USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY16 Final Performance Report
Due date: July 28, 2017

Cover Page

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Fiscal Year:	2016
USDA-ARS Agreement ID:	59-0206-4-006
USDA-ARS Agreement Title:	FHB Management Research in New York.
FY16 USDA-ARS Award Amount:	$ 35,357
Recipient Organization:	Cornell University 341 Pine Tree Road Ithaca NY 14850
DUNS Number:	872612445
EIN:	15-0532082
Recipient Identifying Number or Account Number:	1538466 (OSP# 73081)
Project/Grant Reporting Period:	5/3/2016 - 5/2/2017
Reporting Period End Date:	05/02/17

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
MGMT	Integrated Management of FHB and DON in Wheat in New York.	$ 9,975
MGMT	Genetic Basis of Triazole Resistance and Detection by Isothermal Assay	$ 8,195
PBG	Agroecology of Fusarium graminearum at a Cereal-Natural Grassland Interface.	$ 17,187
	FY16 Total ARS Award Amount	**$ 35,357**

Gary C. Bergstrom

Digitally signed by Gary C. Bergstrom
DN: cn=Gary C. Bergstrom, o=Cornell University, ou=Plant Pathology and Plant-Microbe Biology, email=gcb3@cornell.edu, c=US
Date: 2017.07.28 17:07:05 -04'00'

Gary C. Bergstrom — July 14, 2017
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: *Integrated Management of FHB and DON in Wheat in New York.*

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

To provide more robust recommendations for management of Fusarium head blight.

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

1) major activities

Replicated field experiments were conducted to investigate the individual and combined effects of variety resistance and fungicide application on FHB and DON accumulation in winter wheat.

2) specific objectives

Timing of fungicide application was emphasized in 2016.

3) significant results

The 2016 growing season was the driest in NY in more than 20 years. Severely dry conditions during the season were not conducive for the development of FHB, and incidence was < 1% throughout the trial despite inoculation with *F. graminearum*. In the virtual absence of FHB development, DON concentrations were < 0.04 ppm in all plots, regardless of cultivar or treatment. The only significant difference observed in DON results occurred when the results of all treatments were combined and Otsego had significantly greater DON than all other varieties, though only at a low mean of 0.02 ppm.

4) key outcomes or other achievements

This supports previous research and recommendations that fungicide applications in the absence of significant disease may not be cost effective. On the other hand, when the results of all the treatments were combined, Pioneer 25R25 yielded significantly greater than all other varieties. Pioneer 25R25 is a newly released variety. In previous studies, we have observed Pioneer 25R46 to yield consistently greater than all other varieties. Perhaps the greater stripe rust susceptibility of Pioneer 25R46 negatively impacted the yield of this variety, and the lack of stripe or leaf rust on Pioneer 25R25 conveyed a yield advantage. These results indicate that cultivar selection for rust resistance may have a greater impact on yield than fungicide applications in the absence of significant FHB disease pressure.

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

N/A

4. How have the results been disseminated to communities of interest?
Through field days, winter grower meetings, email listserves, presentations at the FHB Forum, and publication in *Plant Disease Management Reports*.

Project 2: *Genetic Basis of Triazole Resistance and Detection by Isothermal Assay*

1. **What are the major goals and objectives of the project?**
   The proposed research will identify genetic markers associated with triazole resistance in *Fusarium graminearum*, determine if they are responsible for resistance, and use them to develop a rapid molecular assay for resistance detection. The project is comprised of four objectives:1) identify mutations associated with triazole resistance, 2) transform sensitive *Fusarium graminearum* strain with possible resistance genes, 3) develop a loop-mediated isothermal amplification (LAMP) reaction that identifies resistance alleles in the field, and 4) foster adoption of the LAMP assay in both the lab and field.

2. **What was accomplished under these goals?**
   I. Identify mutations associated with triazole resistance

   1) Major Activities
   - Screening isolates for decreased sensitivity to triazoles with a plate growth assay and a discriminating dose of tebuconazole
   - Sequencing cytochrome P450 genes from isolates with various levels of sensitivity
   - Whole genome resequencing of seven isolates that display a range of sensitivities, including a previously characterized isolate with the highest known tebuconazole LC50 value

   2) Specific Objectives
   - Identify isolates with highly reduced sensitivity to a commercial formulation of tebuconazole
   - Detecting DNA polymorphisms in CYP450 homologs with the potential to confer triazole resistance or to serve as molecular markers
   - Comparing CYP promoters, ABC transporters and efflux pump genes from whole genome sequences

   3) Significant Results
   - Of fifty isolates assayed, three had elevated levels of tolerance to tebuconazole as compared to the average background sensitivity
   - No causative or potentially causative polymorphisms have been found in CYP homologs B and C.
   - The latter portion of the CYP A homolog contains no polymorphisms. The first third of this gene has been difficult to amplify and sequence in a number of isolates, which may indicate mutations near the start codon or promoter region.
   - High molecular weight DNA has been prepared for genome sequencing from several of seven isolates.

