USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY17 Preliminary Final Performance Report
Due date: July 31, 2018

Cover Page

Principle Investigator (PI):	Gary Bergstrom
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Fiscal Year:	2017
USDA-ARS Agreement ID:	59-0206-4-006
USDA-ARS Agreement Title:	FHB Management Research in New York.
FY17 USDA-ARS Award Amount:	$ 35,289
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:	5/3/2017 - 5/2/2018
Reporting Period End Date:	5/2/2018

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
MGMT	Integrated Management of FHB and DON in Barley and Wheat in New York.	$ 9,956
MGMT	Genetic Basis of Triazole Resistance and Detection by Isothermal Assay	$ 8,179
PBG	Agroecology of Fusarium graminearum at a Cereal-Natural Grassland Interface.	$ 17,154
	FY17 Total ARS Award Amount	$ 35,289

Gary C. Bergstrom July 31, 2018
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

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Project 1: *Integrated Management of FHB and DON in Barley and 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 2017.

3) significant results
The 2017 growing season resulted in low levels of foliar diseases, FHB and DON. When the results of all cultivars were combined, all fungicide treatments significantly reduced leaf rust and stripe rust. Leaf blotch severity was significantly greatest in the inoculum only plots. All three fungicide treatments significantly reduced FHB and DON as compared with the inoculum only treated plots, and all were below the 2 ppm threshold for acceptable DON concentrations in grain. Test weight was lowest for the inoculum only treatment, but none of the treatments had any significant effect on yield. When the results of all treatments were combined, Pioneer 25R46 had significantly greater leaf and stripe rust than the other cultivars, but also had the lowest leaf blotch. Otsego had significantly greater FHB incidence and index than the other cultivars, but there was no significant difference in DON among the cultivars. Pioneer 25R46 had the greatest test weight, but there was no differentiation of yield among the cultivars. However, when the cultivars were analyzed separately, the fungicide treatments only reduced leaf and stripe rusts for the Pioneer varieties, and leaf blotches were significantly reduced by the fungicides for Erie, Otsego and Pioneer 25R46. FHB incidence and DON was significantly reduced by all fungicide treatments for each cultivar as compared with the inoculum only treatment. Yield was not affected by any of the treatments for each cultivar.

4) key outcomes or other achievements
Overall, these results indicate that all of these fungicide treatments can significantly reduce foliar diseases, FHB and DON under low FHB pressure, and that Otsego is more susceptible to FHB than the other three cultivars. This supports previous research and recommendations that fungicide applications in the absence of significant disease may not be cost effective.

5) What opportunities for training and professional development has the project provided? NA

6) 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 was performed to 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 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? *Address items 1-4) below for each goal or objective.*

1) major activities

- Screening isolates for decreased sensitivity to triazoles with a plate growth assay and a discriminating dose of tebuconazole
- Comparing genome and gene sequences to identify markers associated with fungicide resistance

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 and whole genome sequences of sensitive and reduced sensitivity isolates

3) significant results

- Of ~80 isolates assayed from multiple years and sites, only three had notably 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 A, B and C
- No promoter mutations were associated with reduced sensitivity
- Draft genomes for seven previously unsequenced isolates were generated
- Growth assays at a single dose were as effective for detecting reduced sensitivity as EC50 calculations based on more unwieldy serial dilution growth assays.

4) key outcomes or other achievements

- Isolates acquired from areas of intense agriculture and fields that are known to receive triazole fungicides have not shown high frequency of reduced sensitivity to tebuconazole.
- Sensitivity to tebuconazole was normally and continuously distributed in our metapopulation, indicating multiple genetic factors are involved.
- The CYP450 homologs, commonly the location of triazole resistance mutations, do not appear to contain such mutations in *F. graminearum*.

• Isolates from different crop sources have significantly different distributions of sensitivity to tebuconazole – populations that have undergone fungicide applications (i.e. collected from harvested barley and wheat grain) have higher mean and maximum EC50 values with a skewed distribution compared to the normally distributed phenotypes found in un-treated sources (ie overwintered corn debris). Further work should be performed to determine whether populations overwintering in small grains fields treated with fungicide retain this skewed phenotypic distribution from one season to the next.
• Because no causative mutation has been identified we recommend monitoring for triazole resistance with growth rate assays using a single threshold dose of fungicide, which in this project allowed rapid and effective identification of isolates with reduced sensitivity to tebuconazole.

