USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY10 Final Performance Report
July 15, 2011

Cover Page

PI:	Carl Bradley
Institution:	University of Illinois
Address:	Department of Crop Sciences 1102 S. Goodwin Ave. Urbana, IL 61801
E-mail:	carlbrad@illinois.edu
Phone:	217-244-7415
Fax:	217-333-5299
Fiscal Year:	FY10
USDA-ARS Agreement ID:	59-0206-9-076
USDA-ARS Agreement Title:	Applied Managment of Fusarium Head Blight in Illinois.
FY10 USDA-ARS Award Amount:	$ 47,561

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
MGMT	Uniform Fungicide Tests for Control of Fusarium Head Blight in Illinois.	$ 15,610
MGMT	Integrated Management Strategies for Scab in Illinois.	$ 17,561
MGMT	Best Management Practices of FHB in Wheat using Host Resistance and Fungicides.	$ 11,707
MGMT	Within-Field Inoculum from Corn Debris and the Management of FHB/DON.	$ 2,683
	Total ARS Award Amount	**$ 47,561**

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 Fungicide Tests for Control of Fusarium Head Blight in Illinois.*

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

   Growers now have multiple fungicide products to choose from for management of Fusarium head blight (FHB), and information on which products are the best in reducing FHB severity and DON is needed. Even with the currently-registered products, complete control of FHB and DON with fungicides is not possible; thus, it is important to continually evaluate new fungicides for efficacy against FHB and DON. Fungicide application timing is considered a critical component of achieving the best efficacy; however, due to adverse weather conditions or difficulties in scheduling a custom applicator, timely application is not always possible for a grower. Information is needed on how wide the window of application is for the most efficacious fungicides. Although strobilurin fungicides are good tools for controlling foliar diseases, they have been shown to increase DON levels in grain when applied at later growth stages. Information is needed on how late in the growing season these products can be applied without increasing DON levels. Uniform fungicide trials on winter wheat were conducted at five locations in Illinois during the 2009-2010 growing season. To ensure high levels of disease pressure, four of these sites were mist-irrigated to provide conditions conducive 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:

   Uniform fungicide trials were conducted at five locations in Illinois (Monmouth, Urbana, Brownstown, Carbondale, and Dixon Springs). Mist-irrigation was used at all locations except Monmouth to ensure high levels of FHB. The average FHB incidence and DON in the non-treated controls ranged from 35% to 100% and 3.6 to 6.2 ppm, respectively.

   When applied at Feekes growth stage (FGS) 10.5.1, Prosaro (prothioconazole + tebuconazole; Bayer CropScience) fungicide significantly reduced FHB incidence compared to the non-treated control at three of the five locations, and reduced DON at all four locations in which DON was evaluated (DON was not evaluated at the Brownstown location). Caramba (metconazole, BASF Corporation) fungicide reduced FHB incidence at four of the five locations, and reduced DON at four of the locations. The experimental fungicide A9232D (Syngenta Crop Protection) reduced FHB at three locations, and reduced DON at one of the locations.

   Prosaro and Caramba also were applied at FGS 10.5 and 5 days after FGS 10.5.1. When applied at FGS 10.5, Prosaro reduced FHB incidence at one of the five locations and reduced DON at one of the four locations. Caramba reduced FHB incidence at one location and reduced DON at two locations. When applied 5 days after FGS 10.5.1, Prosaro reduced FHB incidence at one location and reduced DON at two locations. Caramba did not reduce FHB incidence when applied at this timing, but did reduce DON three locations.

Headline (pyraclostrobin; BASF) fungicide applied at FGS 9 did not significantly increase DON compared to the non-treated control at any of the four locations. When applied at FGS 10 or 10.5, Headline did increase DON at two locations.

Impact:

Results from Illinois FHB uniform fungicide trials indicate that the window of application for Caramba and Prosaro may be slightly wider than FGS 10.5.1, and that applications within a few days after FGS 10.5.1 may be effective in reducing FHB incidence and DON. Although the importance of applying fungicides at FGS 10.5.1 to manage FHB and DON will continue to be stressed, the results of this study will provide growers with information that applications slightly after FGS 10.5.1 may still provide some level of protection against FHB and DON.