   4) Key Outcomes or Other Achievements
   - Isolates acquired from areas of intense agriculture and fields that are known to receive triazole fungicides have not had high rates of reduced sensitivity to tebuconazole.

- Sensitivity to tebuconazole appears to be on a continuous scale, indicating multiple genetic factors are involved.
- The CYP450 homologs, commonly the location of triazole resistance mutations, do not appear to contain such mutations.
- Full genome sequencing and comparison of isolates with various levels of sensitivity is likely to yield the most information about potential sources of tebuconazole resistance. Results expected in early Fall 2017.

Objectives II – IV involve confirmation of resistance genes and development of a molecular diagnostic tool. These are being completed in year two of this project.

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

A graduate student, Michael Fulcher, has been leading this project, though stipend and tuition are not covered by the USWBSI grant.

An undergraduate student was supported during summer 2016 for working on this project. This student continued this work for research credit over the last academic year and was awarded a small grant that is being used to enhance the project.

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

The project was introduced to cooperative extension workers at a statewide meeting in 2016, and a conference paper and poster will be presented at the annual USWBSI meeting in 2017.

Project 3: *Agroecology of Fusarium graminearum at a Cereal-Natural Grassland Interface.*

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

The relationship between *Fusarium graminearum* populations in agricultural fields and natural reservoirs is not well characterized. To better define their connection to each other, this project will examine pathogen populations found in three cereal fields surrounding a large natural grassland, Montezuma National Wildlife Refuge. This minimally managed preserve contains diverse grass species and has the potential to contribute inoculum and genetic diversity to pathogen populations in neighboring fields. Three objectives are proposed: 1) measure genetic diversity of *F. graminearum* in wheat fields and Montezuma, 2) assess the likelihood of inoculum exchange between grasslands and cereal crops, and 3) determine host specificity of genotypes using wheat and *Bromus inermis.*

2. What was accomplished under these goals?

I. Measure genetic diversity of *F. graminearum* in wheat fields and Montezuma

1) Major Activities

- Assembling a large number of unique isolates for population analysis
- Developing a broadly applicable *F. graminearum* genotyping platform

2) Specific Objectives

- Collect isolates from cereals, wild grasses and overwintered debris in and around a wildlife refuge
- Designing primers for a highly multiplexed amplicon sequencing platform

3) Significant Results

- Identification, storage, and DNA extraction of ~500 isolates in 2016
- Collection of hundreds of wheat, barley, rye, debris, and grass samples in 2017
- Partial completion of amplicon sequencing platform for genotyping

4) Key Outcomes or Other Achievements

- Diverse isolate collection assembled from ~12 field sites over two years

II. Assess the likelihood of inoculum exchange between grasslands and cereal crops

1) Major Activities

- In vitro inoculum production assays
- Field surveys of host species community and plant density

2) Specific Objectives

- Compare inoculum production potential of multiple isolates and host species on a dry gram basis
- Relate the incidence and frequency of F. graminearum to host community composition and density

3) Significant Results
- Several wild grasses support ascospore production at similar or greater levels than wheat
- There is an isolate x substrate interaction in the production of inoculum
- Recovery of F. graminearum from debris is positively correlated with increasing host species richness and density

4) Key Outcomes or Other Achievements
- A preliminary model was produced to predict the probability of finding F. graminearum in overwintered wild grass debris.
- Dense stands of wild grass have the potential to produce high volumes of inoculum

III. Determine host specificity of genotypes using wheat and *Bromus inermis*
A number of isolates have been collected from wheat and *B. inermis* at multiple sites. This objective is being completed in the second year of the project. We anticipate the first diversity and genotyping data will arrive in Fall-Winter 2017.

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

A graduate student, Michael Fulcher, has been leading this project, though stipend and tuition are not covered by the USWBSI grant.

Two undergraduate students have been involved with this project. One each during the summers of 2016 and 2017.

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

The project was introduced to cooperative extension agents at a statewide meeting in 2016 and preliminary results were presented at the USWBSI conference in 2016 as a poster and flash presentation.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY16 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 FY16 award period?** NA

   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 FY16 award period?** NA

   If yes, how many?

