USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY10 Final Performance Report
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Cover Page

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Fiscal Year:	FY10
USDA-ARS Agreement ID:	59-0206-9-078
USDA-ARS Agreement Title:	Managing FHB through Integrated Practices, Biological Control Agents, and within-field Inoculum Sources.
FY10 USDA-ARS Award Amount:	$ 17,195

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
MGMT	Uniform Biocontrol Agent Test for Control of Fusarium Head Blight and Deoxynivalenol.	$ 3,902
MGMT	Integrated Management of Fusarium Head Blight and Deoxynivalenol across Multiple Locations and Small Grain Classes.	$ 10,732
MGMT	Within-Field Inoculum from Corn Debris and the Management of FHB/DON.	$ 2,561
	Total ARS Award Amount	**$ 17,195**

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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
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: *Uniform Biocontrol Agent Test for Control of Fusarium Head Blight and Deoxynivalenol.*

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

   This research project addresses the research needs of optimizing biological control application timing and methodology, developing control methods that include consistent and effective biological control agents, assessing new control methods for FHB/DON, developing a repository of negative data with potential explanations for why control was not attained and enhancing communication and end user education/outreach opportunities.

   The project very clearly mirrors Goal #2 of the FHB Management Action Plan, i.e. "Develop the next generation of management tools for FHB/DON control". It also contributes to the goals of developing components for use in integrated management of FHB and enhancing communication and end used education/outreach by providing valuable research results on best management practices to clientele.

   The work proposed in the original research grant submission has been completed for the 2007-2008, 2008-2009 and 2009-2010 seasons. The uniform biological trial was conducted on two soft red winter wheat varieties, Elkhart and Roane. All three seasons were very favorable for the development of FHB and DON. Elkhart is a susceptible variety and FHB had a negative impact on yield and lead to high levels of DON in the untreated plots. Roane is moderately tolerant to FHB but still had significant levels of both FHB and DON. The biological control agents used were efficacious on Elkhart, especially in 2009 and 2010.

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):**

   <u>Accomplishment:</u>

   The 2008, 2009 and 2010 growing seasons were very favorable for the development of FHB and the production of DON in soft red winter wheat in Missouri. After several years with little FHB and no differences in treatments the last three years have provided very useful data on the efficacy of biological control agents in the management of FHB and DON.

   Moderate to high FHB levels were recorded in Missouri trials. While none of the treatments reduced in-field disease measurements compared to the control in all trials, treatments involving Prosaro were efficacious in the majority of cases. The double yeast and Taegro applied alone were efficacious in Missouri on 'Elkhart'.

   When results from all trials in all cooperating states were pooled, head severity and index in these biological treatments were significantly lower than the control. In only two instances did any treatment exhibit better efficacy than Prosaro alone; both involved a combination of

Prosaro with Taegro. There was a significant treatment effect for DON content only in the 'Elkhart' MO experiment, with Prosaro followed by the double yeast being the only treatment to reduce DON concentration below the control. FDK was reduced only North Dakota where all treatments had a significant effect. There were no differences in test weights and yields between any treatment at any location.

The results with the biological treatments in these trials are promising. The treatments with the BCA alone or in combination with the fungicide appeared to be comparable in consistency to the standard fungicide and in a few instances provided higher levels of control than the fungicide. Some of instances in which the BCA were inefficacious could have been related to population levels of the organisms declining during shipment or storage. The viable cell concentration in the double yeast inoculum applied in North Dakota, in particular, was considerably lower than expected levels. Formulation to improve shelf life might provide more consistent performance in the future. In addition, populations of the two yeast strains in the double yeast co-culture differ by more than a log unit. Further tests may clarify whether efficacy improvements would be realized with a product containing equivalent populations of these two strains.

Impact:

Although the results with the biological treatments in these trials are promising, commercial availability of these products is still limited. The potential for improving FHB and DON management with the use of biological control agents is good but immediate impacts for producers are difficult to quantify.

Project 2: *Integrated Management of Fusarium Head Blight and Deoxynivalenol across Multiple Locations and Small Grain Classes.*

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

This research project addresses the research need of identifying the best management methods for FHB/DON or good farming practices for FHB/DON management through integrated management studies. Needs addressed also include evaluation of potential disease reductions through combinations of host resistance and fungicides, documentation of the impact of crop sequence on disease risk and potential role as part of the integrated management of FHB/DON and development of outreach materials and opportunities for exchange of information with clientele.

The proposed research project very clearly mirrors Goal #1 of the FHB Management Action Plan, i.e. "Validate integrated management strategies for FHB and DON". It also contributes to the goals of developing the next generation of management tools for FHB/DON control and enhancing communication and end used education/outreach by providing valuable research results on best management practices to clientele.

2009-2010 was the fourth year for the Integrated Management of Fusarium Head Blight and Deoxynivalenol study in Missouri. The recommended treatments were applied to five soft red winter wheat varieties. Ratings were made at the appropriate times and data for the four years of the study has been analyzed and summarized.