Headline fungicide was shown to increase DON levels compared to a non-treated control when applied as early as the boot stage (FGS 10). This information is alarming, and warrants further investigation. The strobilurin fungicides (which includes Headline fungicide) are excellent tools that can be used for foliar disease management, and are labeled for application to wheat up to the FGS 10.5 growth stage. Growers may be at risk of increasing DON levels if a strobilurin fungicide is applied at FGS 10.5 or later, even though these application timings are on the fungicide labels. Further information is needed to determine if other strobilurin fungicides also can increase DON. In addition, information is needed to determine if strobilurin + triazole fungicide combinations also increase DON.

Data from Illinois uniform fungicide trials were compiled with uniform fungicide trial data received from other states. These multi-state results were used to prepare an abstract and poster for the 2010 National Fusarium Head Blight Forum. Information gleaned from this research project has been used to help prepare a multi-state fungicide efficacy table (compiled by members of the NCERA 184 Small Grain Disease Committee) that Extension personnel, crop consultants, industry personnel, and growers have used to help make FHB management decisions. Additionally, information from this research project has been used to prepare multiple Extension newsletter articles and presentations.

Project 2: *Integrated Management Strategies for Scab in Illinois.*

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

Under severe FHB pressure, using only one control tactic is not effective enough to prevent losses. The use of integrated management tactics is needed to provide the highest levels of FHB and DON control. Research studies were initiated to evaluate the combination effects of crop rotation, moderately-resistant cultivars, and foliar fungicides on FHB severity and DON contamination.

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:

Research trials were conducted at Urbana, Monmouth, and Dixon Springs, IL that evaluated the effect of previous crop (soybean or corn stubble), cultivars ranging in FHB susceptibility level, and fungicide (Prosaro fungicide or non-treated) on FHB and DON. At Carbondale, IL, the effect of cultivars ranging in FHB susceptibility level and fungicide (Prosaro fungicide or non-treated) was evaluated.

Average FHB incidence in the no-fungicide controls ranged from 33% to 85% across all locations, with the Carbondale location having the highest FHB incidence. Average DON levels in the no-fungicide controls ranged from 1.7 to 6.8 ppm across all locations, with the Monmouth location having the highest DON levels.

Impact:

Results indicated that using the best FHB management practices in combination with each other provided the lowest FHB incidence and the lowest DON levels. As an example, averaged over all locations in 2010, DON levels were reduced by 88% when the combination of planting into soybean stubble (rather than corn stubble), planting a resistant cultivar, and applying Prosaro fungicide was used. Information from these results have been used to prepare Extension newsletter articles and presentations and a proceedings paper for the 2010 National Fusarium Head Blight Forum. In addition, these results were presented at the 2011 NCERA 184 meeting in Dallas, TX.

Project 3: *Best Management Practices of FHB in Wheat using Host Resistance and Fungicides.*

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

Suppression of FHB under heavy disease pressure frequently requires more than a single method of control. In this experiment we studied the control of FHB under heavy disease pressure using resistant and susceptible varieties in combination with and without fungicide application. Our hypothesis was that the best suppression of FHB will occur by growing a FHB resistant variety in combination with application of a fungicide at flowering

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 third year of this experiment was conducted in the 2009-2010 growing season. Three Fusarium head blight (FHB) susceptible and nine FHB resistant breeding lines and varieties

were grown and three treatments (no fungicide, Caramba® and Prosaro®) were applied to each variety. A split-plot design with three replications and fungicide treatment as the main plots was used. The plots were grown in a mist-irrigated, inoculated nursery to enhance disease pressure. Data were collected on FHB incidence, severity, % Fusarium damaged kernels, deoxynivalenol content (ppm), grain yield and test weight. A similar experiment was conducted in the 2008 and 2009 growing seasons. Useful data were obtained from all three years, and the resultshave been used extensively in meetings with producers.

The following results are based only on the 2009-2010 experiment.