3. **Have any post docs who worked for you during the FY16 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?** NA

   If yes, how many?

4. **Have any post docs who worked for you during the FY16 award period and were supported by funding from your USWBSI grant gone on to take positions with private ag-related companies or federal agencies?** NA

   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 FY16 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

Instructions: Refer to the FY16-FPR_Instructions for detailed instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY16 grant. Only include citations for publications submitted or presentations given during your award period (5/3/2016 - 5/2/2017). If you did not have any publications or presentations, state 'Nothing to Report' directly above the Journal publications section.

Journal publications.
Cummings, J.A., G.C. Bergstrom, R.J. Richtmyer, and R.R. Hahn. 2017. Evaluation of integrated methods for management of Fusarium head blight and foliar diseases of winter wheat in New York, 2016. Plant Disease Management Reports 11: CF030.
Status: Published
Acknowledgement of Federal Support: Not applicable for this type of publication.

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

Other publications, conference papers and presentations.

Conference papers:
Cummings, J.A., and G.C. Bergstrom. 2016. Evaluation of integrated methods for managing FHB and DON in winter wheat in New York in 2016. Pages 18-21 in S. Canty, A. Clark, K. Wolfe and D. Van Sanford (Eds.), Proc. 2016 National Fusarium Head Blight Forum. East Lansing, MI/Lexington, KY: U.S. Wheat and Barley Scab Research Initiative.
Status: Published
Acknowledgement of Federal Support: Yes

Fulcher, M.R. and G.C. Bergstrom. 2016. Linking host community to Fusarium graminearium distribution in New York. Page 59 in S. Canty, A. Clark, K. Wolfe and D. Van Sanford (Eds.), Proc. 2016 National Fusarium Head Blight Forum. East Lansing, MI/Lexington, KY: U.S. Wheat and Barley Scab Research Initiative.
Status: Published
Acknowledgement of Federal Support: Yes

Research presentations by Gary C. Bergstrom in 2016-17 on Fusarium head blight research:

8th Canadian Workshop on Fusarium Head Blight, Plenary Speaker, Ottawa, Ontario, Canada. (11/21/16)
Status: Presented
Acknowledgement of Federal Support: Yes.

Extension presentations by Gary C. Bergstrom in 2016-17 that included updates on Fusarium head blight research:

Finger Lakes Soybean and Small Grains Congress, Waterloo, NY. (2/9/17)
Status: Presented
Acknowledgement of Federal Support: Acknowledged in slides

Western New York Soybean and Small Grains Congress, Batavia, NY. (2/8/17)
Status: Presented
Acknowledgement of Federal Support: Acknowledged in slides

Growing High Quality Malting Barley Meeting, Albany, NY. (12/15/16)
Status: Presented
Acknowledgement of Federal Support: Acknowledged in slides

Growing High Quality Malting Barley Meeting, Batavia, NY. (12/13/16)
Status: Presented
Acknowledgement of Federal Support: Acknowledged in slides

Northeast Certified Crop Advisors Conference, Syracuse, NY. (12/1/16)
Status: Presented
Acknowledgement of Federal Support: Acknowledged in slides.

Mid-Atlantic Crop School, Ocean City, MD. (11/16/16)
Status: Presented
Acknowledgement of Federal Support: Acknowledged in slides

Cornell Fruit Day, Geneva, NY. Update on malting barley research. (7/20/16)
Status: Presented
Acknowledgement of Federal Support: Not applicable for this type of presentation.

Musgrave Research Farm Field Day, Aurora, NY. (7/14/16)
Status: Presented
Acknowledgement of Federal Support: Not applicable for this type of presentation.

Cornell Seed Growers Field Day. Ithaca, NY (7/7/16)
Status: Presented
Acknowledgement of Federal Support: Not applicable for this type of presentation.

Western New York Malting Barley Twilight Meeting, Pavillion, NY. (6/23/16)
Status: Presented
Acknowledgement of Federal Support: Not applicable for this type of presentation.

Hudson Valley Small Grains Field Day, Hurley, NY. (6/15/16)
Status: Presented
Acknowledgement of Federal Support: Not applicable for this type of presentation.

Sowing the Future of Organic Wheat Research in the Northeast, Ithaca, NY. (6/10/16)
Status: Presented
Acknowledgement of Federal Support: Not applicable for this type of presentation.

Small Grains Management Field Day, Aurora, NY. (6/2/16)
Status: Presented
Acknowledgement of Federal Support: Not applicable for this type of presentation.