USDA-ARS / USWBSI
FY04 Final Performance Report
July 15, 2005

Cover Page

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Year:	**FY2004** (approx. May 04 – April 05)
FY04 ARS Agreement ID:	**59-0790-4-116**
FY04 ARS Agreement Title:	**Enhancement of Fusarium Head Blight Resistance in the Southeastern U.S. Germplasm Pool.**
FY04 ARS Award Amount:	**$ 55,379**

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
GIE	Evaluation of Diploid Wheat Relatives and Intergeneric Hybrids for Fusarium Head Blight Resistance.	$ 17,561
VDUN	Development of Fusarium Head Blight-Resistant Wheat for the Southeastern United States.	$ 37,818
	Total ARS Award Amount	**$ 55,379**

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Principal Investigator Date

* BIO – Biotechnology
CBC – Chemical & Biological Control
EDM – Epidemiology & Disease Management
FSTU – Food Safety, Toxicology, & Utilization
GIE – Germplasm Introduction & Enhancement
VDUN – Variety Development & Uniform Nurseries

Project 1: ***Evaluation of Diploid Wheat Relatives and Intergeneric Hybrids for Fusarium Head Blight Resistance.***

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

We are seeking potentially novel sources of resistance to Fusarium Head Blight in wild and cultivated relatives of wheat (A and D genome diploids) and in the Sando collection of intergeneric (*Triticum aestivum x Lophopyrum elongatum)* hybrids. In 2003-04 we evaluated 262 accessions for Type II resistance in the greenhouse and for resistance to Fusarium damage to the grain post-harvest. Plants were inoculated by injecting a single floret with 10 microlitres of a spore suspension containing a mixture of isolates at a concentration of 50,000 spores per milliliter. Type II resistance was evaluated at 21 days post inoculation. Mature seeds harvested from inoculated heads were rated on a scale of 0-5 that reflected the percentage of Fusarium damaged kernels. Nineteen *T. monococcum* and 32 Sando accessions were chosen for rescreening in 2004-05.

2. What were the most significant accomplishments?

The overall level of resistance in the *T. monococcum* accessions was moderate to poor and none of the selected accessions had resistance levels equal to the best material in the Sando collection. The number of florets infected following inoculation ranged from 3.3 to 19.8 (12 to 86% of total florets). We concluded that only two accessions (PI 254195 and PI 428171), both from Turkey and having 12 to 16% spike infection, had sufficient resistance to warrant use as donors of potentially new sources of resistance.

The best Type II resistance and kernel quality was observed among the 32 accessions of intergeneric hybrids in the Sando collection. Fourteen out of 32 accessions (PI 611930, PI 611924, PI 611942, PI 611887, PI 611911, PI 611912, PI 611917, PI 611927, PI 611940, PI 611896, PI 611883, PI 611937, PI 611906 and PI 611939) limited infection to the floret that underwent inoculation. An additional eight accessions (PI 611885, PI 611899, PI 611935, PI 611890, PI 611892, PI 611918, PI 611913 and PI 611907) limited infection to the inoculated and adjacent florets. BC_1F_1 seeds were obtained from crosses between the soft red winter parent NC99-13022 (FHB susceptible) and the Sando accessions PI 611899, PI 611937, PI 611928 and PI 611939. Approximately 20 BC_1F_1 seeds per cross were screened using three 7E chromosome specific markers. This chromosome has been identified as carrying FHB resistance. Segregation for the markers was normal and five selected BC_1F_1 plants per cross were backcrossed to obtain BC_1F_2 seeds. This latter step was speculative, so both remnant BC_1F_1 and BC_2F_1 plants will undergo screening for FHB resistance prior to further backcrossing. Plans to cross remnant F_1 hybrids from the four crosses with a Chinese Spring stock containing an inhibitor of the *Ph* gene were unsuccessful due to poor germination of the genetic stock followed by nicking problems.

Approximately 600 BC_2F_2 plants from the cross between the *T. monococcum* accession PI 167591 and the soft red winter wheat NC98-26143 underwent greenhouse evaluation for Type II resistance. Fifty plants were selected for further evaluation. Seeds of selected individuals will be utilized to plant field nurseries and greenhouse tests in fall 2005.

Most important accomplishment and its impact (how is it being used?):

Accomplishment: Because the best, known sources of resistance to Fusarium head blight in the cultivated wheat gene pool are partial rather than complete, it is timely to seek additional resistance sources in wheat ancestors and related species that might complement those genes already identified. Twenty two accessions in the Sando collection of wheat by wheatgrass hybrids exhibited very high levels of resistance to disease spread in two years of greenhouse evaluations. To date we have obtained backcross hybrids with four of these accessions. Two additional accessions of a wild einkorn exhibited moderate levels of resistance and should be utilized as a resource in the program also.

Impact: This research identified additional sources of Type II resistance to Fusarium head blight that are likely different to those currently in widespread use in U.S. breeding programs. When this resistance is incorporated into an adapted genetic background, it will permit breeders to pyramid this resistance with that currently available and produce lines with higher overall levels of resistance.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before?:

Breeders have immediate access to new sources of resistance if they wish to conduct there own program to transfer resistance from Sando accessions into their germplasm pool, or they can wait until the prebreeding is completed by programs such as ours. The more diverse sources of resistance that can be utilized in variety development, the better will be the resistance on the farm.

