U.S. Wheat and Barley Scab Initiative
FY02 Final Performance Report (approx. May 02 – April 03)
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Cover Page

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Grant Number:	**59-0790-9-043**
Grant Title:	**Fusarium Head Blight Research**
FY02 ARS Award Amount:	**$ 138,111**

Project

Program Area	Project Title	USWBSI Recommended Amount
CBC	Efficacy of foliar fungicides in controlling barley scab in lines with partial resistance.	$20,384
GIE	Evaluation of barley germplasm for resistance to Fusarium head blight in an off-season nursery in China.	$19,740
VDUN	Screening barley lines for scab resistance in uniform nurseries.	$11,440
VDUN	Accelerated development of scab resistant barley varieties.	$90,000
	Total Amount Recommended	**$141,564**

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Principal Investigator Date

Project 1: Efficacy of foliar fungicides in controlling barley scab in lines with partial resistance.

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

Research conducted to test the efficacy of fungicides in controlling Fusarium head blight (FHB) and deoxynivalenol (DON) levels in barley have been conducted using cultivars (i.e. Robust, Foster, and Stander) that are susceptible to FHB. Results indicate that fungicides had little to no effect in reducing DON concentration to levels acceptable to the malting and brewing industry. Minimal information is available on the efficacy of fungicides in controlling FHB and DON levels on genotypes with partial FHB resistance. Production of barley with low to no FHB symptoms and DON content will require an integrated approach that includes use of proper cultural practices, fungicides, and FHB resistant cultivars.

The objective of this study was to determine if the integrated use of fungicides and barley cultivars with partial resistance to FHB would control FHB severity and accumulation of DON. Experiments were conducted in the field and included genotypes resistant, partially resistant, and susceptible to FHB. Fungicides used were Folicur and AMS21619.

2. What were the most significant accomplishments?

We observed the following results in our study:

- Folicur application did not significantly reduce FHB severity or DON level in resistant, moderately resistant, or susceptible genotypes.
- Genotypes sprayed with Folicur generally had greater yield.
- Yield gains due to control of foliar diseases tended to be sufficient to cover the cost of Folicur and its application on cultivars developed and released by upper Midwest barley breeding programs.
- Further research is needed to determine if a fungicide with greater efficacy than Folicur for FHB control can be used with moderately resistant genotypes to reduce DON

Project 2: Evaluation of barley germplasm for resistance to Fusarium head blight 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 2002-03 nursery were breeding lines developed at North Dakota State University, one mapping population developed at 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 last summer were confirmed to be resistant in the Hangzhou nursery. Data for the University of Minnesota mapping population were collected and sent to appropriate researchers. Lines from the ICARDA/CIMMYT breeding program were evaluated in the nursery for the first time under a cooperative agreement.

Project 3: Screening barley lines for scab resistance in uniform nurseries.

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

Regional nurseries for many crops have existed for decades. These nurseries provide data on advanced lines from areas other than where they were developed and foster germplasm exchange. Advanced barley lines with putative FHB resistance and new sources of FHB resistance need to be evaluated in the region where FHB is affecting the crop. Mist-irrigated nurseries that are inoculated with *Fusarium graminearum* are needed so data can be collected even in years when environmental conditions are not conducive for natural infection. A mist irrigated uniform FHB screening nursery, called the MinnDak nursery, has been grown at two sites in Minnesota and two sites in North Dakota the past five growing seasons. This nursery includes breeding lines with putative FHB resistance from four upper Midwest barley breeding programs. Between 25-50 entries have been grown in the nursery each of the past six years. FHB severity and DON accumulation are determined.

The objective of this project is to coordinate the screening of elite barley germplasm from breeding programs developing cultivars adapted to the upper Midwest barley growing region in uniform screening nurseries in Minnesota and North Dakota.

2. What were the most significant accomplishments?

The name of the nursery was changed from the MinnDak nursery to the North American Barley Scab Evaluation Nursery (NABSEN). The name change reflects the inclusion of lines from Canadian barley breeding programs. In 2002, 41 lines were evaluated in the NABSEN grown at seven locations. In 2003 a new nursery location will be added at Toluca, Mexico and be overseen by Dr. Flavio Capetinni, ICARDA/CIMMYT barley breeder. Entries from his program also will be included in the NABSEN for the first time.

Project 4: 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 ten 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?

In the past five years, breeding lines with FHB resistance have been identified. However, a limitation in these lines has been their unacceptable late maturity and tall height. Last summer, several breeding lines were identified that had acceptable FHB resistance and maturity. This observation was confirmed in our off-season FHB nursery in Hangzhou, China in spring 2002. This suggests that we have broken the negative linkage between FHB resistance and maturity. However, the negative linkage between FHB resistance and tall plant height still needs to be broken.

