USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY06 Final Performance Report (approx. May 06 – April 07)
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Cover Page

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Fiscal Year:	2006
USDA-ARS Agreement ID:	59-0790-4-106
USDA-ARS Agreement Title:	An Integrated Approach for Developing Scab Resistant Barley
FY06 ARS Award Amount:	$ 152,034

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Award Amount
EC/HQ	Multi-State Barley Winter Nursery - FY06 (05/06).	$ 13,386
HGR	Evaluation of Barley for FHB Resistance in China.	$ 21,036
VDUN	Development of Scab Resistant Six-rowed Barley Varieties for North Dakota.	$ 117,612
	Total Award Amount	**$ 152,034**

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Principal Investigator Date

* CBCC – Chemical, Biological & Cultural Control
EEDF – Etiology, Epidemiology & Disease Forecasting
FSTU – Food Safety, Toxicology, & Utilization of Mycotoxin-contaminated Grain
GET – Genetic Engineering & Transformation
HGR – Host Genetics Resources
HGG – Host Genetics & Genomics
PGG – Pathogen Genetics & Genomics
VDUN – Variety Development & Uniform Nurseries

Project 1: *Multi-State Barley Winter Nursery - FY06 (05/06).*

1. What major problem or issue is being resolved and how are you resolving it?

Each year, the Barley Improvement Program at NDSU makes over 300 crosses in the hope that a new cultivar will be developed. From the time of crossing to variety release, 10 to 12 years of extensive testing are done on experimental lines to evaluate their agronomic, malting, and brewing quality traits. One component in the development of new varieties is the use of winter nurseries at a southern location. North Dakota State University has made good use of this southern increase for over thirty-five years with the assistance of the American Malting Barley Association and the Malting Barley Improvement Association. The purpose of the winter nursery is: 1) to increase seed volume of experimental lines of barley to allow planting of these lines in yield trials one or two years earlier than would be possible otherwise, 2) to grow F_2 populations of selected crosses for more rapid development, and 3) to grow head rows of selected advanced lines for purification prior to release as varieties. Use of a winter nursery decreases the time from making the cross to variety release by two or three years.

2. List the most important accomplishment and its impact (how is it being used?). Complete all three sections (repeat sections for each major accomplishment):

Accomplishment:
Increase seed for approximately 300 F_5 barley lines with possible FHB resistance was harvested and used to sow replicated preliminary yield trials at two locations in North Dakota.

Impact:
The percentage of lines from the NDSU barley program with reduced FHB severity and DON accumulation continues to increase. Lines from the 2005-2006 winter nursery could enter testing by the American Malting Barley Association as early as 2009.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before?
One line each from the NDSU six-rowed barley breeding project has been accepted for Plant Scale Evaluation by the American Malting Barley Association (AMBA). This is the first NDSU line to be recommended for evaluation in this last step of testing by the AMBA's members. The percentage of lines entered in testing by the AMBA with FHB resistance will continue to increase.

Project 2: *Evaluation of Barley for FHB Resistance in China.*

1. What major problem or issue is being resolved and how are you resolving it?

The ultimate goal of this project is to develop malting barley cultivars resistant to Fusarium head blight. Breeding materials from three upper Midwest barley improvement programs and the ICARDA/CIMMYT barley breeding program were screened in an off-season nursery at Zhejiang University – Hangzhou, China. This nursery has been used for screening upper Midwest barley germplasm since 1995 and over 5,000 entries are screened each year. Materials included in the 2006-07 nursery were breeding lines developed at North Dakota State University, mapping populations developed at North Dakota State University and the University of Minnesota, elite lines from three upper Midwest barley breeding programs and ICARDA/CIMMYT, and spring and winter barley accessions from germplasm collections around the world.

The Hangzhou, China nursery allows us to conduct a field screen for FHB resistance where FHB is the only head blighting disease. Head blight caused by bacteria or fungal pathogens such as *Cochliobolus sativum* often confound the results observed in the upper Midwest U.S. Another unique feature about the nursery is that the range in heading date between barley lines with a spring, winter, or facultative growth habit is less than two weeks. Thus, germplasm with all three types of growth habit can be screened in the same nursery. Finally, the "best" germplasm from several different barley-breeding programs is screened at a common location. Thus, the FHB resistance of all elite germplasm can be directly compared, and breeders can identify lines they wish to advance in their programs or obtain from other breeders to use as parents for their next cycle of crossing.