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 has been assisting with this project for two years. This student continued from paid research to credit hours and developed an independent senior thesis project on Fusarium graminearum biology.

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

Results were shared on a poster at the annual USWBSI meeting. A manuscript is in preparation and genome sequences will be made available online.

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? *Address items 1-4) below for each goal or objective.*

1) major activities
- Assembling a large number of unique isolates for population analysis
- Genotyping and phenotyping isolates
- Analyzing distribution of *F. graminearum* in wild grasses

2) specific objectives
- Collect isolates from cereals, wild grasses and overwintered debris in and around a wildlife refuge, and from remote regions of wilderness in an isolated part of New York with low agricultural production.
- Model pathogen prevalence based on host landscapes
- Examine wild grass host competency
- Assess population structure with neutral genetic markers

3) significant results
- Identification, storage, and DNA extraction of ~1200 *F. graminearum* isolates from 2015-2017 across ~20 field sites
- Regional corn acreage, but not regional small grains acreage, is strongly correlated with pathogen incidence in wild grasses.
- Wild grasses vary in host suitability across the pathogen life cycle, with some appearing equivalent to wheat.
- Isolates collected from wild grasses are just as virulent on wheat spikes as isolates with an agricultural origin.
- At an experimental site with a wheat variety trial, the incidence of head blight in wheat varieties (S-MR) had a similar distribution to that found in the wild grass species on site.
- The pattern of infection seen in wild grasses over three years indicates that conditions conducive to head blight development in small grains also promotes wild grass colonization.

• Three years of grass infection data show some species are more likely to harbor *F. gramimnearum* than others.
• Debris infestation was highest following a high disease season and extremely low following a drought year.
• Microsatellite loci are being amplified for population structure and preliminary results show high genotypic diversity across sites.

4) key outcomes or other achievements
• Large collection of isolates representing different environments, two distinct agricultural landscapes, and numerous hosts plants.
• Chemotype distribution in New York does not vary by host source but is geographically structured.
• High density inoculum sources (ie corn fields) are linked to pathogen incidence in wild crops.
• A high number of NX2 chemotypes were found in one region of New York but preliminary data suggest these are not associated with any single host or local environment.
• Wild grasses are suitable hosts for *F. graminearum* support inoculum production and are colonized under similar conditions to those resulting in small grains infection.

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.

Three undergraduate students have been involved with this project. Two have graduated and continued to study plant pathology. A third is now studying the distribution of *Fusarium* spp associated with wild grasses in New York.

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

Posters have been presented at the USWBSI annual meetings. One manuscript is under review, another has been submitted for review and three are in preparation.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY17 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 FY17 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 FY17 award period?** NA

   If yes, how many?

3. **Have any post docs who worked for you during the FY17 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 FY17 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?

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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 FY17 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 FY17-FPR_Instructions for detailed instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY17 grant. Only include citations for publications submitted or presentations given during your award period (5/3/2017 - 5/2/2018). 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.

Journal publications.

Cummings, J.A., K.L. Myers, G.C. Bergstrom, and P.J. Stachowski. 2018. Evaluation of integrated methods for management of Fusarium head blight and foliar diseases of winter wheat in New York, 2017. Plant Disease Management Reports 12: CF046.
Status: Published
Acknowledgement of Federal Support: Not applicable for this type of publication.

Fulcher, M., Winans, J., Quan, M., Bergstrom, G. 2018. The prevalence of a broad host range pathogen in wild grasses is associated with regional corn production in New York.
Status: Submitted
Acknowledgement of Federal Support: Yes

Fulcher, M., Garcia, J., Damann, K., Bergstrom, G. 2018. Variable interactions between non-cereal grasses and *Fusarium graminearum*.
Status: Submitted
Acknowledgement of Federal Support: Yes

Fulcher, M., Winans, J., Quan, M., Oladipo, E., Bergstrom, G. Population structure of *Fusarium graminearum* at the interface of cereal crops and natural grasses.
Status: In preparation
Acknowledgement of Federal Support: NA

Fulcher, M., Winans, J., Bergstrom, G. Fitness of *Fusarium graminearum* isolates collected from wheat and wild grasses in eastern New York.
Status: In preparation
Acknowledgement of Federal Support: NA

Fulcher, M., Oladipo, E., Bergstrom, G. Effect of host landscape on *Fusarium* community composition in grass spikes.
Status: In preparation
Acknowledgement of Federal Support: NA

Fulcher, M., Winans, J., Cummings, J., Bergstrom, G. Tebuconazole sensitivity in New York population of *Fusarium graminearum* varies with host origin.
Status: In preparation
Acknowledgement of Federal Support: NA

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

Other publications, conference papers and presentations.

