U.S. Wheat and Barley Scab Initiative
FY01 Final Performance Report (approx. May 01 – April 02)
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Cover Page

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Grant Number:	**59-0790-9-043**
Grant Title:	**Fusarium Head Blight Research**
FY01 ARS Award Amount:	**$ 156,675**

Project

Program Area	Project Title	Requested Amount
Chem/Bio	Efficacy of folicur in controlling barley scab in lines with partial resistance	$ 14,985
Germplasm	Evaluation of barley germplasm for resistance to Fusarium head blight in an off-season nursery in China	$ 21,420
Variety/Uniform	Early generation selection for barley lines with Fusarium head blight resistance	$ 25,982
Variety/Uniform	Accelerated Development of Scab Resistant Barley Varieties	$ 87,833
Variety/Uniform	Screening barley lines for scab resistance in uniform nurseries	$ 12,646
	Total Amount Requested	**$ 162,866**

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Principal Investigator Date

(Form – FPR01)

Project 1: Efficacy of folicur 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?

Folicur did not significantly reduce FHB severity or DON accumulation in resistant, moderately resistant, or susceptible genotypes. However, genotypes sprayed with Folicur generally had greater yield due to control of septoria speckled leaf blotch (SSLB), incited by *Septoria passerinii*. Yield gains due to control of SSLB tended to be sufficient to cover the cost of Folicur and its application on cultivars developed and released by upper Midwest barley breeding programs. Preliminary data indicates that efficacy of AMS21619 was slightly better than Folicur in reducing FHB and 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 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 2001-02 nursery include two mapping populations 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.

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 all upper Midwest barley-breeding programs is screened at a common location. Thus, the FHB resistance off 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 moderately high in this year's nursery. Data on FHB severity, plant height, and plant maturity were collected on three mapping populations. Seed was harvested at maturity and sent back to the U.S. for DON analysis. Data will be used to map loci conferring FHB resistance and DON accumulation, and to determine if these loci are independent of loci controlling plant height and maturity. In the elite nursery trials, three accessions previously identified as having putative FHB resistance were found to have lower levels of FHB and acceptable plant maturity. These accessions are C99-12FHB-11, C99-32FHB-45, and PI 565567.

Project 3: Early generation selection for barley lines with Fusarium head blight resistance

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

Efficient development of improved barley cultivars with FHB resistance is dependent on a breeding strategy that maximizes selection of resistant genotypes in each generation. Advancement of susceptible lines for further evaluation is expensive and inefficient because it takes up needed space in the greenhouse and mist-irrigated FHB epidemic nurseries. Based on discussions with other small grain breeders, we established a mist-irrigated FHB epidemic nursery near Osnabrock, ND for selecting resistant barley plants in the F_3 and F_4 generations. The disease pressure is so high in this nursery that seed often does not develop on susceptible plants. This led us to think that we could make selections for FHB resistance in the F_2 generation by either selecting individual plants, or by harvesting the entire population with a plot combine and removing the thin, light seed with slotted sieves and a gravity table.

The objective of this study was to determine the most efficient breeding strategy for identifying barley plants resistant to FHB in the F_2 generation. The selection strategies compared were 1) selection and harvest of individual plants with putative FHB resistance grown in a mist-irrigated FHB epidemic nursery, 2) bulk harvest of seed from all F_2 plants grown in a mist-irrigated FHB epidemic nursery (thin and light seed will be removed using sizing equipment and a gravity table), and 3) bulk harvest of spikes from F_2 plants with putative FHB resistance grown in an uninoculated dryland nursery (thin and light seed will be removed using sizing equipment and a gravity table). Seed from each breeding strategy was handled in the F_3-F_6 generations using our current breeding strategy.

2. What were the most significant accomplishments?

The method of selecting plants in the F_2 generation had minimal impact on the success of identifying FHB resistant plants. Thus, method number 3 from above is recommended over the other two methods because of its simplicity and low cost.

