USDA-ARS / USWBSI
FY04 Final Performance Report
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Cover Page

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Year:	**FY2004** (approx. May 04 – April 05)
FY04 ARS Agreement ID:	**59-0790-4-106**
FY04 ARS Agreement Title:	**An Integrated Approach for Developing Scab Resistant Barley.**
FY04 ARS Award Amount:	**$ 111,311**

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
VDUN	Accelerated Development of Scab Resistant Barley Varieties.	$ 91,799
VDUN	Evaluation of Barley for FHB Resistance in an Off-Season Nursery in China.	$ 19,512
	Total ARS Award Amount	**$ 111,311**

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Principal Investigator Date

* BIO – Biotechnology
CBC – Chemical & Biological Control
EDM – Epidemiology & Disease Management
FSTU – Food Safety, Toxicology, & Utilization
GIE – Germplasm Introduction & Enhancement
VDUN – Variety Development & Uniform Nurseries

Project 1: ***Accelerated Development of Scab Resistant Barley Varieties.***

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 eastern North Dakota and northwestern Minnesota the last 12 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. What were the most significant accomplishments?

For the first time, lines from the NDSU six-rowed barley breeding projects with improved FHB resistance and acceptable malt quality will be candidates for American Malting Barley Association (AMBA) Pilot Scale Evaluation in 2005. While these lines may not have the levels of resistance approaching that of the most resistant accessions (e.g. Chevron and CIho 4196), they accumulate less DON than currently grown varieties, have agronomic performance better than Robust, and appear to have acceptable malt quality. The candidate lines are ND20448 (ND16918/3/ND12738//Foster/CIho 4196) and ND20508 (ND16918*2/CIho 6610). ND20448 accumulates about 23% less DON than Drummond. Yield of ND20448 and Drummond are similar, while days to heading and plant height of ND20448 and Robust are similar. The second line, ND20508, accumulates about 26% less DON than Robust; otherwise, it is similar agronomically to Drummond. Results from micro-malting tests indicate that ND20448 has greater kernel plumpness, malt extract, and alpha-amylase activity than Robust. Grain protein and diastatic power of ND20448 are 0.6 percentage units and 11 ^{o}L lower than Robust, respectively. ND20508 has greater kernel plumpness, malt extract, wort protein, S/T ration, and enzymatic activity than Robust. Grain protein of ND20508 and Robust is similar.

Using a RIL population from the cross Foster/CIho 4196, two QTL in the centromeric region of chromosome 2H were found to confer resistance to FHB. The QTL for low FHB severity in the bin 8 region of chromosome 2H explained from 3 to 9% of the variation, while the QTL in the bin 10 region of 2H explained from 17 to 60% of the variation. A QTL for DON accumulation that explained 9-14% of the variation was found in the bin 2 region of chromosome 4H. This may represent a new QTL not present in other FHB resistant sources. Resistance QTL in the bin 8 region and bin 10 region of chromosome 2HL were provisionally designated *Qrgz-2H-8* and *Qrgz-2H-10*, respectively. The QTL for DON accumulation in chromosome 4H was provisionally named *QDON-4H-2*.

Project 2: ***Evaluation of Barley for FHB Resistance in an Off-Season Nursery 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 about 3,500 entries are screened each year. Materials included in the 2004-05 nursery were breeding lines developed at North Dakota State University, mapping populations developed at North Dakota State University and the University of Minnesota, and elite lines from three upper Midwest barley breeding programs and ICARDA/CIMMYT.

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. What were the most significant accomplishments?

Disease levels were moderate and fairly uniform throughout the nursery. Breeding lines identified with putative FHB resistance in North Dakota the last three growing seasons were confirmed to be resistant in the Hangzhou nursery. Lines from the ICARDA/CIMMYT breeding program were evaluated in the nursery for the third time under a cooperative agreement.

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 you grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

Peer-reviewed Papers

Schwarz, P.B., R.D. Horsley, B.J. Steffenson, B. Salas, and J.M. Barr. 2005. Quality risks associated with the utilization of Fusarium Head Blight infected malting barley. Accepted: J. Am. Soc. Brew. Chem (accepted).

Abstracts

Franckowiak, J.D., B.X. Zhang, R.D. Horsley, B.J. Steffenson, K.P. Smith, and S.M. Neate. 2004. Evaluation of barley in China for Fusarium head blight resistance. p. 58. *In* S.M. Canty, T. Boring, K. Versdahl, J.Wardell, and R.W. Ward (eds.) Proc. of the 2nd International Symposium on Fusarium Head Blight, Orlando, FL, 11-15 Dec 2004. Michigan State University, East Lansing, MI.

Hill, N.S., P. Schwarz, R. Horsley, S. Neate, B. Steffenson, L. Dahleen, B.Cooper, B. Kittle and A. Jones. 2004. Simple and rapid immunoquantification of *Fusarium* in barley and its relationship with DON and FHB scores. p. 403. *In* S.M. Canty, T. Boring, K. Versdahl, J.Wardell, and R.W. Ward (eds.) Proc. of the 2nd International Symposium on Fusarium Head Blight, Orlando, FL, 11-15 Dec 2004. Michigan State University, East Lansing, MI.

Neate, S.M., P.B. Schwarz, N.S. Hill, and R.D. Horsley. 2004. The relationships between Fusarium head blight visual symptoms, *Fusarium* biomass and deoxynivalenol levels in barley. p. 415. *In* S.M. Canty, T. Boring, K. Versdahl, J.Wardell, and R.W. Ward (eds.) Proc. of the 2nd International Symposium on Fusarium Head Blight, Orlando, FL, 11-15 Dec 2004. Michigan State University, East Lansing, MI.

Presentations

Development of scab tolerant barley cultivars at North Dakota State University and the University of Minnesota. Presentation at the Biannual Barley Improvement Conference, Charleston, SC, January 2005.