U.S. Wheat and Barley Scab Initiative
Annual Progress Report
September 18, 2000

Cover Page

PI:	**Richard Horsley**
Institution:	**North Dakota State University**
Address:	**Dept. of Plant Sciences** **Fargo, ND 58105-5051**
Email:	**horsley@badlands.nodak.edu**
Phone:	**701-231-8142**
Fax:	**701-231-8474**
Year:	**FY2000**
Grant Number:	**59-0790-9-043**
Grant Title:	**Fusarium Head Blight Research**
Amount Granted:	**$133,568.00**

Project

Program Area	Objective	Requested Amount
Variety Development & Uniform Nurseries	Accelerate development of resistant varieties.	$70,000.00
Variety Development & Uniform Nurseries	To screen varieties for scab resistance in a uniform nursery.	$10,000.00
Chemical & Biological Control	To screen varieties for scab resistance in a uniform nursery.	$15,840.00
Vareity Development & Uniform Nurseries	Determine most efficient breeding strategy for identifying barley plant resistant to FHB in the F2 generation	$33,568.00
	Requested Total	$129,408.00[1]

Principal Investigator Date

[1] Note: The Requested Total and the Amount Granted are not equal.

Project 1: Accelerate development of resistant 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 eight 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 1997 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. Please provide a comparison of the actual accomplishments with the objectives established.

The objective of this project is to develop six-rowed malting barley cultivars resistant to FHB that are acceptable to producers in North Dakota and adjacent states, and acceptable to those who use and process barley. Research conducted this year was in accordance with our stated objectives. No cultivars were released this year that are resistant or tolerant to FHB.

3. What were the reasons established objectives were not met? If applicable.

Development of new cultivars takes 10-12 years and materials from the breeding program are in all stages of development, and we have been breeding for FHB resistance since 1993. We are using DH breeding for crosses we feel have the greatest potential to produce a resistant cultivar. Use of DH breeding may reduce the length of time needed to develop new cultivars by as much as three years.

4. What were the most significant accomplishments this past year?

We had materials from the F_1 generation to yield trials grown at our Osnabrock, ND research site. All materials grown at this location were on ground in which wheat was the previous crop. We found that this allows us to screen our germplasm under conditions that are conducive for FHB. Entries in our Preliminary, Intermediate, Advanced, and Varietal Yield Trials were identified that had 25% less FHB than currently grown cultivars. These entries will be evaluated for malting quality this winter by the USDA-ARS Cereal Crops Research Unit in Madison, WI and for DON content by the Department of Cereal Sciences at NDSU. The source of the lower FHB severity levels in these lines does not always trace back to Asian or northern European accessions. We have begun to evaluate materials from intercrosses between different sources of resistance. Based on preliminary results from our China

nursery, resistance in these materials approaches that of the most resistant Chinese germplasm. Testing is continuing on these lines.

Project 2: To screen varieties for scab resistance in a uniform nursery.

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 four 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.

2. Please provide a comparison of the actual accomplishments with the objectives established.

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. Research conducted this year was in accordance with the stated objective.

3. What were the reasons established objectives were not met? If applicable.

Not applicable

4. What were the most significant accomplishments this past year?

Twenty-six entries were included in this years MinnDak nursery. Entries were grown in irrigated nurseries at St. Paul and Crookston, MN, and Fargo and Langdon, ND. Dryland nurseries were grown for the first time this year and were sown at Crookston, MN, and Park River and Osnabrock, ND. The disease pressure in the mist-irrigated nurseries is very high; thus, some of the moderately resistant lines can become inundated with FHB. This results in these lines being classified as susceptible to FHB. Growers probably will never experience the disease pressure we see in the mist-irrigated nurseries. The mist-irrigated nurseries will allow us to identify the lines with the greatest levels of FHB resistance and to collect data in years when natural conditions are not conducive for infection. Data from the dryland sites will provide information on lines that would be similar to those observed by growers in their fields. DON data will be collected this fall on entries grown in all nurseries. A final report that includes results from all nursery locations will be completed once DON data are available. Last year's report was submitted to the NWBSI Network & Facilitation Office for posting on the web.