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:

The Integrated Management of Fusarium Head Blight and Deoxynivalenol study in Missouri has been conducted for four growing seasons. A brief description of each year's results and a summary of the results over the four years of the study follow.

Weather conditions during the 2006-2007 season were not conducive for the development of FHB at the Columbia, MO location. Conditions as the wheat crop was flowering were too dry for infection to occur and disease to develop. However, both the 2007-2008 and 2008-2009 seasons were quite conducive for the development of FHB. In both 2008 and 2009 weather conditions were unusually wet and cool as the wheat crop flowered and after flowering.

2007: Weather conditions were not conducive for the development of FHB. In both trials (i.e. corn and soybean residue), the yield was statistically significantly different only by variety. For DON levels effects of residue type and residue type x variety were significant. All main and interaction effects were statistically significant for FHB index. Only residue type and variety were significant for % FDK. DON levels were slightly higher in all varieties in the corn residue trials than in the soybean residue trials.

2008: Weather conditions were quite favorable for the development of FHB and FHB developed in all five varieties in both residue types. In the corn residue trial all main and interaction effects were statistically significant for yield and DON levels. Overall, yields were higher and DON levels lower in the soybean residue than in the corn residue trial.

2009: Weather conditions were again very conducive for the development of FHB in all five varieties in both crop sequence trials. In the corn residue trial all main and interaction effects were statistically significant for both yield and DON. Although yields in the soybean residue trial tended to be lower than the yields of the same varieties in the corn residue trial, weed competition in the soybean trial may have been a factor. The DON levels for all varieties were lower in the soybean residue trial than in the corn residue trial.

2010: Weather conditions were again very conducive for the development of FHB in all five varieties in both crop sequence trials. In the corn residue trial all main and interaction effects were statistically significant for both yield and DON. Yields in the corn residue were

lower than in the soybean residue and DON levels were higher in the corn residue than in the soybean residue. These results reinforce the importance of crop rotation as a management tool for both FHB and DON.

Four Year Summary: Data from the four years for each crop residue type were analyzed using ANOVA. In corn residue, yields were statistically different for year, variety, year x variety and fungicide x variety but not for fungicide alone, year x fungicide or year x fungicide x variety. DON levels were statistically significant different for all main and interaction effects. For both the FHB index and the percent FDK effects were statistically significant for all but year x fungicide x variety.

In soybean residue, yield was statistically significant for all main and interaction effects except year. DON levels and FHB index were statistically significant for all main and interaction effects. Percent FDK was statistically significant for year, fungicide, variety and year x variety but not for year x fungicide, fungicide x variety or year x fungicide x variety.

Impact:

This research has shown the importance of crop sequence or residue type on the level of FHB and DON in the subsequent wheat crop. Crop rotation as a management tool for both FHB and DON management needs to be stressed. In general, the greatest reductions in FHB intensity and DON accumulation were observed when moderately resistant varieties were used with crop rotation and fungicide application. Resistant varieties had lower levels of both FHB and DON in both residue types and with or without fungicide application. Under high disease pressure, a three tier management approach of crop rotation with a non-host, moderately resistant to resistant varieties and fungicide application was required to achieve < 2ppm DON.

This research project has provided data that can be used by producers to manage both FHB and DON levels in wheat. It is unfortunate that just as the third year of the study was completed and producers might adopt recommendations based on the research work, wheat production in Missouri has faced different obstacles. Wet falls in both 2008 and 2009 delayed harvest of row crops and thus of winter wheat. Use of crop sequence to manage FHB was limited by the weather conditions with wheat being planted on harvested fields regardless of residue type present. The importance of variety selection and the use of fungicide applications as the wheat flowers if weather conditions are conducive to the development of FHB were viable options for producers trying to manage FHB and reduce DON levels.

Project 3: *Within-Field Inoculum from Corn Debris and the Management of FHB/DON.*

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 of *Gibberella zeae* to infection of local wheat and barley is important for developing and/or excluding strategies for managing FHB. Our experimental objective is to quantify the relative contribution of within-field corn debris as an inoculum source of *Gibberella zeae* for Fusarium head blight and DON contamination in 20 variable wheat or barley environments over two years, all in regions where corn is the predominant crop in the agricultural landscape and corn debris is left on the land surface over large areas.

