

**USDA-ARS/  
U.S. Wheat and Barley Scab Initiative  
FY09 Final Performance Report  
July 15, 2010**

**Cover Page**

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<b>Fiscal Year:</b>	2009
<b>USDA-ARS Agreement ID:</b>	59-0206-9-072
<b>USDA-ARS Agreement Title:</b>	Breeding and Genetics of Fusarium Head Blight Resistance in Barley.
<b>FY09- USDA-ARS Award Amount:</b>	\$ 140,080

**USWBSI Individual Project(s)**

<b>USWBSI Research Category*</b>	<b>Project Title</b>	<b>ARS Adjusted Award Amount</b>
BAR-CP	Breeding FHB Resistant Six-rowed Varieties.	\$ 86,545
BAR-CP	Mapping and Validating FHB Resistance QTL in Barley.	\$ 53,535
	<b>Total Award Amount</b>	<b>\$ 140,080</b>

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Principal Investigator

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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 Winter Wheat Region  
 SWW – Southern Sinter Wheat Region

**Project 1:** *Breeding FHB Resistant Six-rowed Varieties.*

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

None of the currently grown six-rowed malting barley varieties are more resistant than the variety Robust which has dominated the barley acreage in the Midwest since 1986. We are conducting a comprehensive field-based breeding effort along with implementation of marker assisted selection (MAS) to develop new barley varieties with enhanced FHB resistance. In order for these new varieties to be adopted by growers they must also be agronomically competitive with current varieties and meet the quality standards of the malting and brewing industries. We conduct extensive field evaluation of FHB resistance in inoculated and mist-irrigated nurseries in three locations in Minnesota. Last year we evaluated over 13,000 plots for FHB resistance and submitted over 3,000 grain samples for DON analysis. We are currently only entering lines with enhanced FHB resistance and lower DON levels to the industry malting and brewing tests.

**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:**

One of our variety candidates, M122, is currently in AMBA plant-scale brewing evaluations. This variety was rated satisfactory in its first year of testing by two major brewers. We released M122 as the variety Quest in January 2010. Quest accumulates about half the level of DON compared to the dominant varieties Tradition and Lacey.

Variety candidate M135 was rated satisfactory for quality in two years of AMBA pilot testing. M135 is now eligible for plant scale evaluation. M135 is not quite as resistant as Quest, but has better lodging resistance and similar yield. We are currently reviewing data to determine next steps in industry evaluations.

**Impact:**

The impact of this work will be assessed after the commercial production of Quest in 2011.

**Project 2:** *Mapping and Validating FHB Resistance QTL in Barley.*

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

Progress in breeding for FHB resistance in barley to date has relied entirely on field-based phenotypic selection for disease severity and DON concentration of grain samples. Use of marker assisted selection (MAS) in early generations could provide a valuable tool to enrich breeding populations for resistance alleles at quantitative trait loci (QTL) or by predicting the breeding value of lines using genomic selection prior to screening in the field. A major hurdle to using currently available QTL information for MAS is linkage of the resistance alleles to several undesirable traits (late heading, high grain protein concentration, tall plant height). Our project is focused on characterizing several important QTL regions in barley and resolving undesirable linkages. This information will lead to the implementation of MAS for FHB resistance in barley to complement ongoing traditional breeding efforts. We are currently involved in fine mapping two QTL regions (chromosomes 2H and 6H). We are also using association mapping with breeding germplasm to identify new QTL that have not been discovered in traditional bi-parental mapping populations and that are presumably free of undesirable linkages due to selection within the breeding programs. The association mapping is collaborative with the Busch Agriculture and North Dakota State University breeding and pathology programs and is primarily supported by the USDA Barley Coordinated Agricultural Project (CAP).

**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 are currently analyzing data from years 1-4 of the association mapping project. Similar regions were identified and confirmed to the eight QTL for DON association recently published based on years 1 and 2. To validate these associations we have developed a set of 220 near isogenic line pairs covering many of the DON and FHB QTL identified by association mapping. These lines were planted in two FHB nursery locations in 2010 and will be evaluated for FHB and harvested to determine DON content in the coming weeks.