Conference papers:
Fulcher, M.R., and G.C. Bergstrom. 2017. Prevalence of *Fusarium graminearum* in non-cultivated, gramineous reservoirs. Page 13 in S. Canty, B. Wiermer, and D. Van Sanford (Eds.), Proc. 2017 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., J.B. Winans, and G.C. Bergstrom. 2017. Bases of variable sensitivity to tebuconazole in New York isolates of *Fusarium graminearium*. Page 65 in S. Canty, B. Wiermer, and D. Van Sanford (Eds.), Proc. 2017 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

Salgado, J.D., G. Bergstrom, C. Bradley, K. Bowen, E. Bycamukama, A. Byrne, A. Collins, C. Cowger, J. Cummings, V. Chapara, M.I. Chilvers, R. Dill-Mackey, H.M. Darby, A. Friskop, P. Gautam, N. Kleczewski, L.V. Madden, J. Marshall, H. Mehl, M. Nagelkirk, J. Stevens, D. Smith, S. Wegulo, K. Wise, D. Yabwalo, H.M. Heather-Kelly, and P.A. Paul. 2017. Efficacy of two-treatment fungicide programs for FHB management: A multi-state coordinated project. Pages 20-25 in S. Canty, B. Wiermer, and D. Van Sanford (Eds.), Proc. 2017 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

Salgado, J.D., K. Ames, G. Bergstrom, C. Bradley, E. Byamukama, J. Cummings, V. Chapara, M.I. Chilvers, R. Dill-Macky, A. Friskop, P. Gautam, N. Kleczewski, L.V. Madden, E. Milus, M. Nagelkirk, J. Ransom, K. Ruden, J. Stevens, S. Wegulo, K. Wise, D. Yabwalo, and P.A. Paul. 2017. Robust management programs to minimize losses due to Fusarium head blight and deoxynivalenol in wheat. Pages 26-27 in S. Canty, B. Wiermer, and D. Van Sanford (Eds.), Proc.

2017 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:

E.S. Lutrell Invited Lecture at University of Georgia, Athens, GA ()
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. (2/8/18)
Status: Presented
Acknowledgement of Federal Support: Acknowledged in slides.

Western New York Soybean and Small Grains Congress, Batavia, NY. (2/7/18)
Status: Presented
Acknowledgement of Federal Support: Acknowledged in slides.

North Country Crop Congress, Lowville, NY. (2/7/18)
Status: Presented
Acknowledgement of Federal Support: Acknowledged in slides.

Miner Institute Crop Congress, Chazy, NY. (1/31/18)
Status: Presented
Acknowledgement of Federal Support: Acknowledged in slides.

New York State Growers Expo, Syracuse, NY (1/16/18)
Status: Presented
Acknowledgement of Federal Support: Acknowledged in slides.

Empire State Barley and Malt Summit. Syracuse, NY. (12/13-14/17)
Status: Presented
Acknowledgement of Federal Support: Acknowledged in slides.

Cornell Seed School, Geneva, NY. (12/12/17)
Status: Presented
Acknowledgement of Federal Support: Acknowledged in slides.

Northeast Region Certified Crop Advisor School, Syracuse, NY. (11/29/17)
Status: Presented
Acknowledgement of Federal Support: Acknowledged in slides.

Cornell Field Crop Dealers Meeting, Syracuse, NY. (11/8/17)
Status: Presented
Acknowledgement of Federal Support: Acknowledged in slides.

Musgrave Research Farm Field Day, Aurora, NY. (7/13/17)
Status: Presented
Acknowledgement of Federal Support: Not applicable for this type of presentation.

Cornell Seed Growers Field Day. Ithaca, NY (7/6/17)
Status: Presented
Acknowledgement of Federal Support: Not applicable for this type of presentation.

Northeastern Association of State Departments of Agriculture, Cooperstown, NY. (6/13/17)
Status: Presented
Acknowledgement of Federal Support: Not applicable for this type of presentation.

Hudson Valley Grains Day, Farm Hub, Hurley, NY (7/12/17)
Status: Presented
Acknowledgement of Federal Support: Not applicable for this type of presentation.

Small Grains Management Field Day, Aurora, NY (6/8/17)
Status: Presented
Acknowledgement of Federal Support: Not applicable for this type of presentation.