

**U.S. Wheat and Barley Scab Initiative
 FY01 Final Performance Report (approx. May 01 – April 02)
 July 15, 2002**

Cover Page

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Grant Number:	59-0790-9-052
Grant Title:	Fusarium Head Blight Research
FY01 ARS Award Amount:	\$ 214,162

Project

Program Area	Project Title	Requested Amount
Biotech	Identification of markers linked to scab resistance genes in Ernie	\$ 49,875
Germplasm	Winter Wheat Germplasm Introduction and Introgression	\$ 94,109
Variety/Uniform	Accelerating the Development of Scab Resistant Soft Red Winter Wheat	\$ 80000
	Total Amount Requested	\$ 223,984

Principal Investigator

Date

Project 1: Identification of markers linked to scab resistance genes in Ernie

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

Reports on the genetics of known sources of resistance to *Fusarium* head blight (scab) have been inconsistent but all suggest that inheritance of resistance is complex. Several factors favor the use of molecular markers to accelerate the breeding for scab resistance. Effective use of available sources of resistance requires a highly labor intensive breeding process that involves inoculation, misting and time consuming evaluation procedures. Furthermore, these evaluations cannot be done at the seedling stage so acceleration of selection protocols is limited by the fact that screening and disease evaluation must be done in the adult plant. For winter wheat, the time frame is extended by the vernalization requirement of this class of wheat. The use of molecular tools to tag resistance genes would alleviate many of these problems. 'Ernie', a soft red winter wheat developed and released by the Missouri Agricultural Experiment Station, has been identified by many programs as a valuable source of broadly based scab resistance, having excellent Type II resistance and kernel quality and good Type I resistance under both natural and artificial disease pressure. Combining the resistance genes in Ernie with those from other sources should enhance the resistance in resulting cultivars. The identification of molecular markers associated with the resistance genes in this cultivar will both facilitate pyramiding these genes and reduce the labor associated with scab resistance breeding. MO 94-317 is a widely adapted, inbred (F₁₂) line developed at Missouri that is highly susceptible to scab with a Type II rating of > 90%. It was crossed with Ernie in 1995 to initiate development of a recombinant inbred line (RIL) set for molecular analyses of the scab resistance in Ernie. F₃-derived F₉ recombinant inbred lines (RILs) form the mapping population used to identify QTL associated with type II resistance in Ernie. The population is initially being mapped using AFLP markers and QTL location will be determined using SSR markers.

2. What were the most significant accomplishments?

During FY2001, 300 RILs were advanced to the F₉ generation and re-screened for resistance to *Fusarium graminearum* to verify the phenotypes determined in 2000. Ten plants of each line were grown in a randomized complete block design with 3 replications during the fall of 2001. Plant tissue was collected and plants were allowed to advance through to heading. Type II resistance was evaluated using the point inoculation method and data were collected on 9000 plants. A wide distribution of resistance was identified, skewed towards susceptibility. DNA was extracted from plant tissue and resistance is currently being mapped using AFLP markers. Chromosomal location of QTL will be determined using a set of 300 microsatellites. It is anticipated that the map will be completed by September 2002.

Project 2: Winter Wheat Germplasm Introduction and Introgression

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

Fusarium graminearum Schwabe (teleomorph *Gibberella zea* (Schwein.), also known as scab is an increasingly important problem in the north-central region of the United States. Host resistance has long been considered the most practical and effective means of control but breeding has been hindered by a lack of effective resistance genes and by the complexity of the resistance in identified sources. The objective of this project was to identify, through a world-wide search, additional sources of resistance to *Fusarium* head blight (scab) in winter wheat. After discovery, this project was charged with verifying resistance and disseminating information to wheat breeders nationally. A third objective was to continue to facilitate the introduction of elite scab resistant germplasm from international breeding programs. A systematic search of winter wheat cultivars, breeding lines and land-races currently maintained in the National Small Grains Collection was undertaken. Accessions (4200) from targeted geographical regions where scab is a problem have been identified to be screened first. Approximately 1000 accessions per year are being screened. Accessions were screened in the greenhouse using point inoculation to assess Type II resistance (resistance to spread in the head) and in the field using spray inoculation to collect data on incidence and severity. Kernel quality was assessed from inoculated heads in both the greenhouse and the field. Accessions were retained that had low levels of spread in the greenhouse (#2 spikelets), and/or a low field index (#30%) as well as good kernel quality (#1.5 on a 5 point scale where 1=sound and 5=tombstone). Additional hexaploid wheat germplasm with putative sources of resistance was introduced into the US through Missouri where it is quarantined, increased, screened for Types I and II resistances and distributed to collaborating scientists within the US Wheat and Barley Scab Initiative