Project 2: ***Development of Fusarium Head Blight-Resistant Wheat for the Southeastern United States.***

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

The Fusarium Head Blight (FHB) epidemic of 2002-03 left one-half of the North Carolina wheat crop unsuitable for human consumption. We are resolving this problem by developing southeastern adapted cultivars with high levels of FHB resistance combined with superior productivity, disease and insect resistance and end-use quality that the wheat community expects. To provide breeding programs with solid, independent data on resistance in advanced generation lines the Uniform Southern Soft Red Winter Wheat Fusarium Head Blight Nursery is coordinated by North Carolina State University.

2. What were the most significant accomplishments?

Twenty two $F_{6:8}$ lines derived from crosses between FHB resistant Chinese parentage and North Carolina adapted germplasm were entered in the 2004-05 Preliminary Yield Test. This represented the first time FHB resistant lines underwent multi-location replicated yield testing in our program. Four lines with good FHB resistance and overall agronomic quality were selected. We verified that three of the four contain *Qfhs.ndsu-3BS* and one of these three also contains *Qfhs.ifa-5A.* Thirty four $F_{5:7}$ lines containing FHB resistant Chinese parentage plus 72 lines containing soft red winter parentage with moderate FHB resistance were selected to enter preliminary yield testing in 2005-06. Eight hundred $F_{3:4}$ head rows and 570 advanced generation lines were evaluated in an inoculated and misted field nursery. Five thousand heads in the F_3 generation were selected from 50 bulk populations segregating for FHB resistance. These will be evaluated in 5,000 F_3:$_4$ head rows in 2005-06 for overall adaptation, disease and insect resistance. Over 9,000 F_2 heads were selected from 96 bulk populations segregating for FHB resistance. These will be advanced as 96 F_3 bulk populations in 2005-06. Nineteen of these have been selected to undergo enhancement during summer 2005 by identification of plants containing *Qfhs.ndsu-3BS* which will be bulked prior to planting in fall 2005. Nine 3-way F_1 populations underwent MAS to increase the frequency of *Qfhs.ndsu-3BS* in the F_2 bulk populations. Eighty five 2- and 3-way F_1's segregating for FHB resistance were advanced to the F_2 generation for bulk propagation. One hundred ninety eight 2- and 3-way F_1's were made in the greenhouse with FHB resistant parents. Liu and Anderson (Crop Sci., 43:760-766) identified lines distinct from Sumai 3 based on allelic content at five SSR loci. BC_1F_1 seeds were obtained in crosses involving 16 of these in a backcross program to introgress diverse FHB resistance into North Carolina adapted germplasm. The Uniform Southern Nursery program increased to 41 entries in 2003-04 submitted by eight US public and private breeding programs and one Romanian cooperator. Eleven cooperators (9 US and one each in Romania and Hungary) returned greenhouse and/or field nursery data. The data were summarized in a nursery report distributed to wheat breeders and pathologists in Dec 2004. The 2004-05 Uniform Southern Nursery containing 48 entries submitted by nine US and Romanian cooperators was distributed in fall 2004. Almost all entries contained pedigrees that included known sources of FHB resistance. This is a milestone for the southern nursery.

Most important accomplishment and its impact (how is it being used?):

Accomplishment: The Fusarium Head Blight (FHB) epidemic of 2002-03 left one-half of the North Carolina wheat crop unsuitable for human consumption. We evaluated 22 advanced generation lines with Chinese resistance to FHB in replicated yield trials in North Carolina for the first time. Four lines exhibited adequate overall agronomic performance to be advanced to the next stage of testing and one line will be utilized as a parent in our next round of crossing in winter 2005-06. We utilized marker assisted selection to increase the frequencies of two FHB resistance loci in three-way F_1 and F_2 bulk populations. We coordinated the Uniform Southern Fusarium Head Blight Screening Nursery with eleven cooperators from the U.S. and Europe. Data were obtained on FHB resistance on 41 lines in 11 environments and the results were published and made available on the web.

Impact: Advanced generation wheat lines adapted to the southeastern U.S. with moderate to high levels of FHB resistance were made available to 11 cooperators should they want to utilize this material in their own breeding programs. Our program is one to two generations from having material with moderate to good levels of FHB resistance entering regional yield testing programs. Uniform Nurseries provided rapid dissemination of resistant lines throughout the breeding community and provided a ready source of information on the true levels of resistance in advanced generation breeding lines.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before?:

The scientific community has a number of new lines adapted to the Southeastern U.S. with good levels of FHB resistance. This makes it easier to develop new commercial varieties with FHB resistance.

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 you grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

Browne, R., J. P. Murphy, plus 12 authors. 2005. Evaluation of components of Fusarium Head Blight resistance in soft red winter wheat germ plasm using a detached leaf assay. Plant Dis. 89:404-411

Murphy, J. P., R. A. Navarro, and D. A. Van Sanford. 2004. Uniform Southern Soft Red Winter Wheat Fusarium Head Blight Screening Nursery. Dept. Crop Science, N.C. State Univ., Raleigh.

Murphy, J. P., R. A. Navarro, and D. A. Van Sanford. 2004. 2003-04 Uniform southern soft red winter wheat Fusarium head blight screening nursery. p. 132. *In* S. M. Canty, T. Boring, J. Wardwell, and R. W. Ward (eds.) Proc. 2nd International Symposium on Fusarium Head Blight, 11-15 Dec.; Orlando FL, USA. Michigan State Univ., East Lansing. MI.

Browne, R., J. P. Murphy, plus 12 authors. 2004. Evaluation of Fusarium Head Blight resistance in soft red winter wheat germplasm using a detached leaf assay. p. 22 *In* S. M. Canty, T. Boring, J. Wardwell, and R. W. Ward (eds.) Proc. 2nd International Symposium on Fusarium Head Blight, 11-15 Dec.; Orlando FL, USA. Michigan State Univ., East Lansing. MI.