

**USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY07 Final Performance Report (approx. May 07 – April 08)
July 15, 2008**

Cover Page

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Fiscal Year:	2007
USDA-ARS Agreement ID:	59-0790-4-106
USDA-ARS Agreement Title:	An Integrated Approach for Developing Scab Resistant Barley
FY07 ARS Award Amount:	\$ 227,369

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
HGG	Determining the Genetic Basis of FHB Resistance and Low DON in Shenmai 3 Barley.	\$28,293
IIR	Evaluation of Barley for FHB Resistance in China.	\$ 33,179
VDUN	Development of Scab Resistant Six-Rowed Barley Varieties for North Dakota.	\$ 121,951
VDUN	Development of Scab Resistant Two-Rowed Barley Varieties for North Dakota.	\$ 43,946
	Total Award Amount	\$ 227,369

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
IIR – Integrated/Interdisciplinary Research
PGG – Pathogen Genetics & Genomics
VDUN – Variety Development & Uniform Nurseries

Project 1: *Determining the Genetic Basis of FHB Resistance and Low DON in Shenmai 3 Barley.*

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

Some of the best sources of FHB resistance and low DON accumulation in barley are the Chinese accessions CIho 4196 and Zhedar 2. These accessions are extremely tall and late maturing due to a linkage block of genes found in the centromeric region of chromosome 2H. The cultivar 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 overall goal of this project is to identify molecular markers associated with FHB resistance in Shenmai 3 that can be used for marker assisted selection and to determine the interaction of genes in this cultivar controlling FHB resistance, DON accumulation, maturity and plant height.

**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:

DArT data were collected on the mapping population. The population and parents also were grown in FHB nurseries at Langdon and Osnabrock, ND. Data on percent FHB severity, DON accumulation, plant height, and heading date were collected. Preliminary data suggest that QTL for FHB severity and DON accumulation are located in a region of chromosome 2H where QTL for these traits had been identified in Zhedar 2, CIho 4196, and Chevron.

Impact:

A linkage block that contains QTL for reduced FHB severity and DON accumulation, along with acceptable maturity and plant height has been identified. Because the linkage block does not contain loci for late maturity and tall plants, breeders should be able to develop varieties resistant to FHB severity and DON accumulation with acceptable maturity and plant height more efficiently.

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 source of FHB resistance and low DON accumulation with the 2H QTL for these traits that are positively linked to acceptable maturity and plant height.

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?

A screening nursery for FHB resistance in China has been used since 1995. An important feature of the nursery is that materials from all Midwest barley breeding programs and the ICARDA/CIMMYT barley breeding program are grown in a common environment where the only causal organism causing head blight is *Fusarium graminearum*. Information collected on plants grown in the nursery is shared among all collaborators in the nursery, and improved parents are identified and also shared. The nursery is located at Zhejiang University and is overseen by Professor Bingxin Zhang, a professor in the Department of Plant Protection.

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:

During the 11 years of growing the nursery in China, it has been used for screening accessions from various germplasm collections for new sources of FHB resistance, genotyping mapping populations for FHB resistance and DON accumulation, and screening breeding lines for FHB resistance. Over the years, new sources of resistance have been identified and over 10 different mapping populations have been screened. Accessions screened in 2007 were from the USDA-ARS-NSGC and the Vavilov Institute in Russia. Accessions, including *Hordeum spontaneum*, were identified with putative resistance. Advanced breeding lines from the University of Minnesota (U of M), North Dakota State University (NDSU), ICARDA, and Busch Agricultural Resources, Inc. were identified with improved FHB resistance. FHB severity data on mapping populations developed at the U of M and NDSU were collected and used for QTL mapping and marker assisted selection validation.

Impact:

Lines with FHB severity were identified in all breeding programs with better FHB resistance than Robust.

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?:

Multiple breeding lines and potentially wild barley accessions with improved FHB resistance as compared to Robust.

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?

