USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY08 Final Performance Report (approx. May 08 – April 09)
July 15, 2009

Cover Page

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Fiscal Year:	2008
USDA-ARS Agreement ID:	59-0790-4-093
USDA-ARS Agreement Title:	Developing Technologies to Enhance Utility for B. Subtilis Against Wheat Scab.
FY08 USDA-ARS Award Amount:	$ 75,792

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Adjusted Award Amount
MGMT	Enhancing Biocontrol of FHB/DON Through an Understanding of Microbial Ecology.	$31,970
MGMT	Evaluation of Integrated Management Strategies for FHB in New York.	$ 17,438
MGMT	Relative Contribution of within-Field Inoculum to FHB Infection.	$ 26,384
	Total Award Amount	**$ 75,792**

July 14, 2009

Principal Investigator Date

* MGMT – FHB Management
FSTU – Food Safety, Toxicology, & Utilization of Mycotoxin-contaminated Grain
GDER – Gene Discovery & Engineering Resistance
PBG – Pathogen Biology & Genetics
BAR-CP – Barley Coordinated Project
HWW-CP – Hard Winter Wheat Coordinated Project
VDHR – Variety Development & Uniform Nurseries – Sub categories are below:
SPR – Spring Wheat Region
NWW – Northern Winter Wheat Region
SWW – Southern Sinter Wheat Region

Project 1: *Enhancing Biocontrol of FHB/DON Through an Understanding of Microbial Ecology.*

1. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?**
   The goal of this research is to identify strategies for enhancement of FHB biocontrol by elucidating the ecology of interactions between *F. graminearum* and the biocontrol agent *Bacillus subtilis* strain TrigoCor on wheat florets. Like other biocontrol agents assessed by USWBSI researchers, TrigoCor gives excellent and consistent biological control of FHB in the greenhouse but not in the field; we aim to identify the factors leading to this disparity by describing the dynamics of microbial populations and of *Bacillus*-generated antifungal metabolites relative to biological control. We examined populations of *Bacillus* on wheat florets over critical infection periods in the greenhouse and in two field environments in New York. Using dilution plating, we quantified *Bacillus* populations on wheat heads at 4-5h, 48h, 7d, and 14d after *Bacillus* application. In greenhouse experiments, *Bacillus* populations survived at significantly high levels (10^7 CFUs per head) that were consistent throughout the sampling period. In both field locations, *Bacillus* populations increased from 10^3 to 10^6 CFUs per head over the first week following *Bacillus* application, and remained at 10^6 CFUs per head 14d after application. At one of our field locations additional samples were taken at 21d after *Bacillus* application as well as at harvest, and *Bacillus* populations were present at both these sampling times at 10^5 CFUs per head. In addition to viable bacterial populations, we are also assessing the production and persistence of antifungal metabolites relative to biological control in controlled and field environments. We have developed a protocol for extracting lipopeptides from commercially sprayed wheat heads in the field and for analyzing them using HPLC. Using this protocol we are able to detect the iturin class of lipopeptides, which are the compounds largely responsible for the biocontrol activity of TrigoCor. We are currently analyzing samples collected from field locations sprayed with *Bacillus* in summer 2008, and will relate these results to their corresponding DON levels and *Bacillus* population levels.

2. **List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):**

   Accomplishment:
   We demonstrated that *Bacillus* survives in abundant numbers throughout the critical period of flowering and early grain development, as well as through harvest.

   Impact:
   The persistence of *Bacillus* on wheat florets suggests this BCA, applied at anthesis, is present in sufficient numbers to protect plants against *Fusarium* infections through flowering and grain development. It is likely that some factor other than inadequate survival of the biocontrol agent is responsible for its inconsistent performance in the field.