2. List the most important accomplishment and its impact (how is it being used?). Complete all three sections (repeat sections for each major accomplishment):

Accomplishment:

Accurate and robust assessment of resistance to FHB in barley requires field evaluation in multiple experiments in carefully established disease nurseries. The Hangzhou nursery has repeatedly provided high quality disease information on a wide range of breeding and genetic material. The most significant accomplishments for the NDSU materials screened are confirmation that lines identified in 2006 in the six-rowed and two-rowed barley breeding programs have significantly better FHB resistance that currently grown cultivars. A mapping population from the cross Shenmai 3 x Rawson was evaluated for FHB severity and spikes were harvested and sent back to Fargo for DON determination. Shenmai 3 is a Chinese cultivar with FHB resistance, low DON accumulation, early maturity, and acceptable plant height. This cultivar represents an important discovery in the search for lines to be used as sources of FHB resistance by barley breeders.

The most important data collected on the University of Minnesota (U of M) entries were related to the evaluation of recombinant near-isogenic lines (NIL) in two QTL regions. One in particular, the bin 8 region of chromosome 2H contains, tightly linked QTL for FHB and

heading date. We collected data on NIL that segregate for the Chevron allele at linked segments in this region. The size of the nursery was expanded by 3,000 rows to accommodate additional screening of spring and winter barley accessions from germplasm collections from around the world.

Impact:

The percentage of lines from the U of M and NDSU barley programs with reduced FHB severity and DON accumulation continues to increase. Malting barley cultivars with improved FHB resistance and lower DON accumulation could be available to growers in less than two years.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before?

One line each from NDSU and the U of M have been accepted for Plant Scale Evaluation by the American Malting Barley Association (AMBA). These are the first two lines to be recommended for evaluation in this last step of testing by the AMBA's members.

Project 3: *Development of Scab Resistant Six-rowed Barley Varieties for North Dakota.*

1. What major problem or issue is being resolved and how are you resolving it?

Fusarium head blight (FHB), primarily incited by *Fusarium graminearum*, adversely affected the quality of barley grown in portions of eastern North Dakota and northwestern Minnesota the last 14 years. Quality of harvested grain was reduced because of blighted kernels and the presence of deoxynivalenol (DON), a mycotoxin produced by the pathogen. Seeding resistant cultivars is the only promising method of controlling FHB in barley because cultural and chemical controls of FHB have been unsuccessful. Introduced barley cultivars grown in field nurseries in China and North Dakota from 1994 to 2001 were identified with putative FHB resistance. My breeding program is incorporating FHB resistance from several of these sources into elite malting barley germplasm. Production of doubled-haploid (DH) lines and development of markers for molecular marker assisted selection are being used to accelerate development of FHB resistant cultivars.

2. List the most important accomplishment and its impact (how is it being used?). Complete all three sections (repeat sections for each major accomplishment):

Accomplishment:

For the first time, one line from my breeding project (ND20448) with improved FHB resistance and acceptable malt quality was recommended for advancement to the American Malting Barley Association's (AMBA) Plant Scale Evaluation Program. Seed will be increased in summer 2007 and in the 2007-2008 winter nursery to provide sufficient seed to sow 600 acres in North Dakota in 2008. While this line may not have the levels of resistance approaching that of the most resistant accessions, it accumulates about 25% less DON than Robust, the second most widely grown cultivar in the state, has agronomic performance similar to Drummond, and appears to have acceptable malt quality.

Impact:

If released as a cultivar, ND20448 would provide growers for the first time the option of growing a six-rowed FHB-resistant cultivar. When used in combination with a fungicide, growers should have a better opportunity of meeting the DON specifications of the malting and brewing industries.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before?

A six-rowed malting barley cultivar with reduced FHB severity and DON accumulation with acceptable malt quality.

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.

Articles/books/publications

Refereed Journal Articles

Hill, N.S., P. Schwarz, L.S. Dahleen, S.M. Neate, R. Horsley, A.E. Glenn, and K. O'Donnell. 2006. ELISA analysis for *Fusarium* in barley: Development of methodology and field assessment. Crop Sci. 46:2636-2642.

Abstracts

Boyd, C., C. Maier, S. Sushailo, R. Horsley, and A. Kleinhofs. 2006. Genetic and physical mapping of the barley chromosome 2 (2H) *vrs1* region of Fusarium head blight resistance QTL. p. 87. *In* S.M. Canty and D. Van Sanford (eds.) Proc of the 2006 National Fusarium Head Blight Forum, Raleigh, NC 10-12 Dec 2006. Michigan State University, East Lansing, MI.

Hill, N.S., S. Neate, B. Cooper, R. Horsley, P. Schwarz, L.S. Dahleen, K.P. Smith, R. Dill-Macky, K. O'Donnell, and J. Reeves. 2006. Is there value in quantifying *Fusarium* mycelium for breeding FHB resistance? p. 98. *In* S.M. Canty and D. Van Sanford (eds.) Proc of the 2006 National Fusarium Head Blight Forum, Raleigh, NC 10-12 Dec 2006. Michigan State University, East Lansing, MI.