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 nine 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 2000 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?

A six-rowed barley germplasm line, 6NDRFG-1, was released. Unlike many of the six-rowed genotypes with good FHB resistance, 6NDRFG-1 does not derive its resistance from 'Chevron' (PI 38061) or Chevron-derived lines. This may be advantageous because Chevron and resistant Chevron-derived progeny generally have fewer plump kernels and lower malt extract. Thus, 6NDRFG-1 represents a six-rowed source of FHB resistance that may have alleles for acceptable malt quality not found in Chevron.

A mapping study is being conducted 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/Heitpas 5) is a six-rowed line developed by BARI that does not derive its FHB resistance from Chevron. The mapping population is being evaluated for FHB infection, DON content, days to heading and maturity, plant height, spike nodding angle, and molecular markers. Preliminary work found chromosomal regions associated with FHB resistance in chromosomes 2H, 5H, and 7H. These associations were significant at all environments where the population was grown. The region in chromosome 2H associated with FHB resistance has the largest effect and is also associated with tall plant height and late maturity. The region in chromosome 5H associated with FHB resistance is located in the middle of the long arm, while the region in chromosome 7H is located in the short arm. These regions also were found to be associated with FHB resistance in a previous mapping study using Chevron as the resistant parent.

Project 5: 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 five 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?

Twenty-eight entries were included in this years MinnDak nursery. Entries were grown in irrigated nurseries at Crookston, MN, and Fargo and Langdon, ND. Dryland nurseries were grown at Park River and Osnabrock, ND. Three lines (2ND19130, ND19192 and FEG31-91) had FHB severity levels similar to the resistant checks. 2ND19130 was the only line with DON levels similar to the resistant checks. A final report that includes results from all nursery locations was submitted to the NWBSI Network & Facilitation Office and is posted on the web (http://www.scabusa.org/pdfs/01_MinnDak_Barley_Nurs-Rep.PDF).

The MinnDak Nursery was expanded in winter 2002 to include entries from Canada and Mexico. To reflect the more inclusive nature of the nursery, the name was changed to the North American Barley Scab Evaluation Nursery (NABSEN).

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.

Publications (peer-reviewed)

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. (accepted).

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.

Publications (non-peer reviewed)

Lamb, K.E., M.J. Green, R.D. Horsley, and B. Zhang. 2001. Mapping genes conferring Fusarium head blight resistance in a Midwest barley accession Hietpas 5. p. 19-20. *In* S.M. Canty, J. Lewis, L. Siler, and R.W. Ward (eds.) 2001 National Fusarium head blight forum proc., Erlanger, KY. 8-10 Dec 2001. U.S. Wheat & Barley Scab Initiative, East Lansing, MI.

Manoharan, M., L.S. Dahleen, T. Hohn, S.P. McCormick, N.A. Alexander, P.Schwarz, and R.D. Horsley. 2001. Transformation of a commercial barley cultivar with genes conferring resistance to Fusarium head blight. p. 21. *In* S.M. Canty, J. Lewis, L. Siler, and R.W. Ward (eds.) 2001 National Fusarium head blight forum proc., Erlanger, KY. 8-10 Dec 2001. U.S. Wheat & Barley Scab Initiative, East Lansing, MI.

Pederson, J.D., R.D. Horsley, and M.P. McMullen. 2001. Efficacy of fungicides in controlling Fusarium head blight on barley genotypes with partial resistance. p. 82-86. *In* S.M. Canty, J. Lewis, L. Siler, and R.W. Ward (eds.) 2001 National Fusarium head blight forum proc., Erlanger, KY. 8-10 Dec 2001. U.S. Wheat & Barley Scab Initiative, East Lansing, MI.

Presentations (invited)

Genetic diversity and characterization of barley genotypes with partial resistance to Fusarium head blight. Presentation at Zhejiang University – Hangzhou, China. May 2002