- Both fungicide and cultivar had a significant effect on all variables.
- Significant interactions between fungicide and cultivar were detected for FDK, DON, and test weight.
- Averaged over all cultivars both Caramba and Prosaro significantly increased yield and test weight, and significantly reduced incidence, FHB index, FDK, ISK index and DON. Only Caramba significantly reduced FHB severity.
- Caramba increased yield by an average of 10.3 bu/A and decreased FDK by 42% and DON by 58%, while Prosaro increased yield by 9.8 bu/A and decreased FDK by 50% and DON by 49%.
- No significant differences were found between Caramba and Prosaro for all measured variables.
- The FHB-resistant cultivars significantly outperformed the FHB-susceptible cultivars, regardless of the treatment, for all parameters.
- When no treatment was applied, yield increased 11.2 bu/A, test weight increased 5.7 lbs/bu., FHB Index decreased 45.2%, FDK decreased 79%, and DON decreased 51%, on average, when FHB-resistant cultivars were grown.
- Resistant cultivars without fungicide significantly outperformed susceptible cultivars with fungicide for all measured traits, except yield and DON.

Impact:

Based on the 2008, 2009 and 2010 data, we clearly demonstrated that best management practices for suppression of FHB under heavy disease pressure include combining a resistant variety with fungicide application. The results from the trial were presented in posters at the 2009 and 2010 Scab Forums, and the results of this experiment have been used extensively locally in Illinois in a number of presentations at field-days and grower meetings to provide producers with important information on best management practices to use for suppression of FHB.

Project 4: *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?

Our experimental objective was 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 eleven variable wheat environments in 2010, 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. The research was conducted in commercial-scale wheat fields in Illinois, Missouri, Nebraska, New York, and Virginia, each following a non-susceptible crop. Replicated (six) microplots containing corn debris from a nearby field or no added debris were set out in each field and were separated by a minimum of 100 ft in each dimension. Wheat spikes above each microplot were rated at soft dough stage for FHB incidence, severity, and index. At grain maturity, at least 100 spikes from each microplot were harvested, dried and shipped to Cornell where grain was threshed from a subsample of spikes and sent to the assigned USWBSI Testing Lab for DON analysis. Mature spikes from each microplot were also suface-disinfested and plated on Fusarium selective media to determine the incidence of spikes infected by *G. zeae*.

Characterization of epidemics over the 11 environments differed through the lenses of visual symptom development, incidence of mature spike infection, and toxin contamination. At every location except Chatham, VA, more than 20% of mature spikes were infected by *G. zeae*, regardless of the degree of symptom development at soft dough stage or the level of DON observed. This suggests that post-anthesis infection was quite common across environments in 2010. Based strictly on FHB index at soft dough, we observed five moderate epidemics (in Illinois, Missouri, and Nebraska) and six mild epidemics (in Nebraska, New York, and Virginia). On the other hand, three of the moderate epidemics, based on symptoms, were associated with toxin levels above 2 ppm. Mean DON levels in the no-debris microplots were 2.9 ppm in Urbana, IL, 4.4 ppm in Columbia, MO, and 12.2 ppm in Novelty, MO, and there was detectable DON at every site except Chatham, VA. Across the 11 environments, there was significantly (P=0.05) higher DON in grain from corn debris microplots (1.8 ppm) than from no-debris microplots (0.2 ppm) only in Bath, NY. It is especially noteworthy that DON levels were not significantly higher in corn debris microplots than no-debris microplots in any of the high DON locations, suggesting the predominance of regional atmospheric inoculum in those locations. FHB incidence, severity, or index was not significantly (P=0.05) higher in corn debris-containing than no-debris microplots in any of the 11 fields at soft dough stage. And only at Wilbur, NE did mature wheat spikes from microplots containing locally overwintered corn debris show a statistically significant increase in infection incidence by *G. zeae* over those from microplots with no corn debris.