Project 2: *Evaluation of Integrated Management Strategies for FHB in New York.*

1. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?**
   This research in New York was part of a multi-state, multi-year field study aimed at demonstrating that integrated management is the most efficacious and economical approach to management of Fusarium head blight and DON. The individual and combined effects of cultivar resistance (four wheat cultivars varying in resistance to FHB) and fungicide (Prosaro at initiation of flowering) were assessed for their effects on FHB, DON, and grain yield. In New York we conducted two separate experiments in 2008, one in wheat planted no-till into corn stubble and one planted no-till into soybean stubble. Central New York experienced dry weather during May-July such that FHB symptoms were at 1% incidence or less at soft dough stages. And yet, detectable levels of DON were recorded for most plots as a result of infection late during grain development. There were no significant effects of treatment except that the FHB susceptible cultivar Caledonia, a leading variety in NY, MI, and Ontario, out yielded the other cultivars in both experiments.

2. **List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):**

   Accomplishment:
   We demonstrated that DON can result from late infections with no associated symptoms and that this late DON accumulation may not be reduced by fungicide application at initiation of flowering.

   Impact:
   The detection of DON in grain from plants that exhibited no visual symptoms of FHB is a reminder that successful integrated management must also address late infections resulting in DON. FHB management should not end at the initiation of flowering. Biological control agents may find future utility in post-flowering control of FHB.

Project 3: *Relative Contribution of within-Field Inoculum to FHB Infection.*

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

   Knowledge of the relative contribution of within-field inoculum sources (i.e., corn and small grain crop debris) of *Gibberella zeae* to infection of local wheat is important for developing and/or excluding strategies for managing FHB. We utilized a marked isolate, release-recapture approach to assess relative contribution of spores from corn stalks to infection of wheat and barley heads at the corn stalk source and at 10 foot and 20 foot radii from the corn stalk sources as well as in more distant portions of the fields. This was the second and final year of the project. The experiment was conducted in a total of eight commercial scale wheat and barley fields in New York and Virginia that lacked corn or cereal residues. Isolates of *G. zeae* from wheat heads were scored for AFLP haplotype and were categorized for identity or non-identity with released clonal isolates possessing unique AFLP haplotypes.

2. **List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):**

   Accomplishment:
   We provided direct (genetic) evidence of the relative contribution of local inoculum to local infection of wheat heads by *Gibberella zeae*. Both within-field, infected corn stalks and background atmospheric sources provided significant levels of inoculum for infection of local wheat heads in six non-epidemic wheat environments in New York and Virginia, in one moderate FHB epidemic wheat environment in Virginia, and in one severe FHB epidemic barley environment in Virginia. Released clones were recovered at their highest frequencies within source plots, at greatly reduced frequencies at 10 and 20 feet from source plots, and only occasionally from non-inoculated sites. A small number of isolates of the released clones were recovered in distant portions of the fields indicating a contribution of corn stalk-derived spores to the mixed atmospheric population of the fungus.

   Impact:
   Our results suggest strongly that FHB management experiments involving a crop debris 'treatment' must employ a physical separation of greater than 20 feet between plots in order to avoid significant interplot interference due to inoculum ingress from infested debris into other plots. Our findings also suggest that debris management in single fields achieved through tillage, crop sequence, or the application of fungicides or biocontrol agents to stubble is unlikely, by itself, to result in sufficiently large reductions of FHB or DON. The contribution of naturally infected corn debris (as opposed to laboratory prepared inocula in this experiment) awaits the outcome of USWBSI debris microplot experiments being conducted in five states in 2009.

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 grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

Publications (not peer reviewed):

Bergstrom, G.C. 2008. Wheat fungicide options for 2008. *What's Cropping Up?* Vol. 18. No. 3:6-7. [http://css.cals.cornell.edu/cals/css/extension/upload/WCUVol18No3_May-Jun2008-2.pdf]

Bergstrom, G.C., and K.D. Waxman. 2008. Microplots in commercial wheat fields for quantifying the local contribution of *Gibberella zeae* from natural corn debris to Fusarium head blight and deoxynivalenol accumulation. Pages in Proc. 2008 National Fusarium Head Blight Forum, Crowne Plaza Hotel at Union Station, Indianapolis, IN, December 2-4, 2008.

Kawamoto, S.O., Crane, J.M., Gibson, D.M., and Bergstrom. 2008. Ecology of *Bacillus subtilis* on wheat florets in relation to biological control of FHB/DON. Pages in Proc. 2008 National Fusarium Head Blight Forum, Crowne Plaza Hotel at Union Station, Indianapolis, IN, December 2-4, 2008.