The association mapping data set is also being used to develop a genomic selection model that will be implemented this Fall.

**Impact:**

Several populations each year are subjected to MAS for specific QTL regions and contribute to the sets of resistant lines that move forward in our breeding program.

Results from this study have encouraged us to employ a new genomic selection approach to improve FHB resistance. This approach will begin delivering new breeding lines that can be evaluated in yield trials in 2011. This is a novel collaborative breeding effort among the University of Minnesota, North Dakota State University, and Busch Agriculture barley breeding programs.

**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.**

Release Quest (formerly M122) in January 2010. Quest has a 50% reduction in disease severity and DON levels compared to Robust, Lacey, and Tradition which currently occupy most of the acreage in the Midwest.

**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.**

Peer-reviewed

Massman, J., B. Cooper, R. Horsley, S. Neate, R. Dill-Macky, S. Chao, Y. Dong, P. Schwarz, G. J. Muehlbauer and K. P. Smith. 2010. Genome-wide association mapping of Fusarium head blight resistance in contemporary barley breeding germplasm. *Mol. Breeding* (in press).

Hamblin, M., T. Close, P. Bhat, S. Chao, K. Abraham, T. Blake, W. Brooks, D. Cooper, C. Griffey, P. Hayes, D. Hole, R. Horsley, D. Obert, K. P. Smith, S. Ullrich, G. Muehlbauer, J-L Jannink. 2010. Population structure and linkage disequilibrium in US barley germplasm: implications for association mapping. *Crop Sci.* (in press)

Non-Peer-reviewed

Mapping QTL for FHB resistance and DON accumulation in barley population COMP351 x M98-102. K.A. Beaubien, T. Szinyei, K.P. Smith and B.J. Steffenson. 2009. Proceedings of the 2009 National Fusarium Head Blight Forum. Wyndham Orlando Resort Orlando, Florida USA, 7-9 December, 2009. P. 109.

Association mapping QTL for FHB resistance in six-row barley breeding lines S. Navara and K.P. Smith. 2009. Proceedings of the 2009 National Fusarium Head Blight Forum. Wyndham Orlando Resort Orlando, Florida USA, 7-9 December, 2009. P. 140

Aggressiveness and Mycotoxin Potential of U.S. *Fusarium graminearum* Populations in Field-Grown Wheat and Barley. 2009. Liane R. Gale, Ruth Dill-Macky, James A. Anderson, Kevin P. Smith and H. Corby Kistler. Proceedings of the 2009 National Fusarium Head Blight Forum. Wyndham Orlando Resort Orlando, Florida USA, 7-9 December, 2009. P. 173.

Characterization of *Fusarium* head blight-responsive genes in diverse wild and cultivated barley. 2009. Benjamin P. Millett, Karen A. Beaubian, Stephanie K. Dahl, Brian J. Steffenson, Kevin P. Smith and Gary J. Muehlbauer. Proceedings of the 2009 National Fusarium Head Blight Forum. Wyndham Orlando Resort Orlando, Florida USA, 7-9 December, 2009. P. 173.

Smith, K. P. 2010. Quest – A new barley variety with improved scab resistance. *Fusarium Focus* Vol 10 Issue 1, P.6.

Smith, K. P. 2010. University of Minnesota releases barley variety ‘Quest’ with improved scab resistance. *Prairie Grains*, April 2010. P. 22.

Smith, K. P. 2009. Advanced Cycle Breeding Six-rowed Malting Barley for the USA. Australian Barley Technical Symposium, Sunshine Coast, Queensland, Australia Sept 13-16, 2009.

Powers, C. A and K. P. Smith. 2009. Patterns of LD within a barley breeding program: Impact of breeding history. *Plant & Animal Genomes XVII Conference*. January 10-14, 2009, Town & Country Convention Center, San Diego, CA. P267.