Project 3: Determine if the integrated use of fungicides and barley cultivars with partial resistance to Fusarium head blight will control FHB severity and accumulation of DON.

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 FHB and 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.

2. Please provide a comparison of the actual accomplishments with the objectives established.

The objective of this study is to determine if the integrated use of a fungicide (Folicur) and barley genotypes with partial resistance to FHB will control FHB severity and accumulation of DON under field and greenhouse conditions. Greenhouse experiments will be conducted this fall and winter. Research conducted this year was in accordance with the stated objectives.

3. What were the reasons established objectives were not met? If applicable.

Not applicable.

4. What were the most significant accomplishments this past year?

Field experiments were grown at three locations, Langdon, Osnabrock, and Fargo, ND. To date, only FHB severity data from Osnabrock and Fargo have been analyzed. Conditions were conducive for FHB infection at Langdon and Osnabrock and unfavorable at Fargo. Mean FHB severity was 0.7% at Fargo and 4.2% at Osnabrock. At both locations the fungicide by genotype interaction was not significant. However, there was a trend for the genotypes receiving fungicide to have lower FHB severity than their untreated counterpart. The genotype main effect was significant at both locations while the fungicide main effect was not significant. Once the data for Langdon are available for analysis, a combined ANOVA across locations will be conducted for heading date, plant height, foliar disease, FHB severity, stem breakage, kernel plumpness, kernel color, and yield. The concentration of DON on the grain from each plot will be determined this winter by Dr. Paul Schwarz's laboratory in the Department of Cereal Science at NDSU. This study will be repeated next year at the same locations and in the greenhouse this winter.

Project 4: Determine most efficient breeding strategy for identifying barley plant resistant to FHB in the F2 generation

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.

2. Please provide a comparison of the actual accomplishments with the objectives established.

The objective of this study is to determine the most efficient breeding strategy for identifying barley plants resistant to FHB in the F_2 generation. The selection strategies being compared are 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 will be handled in the F_3-F_6 generations using our current breeding strategy. The population ND15483/PI328029 was dropped from the study and replaced by ND15483/C97-21-63. We also included into the study the comparison of growing F_3 lines in New Zealand vs. the China FHB nursery.

3. What were the reasons established objectives were not met? If applicable.

The population ND15483/PI328029 was dropped because PI328029 was found to be susceptible to FHB upon further testing. The comparison of growing and selecting F_3 lines in New Zealand or the China was done to determine if the use of the China FHB nursery resulted in lines with greater FHB resistance.

4. What were the most significant accomplishments this past year?

Materials were harvested from China and New Zealand last winter, grown in North Dakota this past summer, grown in our Yuma, AZ nursery this winter, and will be advanced to yield trials next summer.

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

Horsley, R.D., and J.D. Franckowiak. 2000. Barley variety improvement at North Dakota State University. p. 18-23. *In* M. Davis (ed.) Proc. Red River Valley Barley Day, Grand Forks, ND. 6 Jan 2000. American Malting Barley Association, Inc.

Rudd, J.C., R.W. Stack, R.D. Horsley, A.L. McKendry. 1999. Host plant resistance genes in wheat, barley, and their relatives: I. Sources, mechanisms, and utility in conventional breeding systems. p. 83. *In* Agronomy Abstracts. ASA, Madison, WI.

Urrea, C.A. 2000. Genetic studies of Fusarium head blight resistance and deoxynivalenol content accumulation in barley. Ph.D. Thesis. North Dakota State Univ., Fargo.

Presentations

Barley variety improvement at North Dakota State University. Invited presentation at the Red River Valley Barley Day, Grand Forks, ND. 6 January 2000.

Update on the North Dakota Barley Improvement Program. Invited presentation to the North Dakota Barley Council county representatives at their annual summer meeting, Carrington, ND. 10 July 2000.