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

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Fiscal Year:	2008
USDA-ARS Agreement ID:	59-0790-4-114
USDA-ARS Agreement Title:	Collaborative Studies of Fungicides and Application Techniques for Improved Control of Fusarium Head Blight.
FY08 USDA-ARS Award Amount:	$ 89,245

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Adjusted Award Amount
MGMT	Greenhouse Studies of Environmental Influences on DON Production in Wheat.	$29,063
MGMT	Integrated Cropping System Study across Multiple Grain Classes and Locations, ND.	$ 48,439
MGMT	Uniform Fungicide Trials to Evaluate FHB and DON Reduction in Multiple Grain Classes, ND.	$ 11,743
	Total Award Amount	**$ 89,245**

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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
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: *Greenhouse Studies of Environmental Influences on DON Production in Wheat.*

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

The growth stages of susceptibility to FHB and DON accumulation may vary among grain classes and a variety's level of susceptibility to FHB. Duration of post-flowering moisture also may affect severity of disease and different grain classes or varieties may react differently to moisture duration. Determining effects of moisture duration and infection growth stages on FHB severity and DON in varying classes and varieties will help determine optimum fungicide application and or harvest strategies.

FHB susceptible and moderately resistant cultivars of hard red spring wheat (Trooper and Glenn) and durum wheat (Monroe and Divide) were grown in the greenhouse and inoculated with spores of *Fusarium graminearum* at one of four growth stages: Feekes 10.5 = full head emergence; Feekes 10.51 = flowering; Feekes 10.54 = kernel watery ripe; and Feekes 11.2 = soft dough stage. Following inoculation, plats were exposed to 2 days, 5 days total of intermittent misting under an overhead RainBird sprinkler, delivering mist every 15 minutes, four times/night. Plants were then grown to maturity. Three replications of each 4 varieties x 4 growth stages x 3 misting periods were evaluated.

Results indicate that the most susceptible growth stage for infection and highest DON accumulation often occurred with inoculations at Feekes 10.51, but substantial FHB severity and DON accumulations occurred in susceptible cultivars even at Feekes 10.54 and Feekes 11.2, with 5 or 10 days of misting. Two days of mist always had the lowest disease parameters, and in resistant cultivars, almost no disease occurred with two days of mist. The two MR varieties, Divide durum and Glenn spring wheat had approximately half the level of FHB and DON accumulation than the susceptible cultivars at mist periods of 5 and 10 days.

The acetyl derivatives of DON - 3ADON and 15ADON - also were measured; the occurrence of these 3ADON and 15ADON was very infrequent and almost exclusively occurred associated with the susceptible cultivars and when the corresponding DON levels were very high, >25 ppm.

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: Identified that at the Feekes 10.5 growth stage, almost no infection occurs, even with controlled inoculation and long periods of dew. Thus, an application of fungicide at this stage is probably too early. With demonstration that long dew periods at later growth stages allow infection and DON accumulation, application of fungicides up to Feekes 10.54 may be warranted, if environmental conditions are favorable. Fungicide applications at Feekes 11.2 are currently not allowed because of the pre-harvest interval restrictions on the fungicide labels.

Impact: Growers can be advised as to the appropriate growth stages for fungicide application, and be informed that infection and DON accumulation can occur, even at late growth stages. FHB infection and DON accumulation in spring grains does not occur at Feekes 10.5, so application of a fungicide at this growth stage generally is too early. Applications from Feekes 10.51 to Feekes 10.54 growth stage will provide the greatest protection, and application decisions during this period should be made based on disease forecasting models. Very late infections (Feekes 11.2) are generally not treatable with fungicides, because of current pre-harvest intervals, but late infections at this time may necessitate prompt harvesting or pre-harvest "burn-down". Also, this project demonstrated that MR varieties are much more resistant to infection and DON accumulation, no matter what the duration of misting, information which will help spread the word about the value of these varieties and lead to increased acreage of the more resistant varieties.

Project 2: *Integrated Cropping System Study across Multiple Grain Classes and Locations, ND.*

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

   Fusarium head blight is a complex disease and multiple strategies of management are needed to reduce the disease to satisfactory levels, especially under epidemic situations. No one strategy alone has the capacity to bring the level of the disease down to acceptable FHB and DON levels when environment is very favorable. The purpose of this multi-state project is to demonstrate that the use of two or more management strategies in combination is more satisfactory in managing FHB than a single strategy.

   In ND, integrated management strategies were studies on winter wheat (variety x fungicide interactions at Lisbon, ND; Joel Ransom coordinator); on spring wheat (variety x fungicide x crop rotation practice at Carrington; Marcia McMullen coordinator); on spring wheat (variety x fungicide at Langdon; Scott Halley and Bryan Hanson, coordinators) and on spring barley (variety x fungicide x crop rotation at Carrington, Stephen Neate and Pat Gross Coordinators; and at Langdon; Scott Halley, coordinator).