Keller, M.D., Schmale, D.G., Waxman, K.D., and Bergstrom, G.C. 2008. Released clones and background inocula of *Gibberella zeae* contributed to Fusarium head blight in winter cereals in New York and Virginia. Pages in Proc. 2008 National Fusarium Head Blight Forum, Crowne Plaza Hotel at Union Station, Indianapolis, IN, December 2-4, 2008.

Waxman, K.D., and Bergstrom, G.C. 2008. Evaluation of integrated FHB management methods under low disease environments in New York. Pages in Proc. 2008 National Fusarium Head Blight Forum, Crowne Plaza Hotel at Union Station, Indianapolis, IN, December 2-4, 2008.

Presentations for Scientific/Professional Audiences:

Swedish University of Agricultural Sciences, Department of Forest Mycology and Pathology. Uppsala, Sweden. An epidemiological approach to cereal disease management. January 22, 2009.

Bioforsk/Norwegian University of Life Sciences, Aas, Norway. An epidemiological approach to cereal disease management. January 19, 2009.

Extension presentations by Gary C. Bergstrom in 2008-09 that included updates on Fusarium head blight research:

Seed Growers Field Day, Ithaca, NY. Update on diseases of cereals, forages, and biofuel feedstock crops (ca. 70 persons) (7/7/09)

Small Grains Management Field Day, Aurora, NY. Integrated management of FHB. (ca. 80 persons) (6/4/09)

Southern Seneca County Crops Clinic, Lodi, NY. Field crop disease update. (ca. 25 persons) (4/1/09)

Northern New York Crops Congress, Carthage, NY. Field crop disease update. (ca. 55 persons) (3/5/09)

Northern New York Crops Congress, Madrid, NY. Field crop disease update. (ca. 35 persons) (3/4/09)

Miner Institute Corn Congress, Chazy, NY. Field crop disease update. (ca. 50 persons) (3/5/09)

Cattaraugus County Crop Congress, Randolph, NY. Field crop disease update. (ca. 30 persons) (2/26/09)

Steuben County Crops Day, Bath, NY. Field crop disease update. (ca. 90 persons) (2/26/09)

Finger Lakes Soybean and Small Grain Congress, Waterloo, NY. Wheat health management with rotations, varieties, and fungicides. (ca. 85 persons) (2/5/09)

Western New York Soybean and Small Grain Congress, Stafford, NY. Wheat health management with rotations, varieties, and fungicides. (ca. 155 persons) (2/4/09)

New York State Small Grains Seed Committee. Waterloo, NY. Cereal disease research and extension update. (12 persons) (3/9/09)

Seed Growers Field Day. Ithaca, NY. Small grain and forage crop disease update; Fusarium head blight. (ca. 60 persons) (7/8/08)

Small Grains Management Field Day. Aurora, NY. Integrated management of FHB. (ca. 100 persons) (6/5/08)

North Country Crop Congress, Carthage, NY. Field crop disease update. (ca. 50 persons) (3/13/08)

North Country Crop Congress, Madrid, NY. Field crop disease update. (ca. 50 persons) (3/12/08)

Monroe Tractor Spray Clinic. Auburn, NY. Plant disease update. (ca. 200 persons) (3/11/08)

New York State Small Grains Seed Committee. Waterloo, NY. Cereal disease research and extension update. (12 persons) (3/4/08)

Seneca County Crop and Dairy Day. Romulus. Field crop disease update. (ca. 25 persons) (2/20/08)

Madison County Crop Congress. Cazenovia, NY. Disease and mycotoxin threats to New York crops. (ca. 50 persons) (1/23/08)

If your FY08 USDA-ARS Grant contained a VDHR-related project, include below a list all germplasm or cultivars released with full or partial support of the USWBSI. List the release notice or publication. Briefly describe the level of FHB resistance. If this is not applicable (i.e. no VDHR-related project) to your FY08 grant, please insert 'Not Applicable' below.

Not applicable.