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 astounding result is that DON levels did not differ significantly between corn debris and no debris microplots in 20 of the 21 winter wheat environments studied over two years. The single exception was in Bath, New York in 2010, an isolated valley environment with less

surrounding grain corn acreage than other locations. It is especially noteworthy that DON levels were not significantly higher in corn debris microplots than no-debris microplots in any of the high DON locations, suggesting the predominance of regional atmospheric inoculum over within-field inoculum in severe epidemic circumstances.

Impact:

By inference of our results over two years and 21 winter wheat environments, it appears that elimination of corn debris from single wheat fields in major corn-producing regions may have rather limited benefits in terms of reducing FHB and especially of reducing DON contamination of grain. One caveat regarding this interim conclusion is that the microplot experimental design (small area sources of corn debris) we used may have resulted in an underestimation of the contribution of large area sources of corn debris to wheat infection and DON contamination. Much larger replicated plots will be necessary to definitively assess the quantitative contribution of corn debris to local wheat infection and DON accumulation on an agricultural field scale. This is the approach being taken in the FY11 project by Bergstrom et al and being conducted in wheat fields in seven states.

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.

Presentations:

Bradley, C. A. 2011. Management of wheat diseases. Illinois Wheat Association Winter Forum. February 15, 2011, Mt. Vernon, IL.

Bradley, C. A. 2011. Winter wheat disease identification and management. Joint University of Illinois – Purdue University Winter Wheat Workshop, February 28, 2011, Vincennes, IN.

Non-peer reviewed articles

Abstracts and Proceedings:

Bergstrom, G. C., Waxman, K. D., Schmale, D. G., Bradley, C. A., Sweets, L. E., Wegulo, S. N., and Keller, M. D. 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 Head Blight Forum, Milwaukee, WI, pp. 69-70.

Bradley, C. A., Adee, E. A., Ebelhar, S. A., Dill-Macky, R., Wiersma, J. J., Grybauskas, A. P., Kirk, W. W., McMullen, M. P., Halley, S., Milus, E. A., Osborne, L. E., Ruden, K. R., and Young, B. G. 2010. Proceedings of the 2010 National Fusarium Head Blight Forum, Milwaukee, WI, pp. 74.

Bradley, C. A. 2010. A scabby start with a moldy finish: a look back at the major field crop diseases of 2009. Proceedings of the 2010 Illinois Corn and Soybean Classic Meeting Series, pp. 46-51.

Brucker, E. A., Karplus, N. H., Bradley, C. A., and Kolb, F. L. 2010. Evaluation of host plant resistance and fungicide treatment for suppression of Fusarium head blight. Proceedings of the 2010 National Fusarium Head Blight Forum, Milwaukee, WI, pp. 75.

Schisler, D. A., Paul, P., Boehm, M. J., Bradley, C. A., and Dunlap, C. A. 2010. Colonization of wheat heads by antagonist *Cryptococcus flavescens* OH 182.9 when applied alone or in combination with different concentrations of Prosaro and the effect on Fusarium head blight development in field-grown wheat. Proceedings of the 2010 National Fusarium Head Blight Forum, Milwaukee, WI, pp. 98-102.

Willyerd, K. T., Bradley, C. Grybauskas, A., Hershman, D., Madden, L., McMullen, M., Osborne, L., Sweets, and Paul, P. 2010. Multi-state evaluation of integrated management strategies for Fusarium head blight and deoxynivalenol in small grain. Phytopathology 100:S137.

Willyerd, K., Madden, L., McMullen, M., Wegulo, S., Bockus, B., Sweets, L., Bradley, C., Wise, K., Hershman, D., Bergstrom, G., Grybauskas, A., Osborne, L., Esker, P., and Paul, P. 2010. Inoculated field trials for evaluating FHB/DON integrated management strategies. Proceedings of the 2010 National Fusarium Head Blight Forum, Milwaukee, WI, pp. 109-110.

Extension Publications, Articles:

Illinois Pest Management and Crop Development Bulletin Newsletter Articles (available at http://ipm.illinois.edu/bulletin/index.php*)*

Bradley, C. A. 2010. Wheat disease update. Issue 4, April 29, 2010.

Bradley, C. A. 2010. Update on scab and wheat rusts in Illinois. Issue 8, May 28, 2010.