Since the inception of this project, a main objective has been to transfer FHB resistance and low DON accumulation from unadapted resistant accessions to our elite Midwest six-rowed malting barley germplasm. A limitation in this effort has been a linkage block near the centromeric region of chromosome 2H that is found in most of the resistant accessions. The linkage block includes loci controlling FHB resistance, DON accumulation, heading date, plant height, and maturity. A strategy we are using to overcome the negative linkages in chromosome 2H is to control plant height and maturity using genes from outside the critical region. For example, parents containing the *sdw1* (semidwarf 1) gene in chromosome 3H were crossed to tall FHB resistant lines as a means for reducing plant height in FHB resistant progeny.

**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:

The breeding line ND20448 was found satisfactory in its second year of Pilot Scale evaluation by the American Malting Barley Association (AMBA) and was approved for advancement to Plant Scale evaluation. Approximately 600 acres of ND20448 will be grown in North Dakota during the 2008 growing season to provide grain for Plant Scale malting and brewing evaluations.

Impact:

A breeding line with increased resistances to FHB and DON accumulation that appears to have acceptable malting quality and agronomic performance. The line is being used by multiple breeding programs as a parent in their crossing blocks.

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?:

ND20448 is the first lines from the NDSU six-rowed barley breeding program to reach Plant Scale evaluation by the AMBA.

Project 4: *Development of Scab Resistant Two-Rowed Barley Varieties for North Dakota.*

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

The research on this project focused on improved resistance to FHB, incited primarily by *Fusarium graminearum*, in two-rowed spring malting barley for the Upper Midwest. Malting barley growers and their consumers need cultivars in which the toxin DON does not accumulate or is very low. Many years of breeding are required to develop such cultivars; thus, intermediate goals were developed as follows: 1) to identify good selections from crosses to FHB resistant accessions, 2) to accumulate FHB resistance by crossing good lines and selecting superior lines from their progenies, and 3) to study genetic mechanisms that contribute to reduced levels of FHB severity. Accessions previously identified as partially resistant to FHB were crossed again to elite breeding lines. Their F₅ lines were evaluated in FHB screening nurseries near Hangzhou, China and Osabrock, North Dakota. The inheritance of genes for FHB reaction, DON accumulation, maturity, and plant height were studied in segregating progenies to better understand how to make progress in developing two-rowed barley lines with improved FHB resistance.

**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:

The cultivar Pinnacle was released in June 2007. Pinnacle has slightly better FHB resistance and accumulates similar levels of DON as Conlon. Conlon accumulates about 50% less DON than Robust and is the only two-rowed cultivars from the Midwest US that is on the AMBA list of recommended malting barley cultivars. The yield potential and straw strength of Pinnacle are superior to that of Conlon. ADM malt, Rahr Malt, Miller Brewing and Boulevard Brewing have agreed to perform Plant Scale evaluation of Pinnacle in 2008. Anheuser-Busch will perform another year of Pilot Scale evaluation of Pinnacle before deciding if they will it for Plant Scale brewing evaluation.

Impact:

Provided growers with a barley cultivar that accumulates similar levels of DON as Conlon, but has superior yield potential and straw strength. Pinnacle is adapted for the Red River Valley region of North Dakota and Minnesota, whereas Conlon is not.

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 reduced DON accumulating cultivar with superior yield potential and wider adaptation than Conlon barley.

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.

Abstracts

Boyd, C., R. Horsley, and A. Kleinhofs. 2007. Barley chromosome 2 (2H) bin 10 Fusarium head blight resistance QTL: mapping and development of isolines. p. 170. *In* S. Canty A. Clark, D. Ellis, and D. Van Sanford (eds.) Proc of the 2007 National Fusarium Head Blight Forum, Kansas City, MO 2-4 Dec 2007. ASAP Printing, Okemos, MI.

Presentations

Update on the NDSU Barley Breeding Program at the 2008 North Dakota Barley Show, Osnabrock, ND in March 2008.