Research is continuing to identify molecular markers linked to genes conferring FHB resistance in a doubled-haploid (DH) population derived from the cross Foster/C93-3230-24. The line C93-3230-24 (B2912*2/Heitpas 5) is a six-rowed line developed by Busch Agricultural Resources that did not derive its FHB resistance from Chevron. Field experiments were conducted in eight mist-irrigated FHB nurseries during 2001 and 2002 using 118 DH lines and parents. Construction of a linkage map consisting of RFLP and SSR markers is in progress. Single locus analysis using available marker data identified regions in all chromosomes associated with FHB resistance The region with the largest effect on FHB resistance appears to be in chromosome 2H near the *vrs1* locus. Results in this study are similar to those obtained by others using the resistant six-rowed cultivar ‘Chevron’ and the ICARDA/CIMMYT line ‘Gobernadora’. Thus, results suggest that the Midwest derived line C93-3230, the Swiss cultivar Chevron, and Gobernadora may have similar alleles for FHB resistance. Research also is being conducted to determine the genetic diversity among a series of accessions with FHB resistance using SSR markers.

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.

Refereed Publications

Urrea, C.A., R.D. Horsley, and B.J. Steffenson. 2002. Heritability of Fusarium head blight resistance and deoxynivalenol accumulation from barley accession CIho 4196. Crop Sci. 42:1404-1408.

Urrea, C.A., R.D. Horsley, B.J. Steffenson, and J.D. Franckowiak. 2002. Registration of 6NDRFG-1 six-rowed barley germplasm line with partial Fusarium head blight resistance. Crop Sci. 42:675.

Abstracts

Agrama, H.A., L.S. Dahleen, R.D. Horsley, B.J. Steffenson, P.B. Schwarz, A. Mesfin, and J.D. Franckowiak. 2002. QTL analysis of Fusarium head blight in barley using the Chinese line Zhedar 2. p. 2. *In* S.M. Canty, J. Lewis, L. Siler, and R.W. Ward (eds.) 2001 National Fusarium head blight forum proc., Erlanger, KY. 7-9 Dec 2002. U.S. Wheat & Barley Scab Initiative, East Lansing, MI.

Lamb, K.E., M.J. Green, R.D. Horsley, and B. Zhang. 2002. Mapping genes conferring Fusarium head blight resistance in C93-3230-24. p. 31. *In* S.M. Canty, J. Lewis, L. Siler, and R.W. Ward (eds.) 2001 National Fusarium head blight forum proc., Erlanger, KY. 7-9 Dec 2002. U.S. Wheat & Barley Scab Initiative, East Lansing, MI.

Pederson, J.D. R.D. Horsley, M. McMullen, and K. McKay. 2002. Efficacy of fungicides for controlling FHB in barley genotypes with partial resistance. p. 110. *In* S.M. Canty, J. Lewis, L. Siler, and R.W. Ward (eds.) 2001 National Fusarium head blight forum proc., Erlanger, KY. 7-9 Dec 2002. U.S. Wheat & Barley Scab Initiative, East Lansing, MI.

Horsley, R.D. 2002. Efficacy of fungicides for controlling FHB in barley genotypes with partial resistance. p. 11. *In* L.S. Dahleen (ed.) Proc. North American Barley Researchers Workshop, Fargo, ND. 22-25 Sep 2002. USDA-ARS-CCRU.

Lamb, K.E., M.J. Green, R.D. Horsley, and B. Zhang. 2002. Mapping genes conferring Fusarium head blight resistance in C93-3230-24. p. 27. *In* L.S. Dahleen (ed.) Proc. North American Barley Researchers Workshop, Fargo, ND. 22-25 Sep 2002. USDA-ARS-CCRU.

Monoharan, M., L.S. Dahleen, T. Hohn, S.P. McCormick, N.A. Alexander, P.Schwarz, S. Neate, and R.D. Horsley. 2002. Transformation of barley cv. Conlon with genes for resistance to Fusarium head blight. p. 28. *In* L.S. Dahleen (ed.) Proc. North American Barley Researchers Workshop, Fargo, ND. 22-25 Sep 2002. USDA-ARS-CCRU.

Invited Presentations

Efficacy of fungicides for controlling FHB in barley genotypes with partial resistance. Presented September 2002 at the 17th North American Barley Researchers' Workshop.

Efficacy of fungicides for controlling FHB in barley genotypes with partial resistance. Presented December 2002 at the Annual National Wheat and Barley Scab Initiative Forum.