   Overall, FHB at all sites was lower in 2008 than 2007. However, significant differences in FHB, DON and yield generally were evident with management practices. In winter wheat at Lisbon, ND, Prosaro fungicide application in combination with more resistant varieties resulted in an approximate 50% reduction in FHB severity and 8-10 bu yield increase over use of a resistant variety alone. Reduction of FHB severity in spring wheat at Carrington was approximately 80% by growing varieties on soybean ground vs wheat ground, and Prosaro fungicide applied at flowering reduced FHB severity by 67.4% averaged over 4 varieties. Fungicides on spring wheat at Langdon reduced FHB severity by 70% and increased yield by 6.1 bu when averaged over 18 cultivars. Fungicide reduced DON accumulation by 77.2% on the most susceptible cultivar, while a combination of resistant cultivar and fungicide application always resulted in the lowest DON levels (0.3 ppm) vs 5.3 ppm on a susceptible cultivar that was untreated (treatment of this cultivar reduced DON to 1.4 ppm).

   In 6-row barley at Carrington, DON was reduced by 40% with fungicide application, and DON levels were reduced by 60% with barley grown on soybean ground instead of wheat ground. A combination of fungicide plus good rotations resulted in the greatest reduction of FHB severity in 2-rowed barley, a 26% greater reduction of DON than no fungicide and no rotation. At Langdon, DON levels in barley averaged around 1.5 for the untreated checks, but the lowest DON was achieved with both test varieties when Proline was applied, an 86% reduction on the susceptible cultivar and an 82% reduction on the more resistant experimental line.

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 continue to demonstrate that multiple strategies of good resistance, fungicide application and appropriate rotational host improves FHB management and gives the best reductions in FHB severity and DON accumulation, even under less severe outbreaks of FHB. Thus, good strategies are beneficial even in the absence of an severe FHB epidemic.

Impact: This information provides valuable evidence that disease management for FHB should be an integrated approach in these spring grain classes. Reliance on a variety's level of resistance may not be enough in an epidemic situation, but even under milder levels of FHB and DON, use of variety in conjunction with fungicide, and/or in conjunction with good rotations, is beneficial to yield and quality parameters. This evidence may be used to continue to demonstrate to producers the value of various management practices and how integration works.

Project 3: *Uniform Fungicide Trials to Evaluate FHB and DON Reduction in Multiple Grain Classes, ND.*

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

   Foliar fungicide application is one of the key components of an integrated disease management system for FHB and the associated mycotoxins. Although different fungicides are registered for small grains, applying the most efficacious fungicide for FHB and DON reduction is important. The USWBSI sponsored uniform fungicide trials across multiple states and grain classes have provided useful information on fungicide efficacy and this data has been critical for some of the recent federal registrations achieved (2007 and 2008) for the best FHB fungicides (triazole products). Growers now have some good products to chose from, but even these best generally have some limitations, such as pre-harvest interval, possible development in the future of resistance, and timing of application unknowns. Additional research should be conducted to determine effect of timings later than Feekes 10.51 on FHB and DON, and also to look at new combinations of products, or at any new chemistries that may become available.

   The 2008 uniform fungicide trials looked at 6 treatments compared to the check, and looked at efficacy of four triazoles, one at two rates, and a flutriafol product. The flutriafol product does not have registration for wheat or barley. In ND, the uniform fungicide protocol was done at 3 locations (Fargo, Carrington, and Langdon, representing three different environments) and on three grain classes, spring wheat, durum wheat and spring barley, with multiple varieties in the tests.

   In all ND studies, FHB was not severe, only light to moderate levels of infection. In all studies, the flutriafol product was not as efficacious in reducing FHB or DON as the Folicur, Prosaro, Proline or Caramba products tested. Reduction of FHB and DON was the greatest in wheat and durum with Prosaro at 6.5 lf oz/acre, Proline at 5 fl oz/acre, or Caramba at 14 fl oz/acre. In spring wheat and durum, reductions in FHB ranged from 65% to 92% and DON reductions ranged from 66 % to 100%. In barley, the highest DON reduction was with Proline fungicide, a 92% reduction. Yield increases with the best products ranged from 11% to 17.3%, depending on the trial. In all cases with the best products, yield and quality responses would have been economic with fungicide use, under the 2008 grain prices.

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 uniform fungicide trial group continues to demonstrate which products have the greatest efficacy against FHB and DON accumulation, under a wide range of environments and across multiple grain classes. This data shows that producers have some options for FHB management by using good fungicides, even in years or locations when severe epidemics are not present.

Impact: The impact of the 2008 data is that fungicides that have just been registered are very efficacious in reducing FHB and DON across all these spring grain classes. This information was widely distributed at grower meetings, crop consultant meetings, and various field days and workshops in ND. The information is regularly used by ND producers for making fungicide decisions.