2. What were the most significant accomplishments?

Approximately 1000 Yugoslavian accessions were screened for resistance, completing the 2000 accessions from the Balkans targeted from the National Collection. Sixty-eight accessions have held up well under two cycles of greenhouse and field evaluation at Missouri. An additional 246 accessions will be evaluated for the second cycle during the 2002/2003 grants cycle. Fifty Asian lines identified through 4 cycles of screening as having type II resistance were evaluated for both type I and type II resistance using a split plot experiment replicated 6 times with 10 plants/rep/treatment. Data are being prepared for publication and doubled haploids of the five top lines crossed to the highly susceptible MO 94-317 are being developed in collaboration with Dr. Mujeeb Kazi at CIMMYT. The CIMMYT collaboration resulted in the introduction in November 2001 of wheat germplasm from Argentina (107 lines), Brazil (19 lines), Japan (15 lines) and CIMMYT (41 lines). These were quarantined in fall/winter 2001/2002 and following further increase will be distributed to collaborating scientists nationally. In April 2001, seed of 57 accessions from CIMMYT, and China were distributed to 15 programs nationally. These lines were screened for resistance at Missouri during 2001/2002 and data are being posted to the web at the US Wheat and Barley Scab Initiative web site.

Project 3: Accelerating the Development of Scab Resistant Soft Red Winter Wheat

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

Fusarium graminearum Schwabe (teleomorph *Gibberella zea* (Schwein.), also known as scab is an increasingly important problem in the north-central region of the United States. In Missouri alone yield losses have exceeded \$350 million dollars since 1990. Breeding has been hindered by a lack of sources of resistance. No source of complete resistance is known, and current sources provide only partial resistance. In addition, there has been a lack of routine screening of breeding material to eliminate the highly susceptible lines thereby lessening the economic losses in the farm community. The long term objectives of our scab research include: 1) the continued identification of useful adapted sources of resistance to scab through routine screening of all advanced breeding material using both field and greenhouse inoculation protocols; (2) to share newly identified Missouri sources with cooperating programs through the cooperative scab nursery system; (3) to incorporate new sources of resistance, and/or combine multiple sources of resistance into elite Missouri soft red winter wheat breeding lines; (4) to study the genetics of newly identified sources of resistance, differing from Sumai 3 or other known and well-used sources of resistance, using both conventional and molecular genetic approaches. 'Ernie', a soft red winter wheat developed and released through the Missouri Agricultural Experiment Station that possesses high levels of Type II resistance, moderate levels of type I resistance and good kernel quality under inoculation has been used as the Missouri resistant check for this work since 1998. It had a greenhouse scab index of 15-18% and a field index of 12% in 2001 compared to the susceptible Missouri check MO 94-317 which has a greenhouse index of 92% and field index of 60%.

2. What were the most significant accomplishments?

Results from evaluations of approximately 300 entries being advanced in yield trials in 2002 identified 68 lines from 49 pedigrees that had field indices (incidence x severity) and Type II reactions from greenhouse evaluations of less than 25%. Of these pedigrees, 37 differ from Ernie by descent and are not derived from Chinese sources of resistance. Of the 68 lines that will be retained, 32 had greenhouse scores less than Ernie while 38 had field scores less than Ernie. They provide either different sources or different types of resistance in adapted genetic backgrounds and their combination with other exotic sources and types of resistance should enable accelerated development and release of scab resistant varieties that possess either more effective or more stable scab resistance. One of these pedigrees, MO 11769/Madison has yielded at least 4 lines that have levels of type II resistance that are consistently less than Ernie. In the 2001 Northern Winter Wheat Scab Nursery, MO 980525 and its sister line MO 981020 were the best lines in the nursery and were the only two lines that were scored as resistant in all 7 criteria measured. In addition, MO 980525 either won or was in the top yield group at most Northern Corn Belt locations of the Eastern Soft Red Winter Wheat Nursery in 2001. It is doing equally well in 2002 and we expect to release it to growers in September 2002. A doubled haploid mapping population of MO 980525 is currently being developed in collaboration with Dr. Mujeeb Kazi at CIMMYT.

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:

McKendry, A. L., J. P. Murphy, K. S. Bestgen, R. Navarro, and M. H. O'Day. 2001. Resistance to Fusarium Head Blight in Accessions from the Balkans: A Progress Report. p. 194-197. In: Proceeding of the 2001 National Fusarium Head Blight Forum. Erlanger, KY Dec. 8-10, 2001.

McKendry, A. L., K. S. Bestgen, and M. H. O'Day. 2001. Types I and II Resistance to Fusarium Head Blight in Asian and Italian Germplasm. p. 198. In: Proceeding of the 2001 National Fusarium Head Blight Forum. Erlanger, KY Dec. 8-10, 2001.

McKendry, A.L., D.N. Tague, and K.S. Bestgen. 2002. Resistance to Fusarium head blight in Asian and Italian winter wheat germplasm. (In preparation for Crop Science).

McKendry, A.L., K.S. Bestgen and D.N. Tague. 2002. Stability of resistance to Fusarium head blight across genotype and isolate. (In preparation for Crop Science)

Presentations:

Invited:

Wheat Scab: The Search for Resistance. Seminar given April 11, 2002 at the University of Wisconsin, Madison.

National Wheat and Barley Scab Initiative: Progress towards finding resistance to Fusarium head blight. Talk given to the Missouri Seed Improvement Annual Meeting, February 4th, 2002