accomplishment:

Accomplishment:

The development of the FHB resistant dominant MS population is on-going using recurrent half-sib selection. The resistant male sterile plants have been tagged and we will harvest those plus a random sample of this base population for future evaluations. These samples will allow us to estimate heritability and gain from selection.

Impact:

This project will be evaluated for genetic gain after several cycles of selection using derived lines. This breeding method provides a mechanism to accumulate genes for FHB resistance from diverse sources in locally adapted backgrounds. These populations will be beneficial to regional and local breeding programs because they are an adapted source of FHB resistance. 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.

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

1. What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?

We are evaluating the FHB-resistance in varieties and advanced lines in the northern soft winter wheat breeding programs. In our misted, inoculated nursery, we evaluated the Northern Uniform Winter Wheat Scab Nursery (NUWWSN) and our Cornell Advanced Lines as well as varieties being marketed in New York (if permitted by the company). We are generating objective data on FHB resistance in varieties that are, or will be marketed in NY so that the farmer can make informed choices of varieties and so that our recommendations are accurate.

2. List the most important accomplishments and their impact (i.e. how are they being used) to minimize the threat of Fusarium Head Blight or to reduce mycotoxins. Complete both sections; repeat sections for each major accomplishment:

Accomplishment:

Each year we have collected incidence, severity, FDK, and DON data on the cooperative nurseries and submitted the data for inclusion in the FHB database. 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.

Impact:

Cooperative nurseries are essential for comparing advanced selections from different breeding programs, exchange of germplasm, and for assessing breeding progress. The NUWWSN is effective in accomplishing these goals and is a critical cooperative activity.

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

1. What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?

We implanted this project with the goal of evaluating the efficacy of genomic selection (GS) for FHB resistance. Native resistance to FHB has been well documented in Eastern US Soft Winter Wheat and it includes Type I & II as well as resistance to kernel infection (RKI) and toxin accumulation (RTA). Previously, we reported that the best approach to selecting against deoxynivalenol (DON) content was to use an index of incidence, severity, and FDK. This index was most predictive of varieties with grain containing low DON (Rutkoski et al 2012). That study indicated that many QTL with small effects are involved in resistance. Traditional marker assisted selection is less effective in improving quantitative traits controlled by many QTL, consequently we are using genomic selection in an attempt to resolve this problem.

2. List the most important accomplishments and their impact (i.e. how are they being used) to minimize the threat of Fusarium Head Blight or to reduce mycotoxins. Complete both sections; repeat sections for each major accomplishment:

Accomplishment:

In this cooperative project, each breeding program contributed resistant parents and lines with varying FHB resistance from multiple crosses involving resistant and susceptible parents. We evaluated those lines in our FHB screening nursery for incidence, severity, FDK and DON for the previous four years. We have now completed the first cycle of selection by assisting with the intermating of the selected parents from this work. In 2011 we presented the results from our GS work on cooperative nurseries at the USWBSI Forum and published a paper (Rutkoski et al 2012) describing the utility of GS using cooperative FHB nursery data. Cross validation of genomic estimated breeding values compared to actual phenotypic values resulted in correlations ranging from 0.3 to 0.7 suggesting that GS for FHB would be successful. This project will generate empirical data to test that hypothesis.

Impact:

The limitations to traditional biparental and association QTL mapping and marker assisted selection approaches to breeding for FHB resistance have indicated that an alternative breeding method is needed. GS complements marker assisted selection and takes advantage of the potentially large number of unique resistance sources. This project, combined with the information in our earlier study on GS have set the stage for greatly enhancing the rate of genetic gain and variety development from selection for FHB resistance using genomic and marker assisted selection methods.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY14 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 FY14 award period? Yes**

If yes, how many? One participated in the scoring of our nurseries but he was not supported financially by the USWBSI.

- 2. Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY14 award period? Yes**

If yes, how many? Three participated in the scoring of our nurseries but they were not supported financially by the USWBSI.

- 3. Have any post docs who worked for you during the FY14 award period and were supported by funding from your USWBSI grant taken faculty positions with universities? Yes**

If yes, how many? One participated in the scoring of our nurseries but he was not supported financially by the USWBSI. He has taken a faculty position at the Univ of Dublin.

Have any post docs who worked for you during the FY14 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?

Include below a list of all germplasm or cultivars released with full or partial support of the USWBSI during the FY14 award period. List the release notice or publication. Briefly describe the level of FHB resistance. If not applicable because your grant did NOT include any VDHR-related projects, enter N/A below.

FY13 Award Period:

Otsego Soft Red Winter Wheat - Crop Science Registration manuscript in preparation. A release notice has been distributed through the Cornell Cooperative Extension Network. FHB resistance is moderate and native in origin.

FY14 Award Period:

Erie Soft Red Winter Wheat - Crop Science Registration manuscript in preparation. A release notice has been distributed through the Cornell Cooperative Extension Network. FHB resistance is moderate and native in origin.

Both of these varieties have been made available for licensing and Foundation seed quantities are adequate. Otsego has been licensed and sold by 4 seed companies. Erie seed stocks are available for sale in fall 2015.

Include below a list of the publications, presentations, peer-reviewed articles, and non-peer reviewed articles written about your work that resulted from all of the projects included in the FY14 grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

Field days and Public Presentations Reporting FHB Information:

New World Foundation – June 23, 2014
Extension Agent Training School – November 18, 2014
New York Crops Expo – January 23, 2014
Wheat Management Field Day – June 6, 2014
Hudson Valley Field Day – June 23, 2014
Seed Growers' Field Day – June 24, 2014
Craft Brewers & Industry Working Group Meeting – February 9, 2015
Farm to City Expo – Going with the Grains – March 10, 2015

Cornell Small Grains Performance Trials – Extension Publication 2014-15

2014 Soft White Winter Wheat Summaries -

<http://plbrgen.cals.cornell.edu/sites/plbrgen.cals.cornell.edu/files/shared/SWWW%20Reg14%20tableP.pdf>

2014 Red Winter Wheat Summaries -

<http://plbrgen.cals.cornell.edu/sites/plbrgen.cals.cornell.edu/files/shared/SRW%20Reg14%20Table.pdf>