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.

Bradley, C.A., and McMullen, M. P. "Fungicides for FHB Management: Past, Present, and Future." In: Canty, S.M., E. Walton, A. Clark, D. Ellis, J. Mundell, and D. Van Sanford. Proc. of 2008 National Fusarium Head Blight Forum. Dec. 2-4, 2008. Indianapolis, IN. Lexington, KY: University of Kentucky. p.12.

Bradley, C.A., Adee, E., Ebelhar, S., Young, B., Burrows, M., McMullen, M., Luakch, J., Osborne, L., Ruden, K., Sweets, L., and Wise, K. "Multi-State Uniform Fungicide Trials to Control Fusarium Head Blight and Deoxynivalenol." In: Canty, S.M., E. Walton, A. Clark, D. Ellis, J. Mundell, and D. Van Sanford. Proc. of 2008 National Fusarium Head Blight Forum. Dec. 2-4, 2008. Indianapolis, IN. Lexington, KY: University of Kentucky. pp.13-16.

Burlakoti, R. R., Ali, S., Secor G. A., Neate, S. M., McMullen, M. P., and Adhikari, T. B. 2008. "Genetic Relationships Among Populations of *Gibberella zeae* from Barley, Wheat, Potato, and Sugar Beet in the Upper Midwest of the United States." Phytopathology 98:969-976.

Burlakoti, R.R., Ali, S., Secor, G.A., Neate, S.M., McMullen, M.P., and Adhikari, T.B. 2008. "Comparative Mycotoxin Profiles of *Gibberella zeae* Populations from Barley, Wheat, Potato, and Sugar Beet." J. of Applied and Environmental Microbiology (AEM) 74:6513-6520.

Halley, S., Van Ee, G., Hofman, V., McMullen, M., Hollingsworth, C., and Ruden, B. 2008. "Ground Application of Fungicide for the Suppression of Fusarium Head Blight in Small Grains." NDSU Ext. Circular AE-1314 (revised). 4p.

McMullen, M., Jordahl, J., and Meyer, S. "Infection Timing and Moisture Duration Effects on FHB and DON Development in Spring Wheat and Durum." In: Canty, S.M., E. Walton, A. Clark, D. Ellis, J. Mundell, and D. Van Sanford. Proc. of 2008 National Fusarium Head Blight Forum. Dec. 2-4, 2008. Indianapolis, IN. Lexington, KY: University of Kentucky. p. 43.

McMullen, M., Halley, S., Schatz, B., Meyer, S., Jordahl, J., and Ransom, J. 2008. "Integrated Strategies for Fusarium Head Blight Management in the United States." Cereal Research Comm. 36, Suppl. B: 563-568.

McMullen, M. 2008. Integrated Pest Management. Page 33 in: NDSU 2009 Crop Production Guide No. 19, NDSU Extension Service. 271 p.

McMullen, Marcia P. and Markell, Samuel G. 2008. 2009 North Dakota Field Crop Fungicide Guide. NDSU Extension Circular PP-622 (revised). 62p.

McMullen, M., Zhong, S., and Neate, S. 2008. Fusarium Head Blight (scab) of Small Grains. NDSU Extension Circular PP-804 (revised). 4 p.

McMullen, M., Meyer, S., and Jordahl, J. 2009. "Evaluation of Fungicides for Reduction of Fusarium Head Blight and Foliar Diseases in Barley, 2008." In: Plant Disease Management Reports, American Phytopathological Soc. online publication: http://www.plantmanagementnetwork.org/pub/trial/PDMR/reports/2009/CF010.pdf

McMullen, M., Jordahl, J., and Meyer, S. 2009. "Evaluation of Fungicides for Reduction of Fusarium Head Blight and Foliar Diseases in Wheat, 2008." In: Plant Disease Management Reports, American Phytopathological Soc. online publication: http://www.plantmanagementnetwork.org/pub/trial/PDMR/reports/2009/CF011.pdf

Paul, P.A., Madden, L., McMullen, M., Hershman, D., Sweets, L., Wegulo, S., Halley, S., Osborne, L., Ruden, K., and Padgett, B. "Integrated Management of FHB and DON in Small Grian: 2008 Uniform Trials." In: Canty, S.M., E. Walton, A. Clark, D. Ellis, J. Mundell, and D. Van Sanford. Proc. of 2008 National Fusarium Head Blight Forum. Dec. 2-4, 2008. Indianapolis, IN. Lexington, KY: University of Kentucky. pp.52-55.

Ransom, J.K., and McMullen, M.V. 2008. Yield and Disease Control on Hard Winter Wheat Cultivars with Foliar Fungicides. Agronomy J. 100:1130-1137.

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.