U.S. Wheat and Barley Scab Initiative
FY00 Final Performance Report (approx. May 00 – April 01)
July 30, 2001

Cover Page

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Grant Number:	**59-0790-9-052**
Grant Title:	**Fusarium Head Blight Research**
2000 ARS Award Amount:	**$168,537**

Project

Program Area	Project Title	Requested Amount
Germplasm Introduction & Enhancement	Winter wheat germplasm introduction and introgression.	$57,750.00
Variety Development & Uniform Nurseries	Accelerating the development of scab resistant soft red winter wheat.	$75,000.00
Biotechnology	Identification of markers linked to scab resistance genes in Ernie.	$29,127.00
	Requested Total	$161,877.00[1]

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Principal Investigator Date

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

Project 1: 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 zeae* (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. In FY99, 937 accessions from Asia, South America and Italy were evaluated. 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). In FY2000 resistant lines from evaluation of the first 937 accessions were verified and 1006 accessions from Yugoslavia were screened in the greenhouse and field for the first time using the same protocols. A visit to China in May 2000 facilitated the introduction of elite Chinese sources of resistance into the United States (through CIMMYT). Sources were identified that differed from Sumai 3 which is currently widely used in US breeding programs. A visit to CIMMYT facilitated the further introduction of CIMMYT breeding lines, cultivars and wide crosses containing scab resistance genes as well as Romanian sources of resistance.

2. What were the most significant accomplishments?

During FY99, 937 accessions from Asia, Brazil and Italy were screened. Resistance was identified in accessions from China (133), S. Korea (9), Japan (13), Brazil (2), and Italy (17).In FY2000, resistance was verified in 41 accessions including 32 from China, 2 from Japan, 1 from S. Korea, and 6 from Italy. Of these, 20 were distributed in FY2000 to wheat breeders at 17 institutions nationally. The remaining 21 will be distributed in FY2001. Of 1006 accessions screened from the former Yugoslavia, 237 accessions were identified for verification including: 209 landraces, 9 cultivated lines, 7 cultivars and 12 breeding lines. Resistance in these lines will be verified in FY2001. Scab resistant lines were introduced into the United States through collaboration with CIMMYT including: 27 bread wheats, 21 synthetic hexaploid derivatives, 8 elite sources of resistance from China, and 7 sources from Romania. Fifty-seven lines were quarantined in Missouri and have been distributed to breeders in 12 wheat breeding programs nationally. Data were published to the US Wheat and Barley Scab Initiative web site.

Project 2: 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 zeae* (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 goals of this project were to: (1) systematically evaluate all advanced breeding lines for scab resistance, (2) incorporate genes for resistance primarily from China, Japan, Italy, Eastern Europe and CIMMYT into elite breeding lines, (3) grow and evaluate the 2000 Winter Wheat Scab Nursery, and (4) study the inheritance of resistance in '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. Breeding lines entering their second year of preliminary yield evaluation were screened for type II resistance using point inoculations in the greenhouse and for incidence and severity using spray inoculations in the field. Approximately300-400 advanced lines are evaluated annually. Genetic populations were developed to study resistance in Ernie and recurrent selection populations were developed to pyramid known resistance genes into adapted backgrounds.

2. **What were the most significant accomplishments?**
   The scab screening nursery was doubled in size for the summer of 2000 to evaluate 55 F2 populations segregating for scab resistance, approximately 3,000 F5 head rows selected from populations developed from parents with good to excellent levels of scab resistance, and approximately 150 plots of lines in advanced stages of testing. Highly susceptible lines were eliminated from the breeding stream thereby providing immediate relief from losses for Missouri growers as these lines are evaluated for potential release. New pedigrees (32) were identified that carry excellent incidental Type II resistance and kernel quality combined with good Type I resistance. A further 350 lines will be evaluated in 2001. . The 2000 Winter Wheat Scab Nursery was screened for Type I resistance in the field and for Type II resistance and kernel quality in the greenhouse during the spring of 2000. Growth room crosses were made during the summer to continue development of genetic populations for conventional genetic analyses of resistance in Ernie. Populations were completed and genetic analyses will be conducted in 2001. New germplasm was introduced into Missouri genetic backgrounds in the fall/winter greenhouse cycles during which, 750 crosses between and among adapted and introduced wheats were made with approximately 60 different pedigrees. One advanced line (MO 980525) containing excellent functional levels of Types I and II resistance and good kernel quality was entered into wide-scale testing across the soft red winter wheat region through the Uniform Eastern Winter Wheat Nursery. It is being evaluated for potential release in 2002. Finally, four advanced lines were entered into the Uniform Winter Wheat Scab Nursery for wide-scale evaluation of scab resistance.

Project 3: 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 (F_{12}) 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. F_3-derived F_8 recombinant inbred lines (RILs) will be used to map, using AFLP and/or SSR markers, major QTL associated with type II resistance in Ernie using the bulk segregant analysis approach.

2. What were the most significant accomplishments?

This project is a two year project and will be completed in FY2001. During FY2000, 300 RILs were advanced to the F_8 generation. Ten plants of each line were grown in a randomized complete block design with 3 replications during the fall of 2000. 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 will be mapped in 2001 using SSR and/or AFLP markers. Previously identified markers associated with scab resistance in Chinese sources of resistance will be used to determine allelism of identified QTLs with known resistance genes.

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:

Rudd, J.C., R.D. Horsley, **A.L. McKendry**, and E.M. Elias. 2001. Host plant resistance genes for Fusarium head blight: sources, mechanisms and utility in conventional breeding systems. Crop Science 41:620-27. (peer-reviewed)

McKendry, A.L. and K.S. Bestgen. 2000. Greenhouse based evaluation of Asian and Italian winter wheat germplasm for type I resistance to Fusarium head blight. 2000 National Fusarium Head Blight Forum, Erlanger, KY, December 10-12, 2000. (Not peer-reviewed)

McKendry, A.L., J. P. Murphy, K.S. Bestgen, R. Navarro. 2000. Evaluation of Yugoslavian winter wheat germplasm for resistance to Fusarium head blight. 2000 National Fusarium Head Blight Forum, Erlanger, KY, December 10-12, 2000. (Not peer-reviewed)

Truong, L. 2000. Research into scab resistance will allow producers to have their cake and eat it too. The Source. College of Agriculture, food and Natural Resources, University of Missouri, Columbia. (Missouri Agricultural Experiment Station publication). Not peer-reviewed.

Presentations:

McKendry, A.L. 2000. Broadening the Genetic Base for Scab Resistance Through a CIMMYT/National Scab Initiative Partnership. 2000 National Fusarium Head Blight Forum, Erlanger, KY, December 10-12, 2000.

McKendry, A.L. 2000. Wheat Scab: The Search For New Sources of Resistance. Presented as part of a symposium entitled: "Wheat Improvement: Problems and Prospects through 2040. American Society of Agronomy Annual Meetings. Nov 5-9. Minneapolis MN