   Our research is based on the hypothesis that spores of *Gibberella zeae* that are deposited on wheat spikes and that result in Fusarium head blight come primarily from well-mixed, atmospheric populations in an area. Our results should provide a realistic range of estimates for the scab and DON reduction benefits to be realized by avoiding cereal planting into corn stubble. It will also suggest the magnitude of FHB/DON reduction to be expected from tillage or other direct debris management techniques in a single field of wheat or barley within a larger corn production region. Building on techniques perfected in New York and Virginia in 2007-2008, we will use a marked (AFLP) isolate, release-recapture experimental approach to assess relative contribution of localized clonal inocula to infection of cereal heads at the source and at more than 100 feet from the source in commercial wheat and barley fields otherwise lacking corn or cereal debris. We expect that concentrated clonal inoculum may overestimate the contribution of local inoculum to FHB and DON, so we are also employing replicated microplots in each experimental field with naturally overwintered corn debris collected from sources close to those same wheat and barley fields. The research will be conducted in two commercial-scale wheat or barley fields per season in Illinois, Missouri, Nebraska, New York, and Virginia. All field sites are in regions with considerable acreage of over-wintered corn residues nearby. Our research addresses Goal #3, to develop a full understanding of specific factors influencing infection and toxin accumulation that can be used to develop the next generation of scab and DON risk assessment measures. Specifically we will (1) elucidate the contribution of local inoculum sources to the temporal and spatial development of FHB epidemics, and this knowledge will, in turn, (2) help refine models for FHB risk assessment. Results from this study will increase our understanding of the spread of *G. zeae* from a local source of inoculum and will be of immediate value in determining the relative risk of infection of wheat by *G. zeae* from within-field sources of inoculum. Ultimately, our efforts will aid in developing and/or excluding strategies for managing FHB and will help refine forecasting/risk assessment models for FHB.

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:

This study was conducted at eleven sites during the 2009-2010 season. Over these environments, six severe epidemics (in Illinois, Missouri and Virginia), two moderate epidemics (in New York) and two mild epidemics (in Nebraska) were encountered. Locally overwintered, natural corn stalks collected in the spring from two different sources in each state were placed in replicated microplots set out in fields the next season. Replicated microplots without additional debris were also established in each field. Wheat heads above each microplot were rated at the soft dough stage for FHB incidence, severity and index. At grain maturity, wheat heads within each microplot were hand harvested and shipped to Cornell University where grain was threshed from a subsample of those heads and sent to Virginia Tech for DON analysis.

Only in one field in Virginia did wheat heads from microplots containing locally overwinter corn debris show a slight but statistically significant increase in FHB incidence and index over those microplots with no debris. The DON levels did not differ significantly between corn debris and no debris microplots in any of the eleven wheat environments.

Impact:

With only two years of data it is difficult to determine the impact of this research. In Missouri the weather conditions during both the 2009 and 2010 growing seasons were so favorable for the development of FHB and DON that the presence or absence of overwintered corn debris in the microplot cage had little effect. A year in which FHB occurs at more moderate level might give results which would have more significance to producers.

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.

Bergstrom, G.C., K.D. Waxman, D.G. Schmale III, C.A. Bradley, L.E. Sweets, S.N. Wegulo and M.D. Keller. 2010. Effects of within-field corn debris in microplots on FHB and DON in eleven U.S. wheat environments in 2010. Proceedings of the 2010 National Fusarium Forum, Milwaukee, WI, December 7-9, 2010. P. 69-70. Abstract in proceedings and poster at forum.

Willyerd, K., L. Madden, M. McMullen, S. Wegulo, B. Bockus, L. Sweets, C. Bradley, K. Wise, D. Hershman, G. Bergstrom, A. Grybauskas, L. Osborne, P. Esker and P. Paul. 2010. Inoculated field trials for evaluating FHB/DON Integrated Management Strategies. Proceedings of the 2010 National Fusarium Forum, Milwaukee, WI, December 7-9, 2010. P.109-110.

Yuen, G.Y., C.C. Jochum, S.A. Halley, L.E. Sweets, W. Kirk and D.A. Schisler. 2010. 2010 Uniform biological control trials- preliminary results. Proceedings of the 2010 National Fusarium Forum, Milwaukee, WI, December 7-9, 2010. P.112-115.

Extension Publications:

Missouri Bulletins:

Bradley, Kevin, Laura E. Sweets, Wayne C. Bailey and J. Allen Wrather. 2010. 2011 Missouri pest management guide: corn, grain sorghum, soybean, winter wheat. University of Missouri Extension publication M171. 172 pp.

2010 Newsletter Articles:

Sweets, L.E. Fusarium head blight or scab of wheat. Integrated Pest and Crop Management Newsletter 20 (8).

Sweets, L.E. Wheat disease update. Integrated Pest and Crop Management Newsletter 20 (8).

Sweets, L.E. Wheat disease update for May 17, 2010. Integrated Pest and Crop Management Newsletter 20 (9).

Sweets, L.E. Field crop disease update- May 27, 2010. Integrated Pest and Crop Management Newsletter 20 (10).

Sweets, L.E. Field crop disease update- June 1, 2010. Integrated Pest and Crop Management Newsletter 20 (11).

Sweets, L.E. Evaluate winter wheat seed quality prior to planting. Integrated Pest and Crop Management Newsletter 20 (17).