USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY11 Final Performance Report
One-Year No Cost Extension (NCE) through FY12
July 16, 2013

Cover Page

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Fiscal Year:	FY11 (NCE for FY12)
USDA-ARS Agreement ID:	59-0206-9-060
USDA-ARS Agreement Title:	Development and Validation of FHB and DON Predictive Models for Barley.
FY11 USDA-ARS Award Amount:	$ 48,150

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
BAR-CP	Validation and Refinement of DON Models in Barley for the Northern Great Plains.	$ 26,687
HWW-CP	Using Association Mapping to Identify and Validate New FHB Resistance QTL and Integrate the QTL into HWW.	$ 3,902
MGMT	Determining the Contribution of Secondary Tillers to Total DON Concentration.	$ 17,561
	Total ARS Award Amount	**$ 48,150**

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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: *Validation and Refinement of DON Models in Barley for the Northern Great Plains.*

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

Fusarium head blight (FHB) of barley continues to be a serious problem for producers in the Northern Great Plains. Barley production in the Dakotas and Minnesota has declined drastically since 1993 and this can be attributed to, at least in part, a single disease of Fusarium head blight. The disease impacts barley production by affecting both grain yield due to less gain filling and seed weight and the accumulation of deoxynivalenol (DON) in the grain. Accumulation of DON in malting barley not only is human health risk, but also make difficult to make beer due gushing problem. Models exist for predicting disease development in wheat, however they are not effective for FHB development and DON production in barley. We are addressing this issue by developing and validating models for forecasting systems that can predict disease and/or DON accumulation in malting barley. The information provided by this model will offer extension specialists, consultants, and producers the information required to make effective management decisions or recommendations.

The objectives of the proposed research were to 1) contribute to the development of an experimental database containing information on cultural practices, weather, and resulting field disease and mycotoxin levels for barley and 2) validate and refine the models for FHB and DON accumulation in barley. Objective 1 was conducted at South Dakota State University. Plots were planted at 8 locations throughout the state of South Dakota and the environment monitored at each location during the growing season. Field ratings of disease were taken and DON concentration in the grain was quantified. In 2012, barley field plots at 6 locations across the state were established and rated for FHB development. The disease was not observed, except on few infected heads at a couple of locations, at all 6 locations, and it might be due to warm and dry weather conditions at heading through late milk. For objective 2, predicted risk was calculated at all locations using the 2-dimensional Weibull model developed from the six growing seasons prior to 2012. This was then compared with the observed risk to estimate the model efficiency.

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>

Two significant accomplishments were achieved throughout the project duration. First, the model was validated with the 8 locations from the region and found that the model had a prediction accuracy of 70% using 2011 weather data. Second, in 2011, the model has been deployed for the disease forecast and risk of DON production for barley growers and other personals associated with barley production by creating a website by Dr. Robert Bruggeman,

Barley Pathologist, North Dakota State University, Fargo. The system is already in operation for the 2013-growing season on NDSU webpage.

Impact:

The disease forecasting model is available on NDSU website and it helps the consultants and producers to make informed decisions about FHB and DON in Barley.

Project 2: *Using Association Mapping to Identify and Validate New FHB Resistance QTL and Integrate the QTL into HWW.*

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

Since 1993, regular scab epidemics have occurred in the hard winter wheat crop of the central and northern Great Plains. A combination of FHB resistant cultivars, fungicide application and other cultural practices seems the best strategy to combat this disease and decrease DON contamination under the recommended limit. There are multiple sources of moderate resistance already present in hard winter wheat germplasm adapted to the region. To best use this germplasm in varietal improvement efforts; the quantitative trait loci (QTL) associated with this resistant should be mapped so that breeders can employ marker-assisted selection to accelerate efforts to develop FHB-resistant lines. This project is part of a larger effort to use association mapping to identify these QTL. The South Dakota State University role in this project was minor, primarily providing some phenotypic data. Drs. Guihua Bai and Stephen Baenziger will submit a detailed progress report on this project.

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:

Phenotypic data for FHB have been obtained from both greenhouse and field disease screening experiments throughout the project duration and the data have been submitted to Dr. Stephen Baenziger (UNL).

Impact:

The phenotypic data of the population collected from SDSU and collaborators will be important for breeders to better select parents for crosses because the population mainly consisted of elite breeding materials and new varieties that breeders use most often as parents in their crosses.

Project 3: *Determining the Contribution of Secondary Tillers to Total DON Concentration.*

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

   Some studies in the past have reported that late infection of wheat and barley results in low disease development but high DON concentration. Formation of higher number of tillers is desirable as it has positive impact on final grain yield. Lateral tillers of wheat and barley, however, have delayed physiological development, which might correlate with the late infection findings. Studies addressing the contribution of secondary tillers in final DON concentration are limited. This project aims to improve our understanding of the relationship between FHB symptoms and DON concentration by examining the contribution of main stem and secondary tillers as it relates to the final DON concentration.

   An understanding of the contribution of secondary tillers in final DON levels in Fusarium-infected wheat and barley heads can be used in disease management, as farmers can use cultivar selection based on tiller numbers depending upon the contribution they provide to DON levels. Adjustments in planting density may also help to manipulate tillering in wheat and barley as required. Further, knowledge obtained from the study might be useful to breeders so that they can consider tillering characteristics in FHB resistant cultivar breeding.

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:

   Field experiment was conducted to evaluate contribution of main spike vs. secondary tillers. Our result suggests that FHB severity tends to be higher in primary spikes than tiller in wheat when infection occurs under favorable weather conditions for the disease development. Similarly, primary spikes have larger contribution towards total DON levels at harvest than tillers.

   Impact:

   This study has improved our knowledge on FHB development and DON production especially in terms of contributions of spikes type. The result has been shared with other colleague working in FHB disease and in the process of publication. Breeders can utilize the information that development of cultivars with fewer tillers is advisable to get low level of DON in the final harvest grain. Further, based on the result obtained from the study, growers can opt to denser planting density to avoid high tillering and consequently high DON levels in the final harvest. The role of primary and secondary tillers spikes in FHB development and DON production will also help in improving the scab-forecasting model.

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.

1. Bondalapati, K. D., Stein, J. M., Neate, S. M., Halley, S. H., Osborne, L. E., and Hollingsworth, C. R. 2012. Development of weather-based predictive models for Fusarium head blight and deoxynivalenol accumulation for spring malting barley. Plant Dis. 96:673-680.
2. Gautam, P., K. D. Bondalapati and J. M. Stein. 2011. Barley Scab: Forecasting to management. In: Canty, S.M., A. Clark, A. Anderson-Scully, D. Ellis, and D.A. Van Sanford (Eds.), Proceedings of the National Fusarium Head Blight Forum; 2008 Dec 2-4; Indianapolis, IN. Lexington, KY. University of Kentucky pp:136
3. Gautam, P., S. Halley and J. Stein. 2012. Deoxynivalenol concentration in primary spikes and tillers of barley and wheat. In: Proceedings of APS Meeting, August 4-8, Providence, RI.
4. Gautam, P., S. Halley and J. Stein. 2012. Contribution of primary spikes vs. tillers to total deoxynivalenol in harvested grain of wheat and barley. American Journal of Agricultural and Biological Sciences (in press).
5. Gautam, P. 2011. Contribution of secondary tillers to total deoxynivalenol concentration in harvest grain. In: Canty, S.M., A. Clark, A. Anderson-Scully, D. Ellis, and D.A. Van Sanford (Eds.), Proceedings of the National Fusarium Head Blight Forum; 2008 Dec 2-4; Indianapolis, IN. Lexington, KY. University of Kentucky pp:137