USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY05 Final Performance Report (approx. May 05 – April 06)
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Cover Page

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Fiscal Year:	**2005**
FY05 ARS Agreement ID:	**59-0790-4-094**
Agreement Title:	**Hastening the Development of Specialty Spring Wheats with Resistance to Fusarium Head Blight.**
FY05 ARS Award Amount:	**$ 39,730**

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
VDUN	Hastening the Development of Specialty Spring Wheats with Resistance to Fusarium Head Blight.	$ 39,730
	Total Award Amount	**$ 39,730**

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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: *Hastening the Development of Specialty Spring Wheats with Resistance to Fusarium Head Blight.*

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

Specialty spring wheats, such as hard white and waxy spring wheat are generally highly susceptible to Fusarium Head Blight (FHB), and high demand for these specialty wheats requires that they have some level of resistance to FHB. Furthermore, resistant spring wheat cultivars primarily exhibit resistance to spread of the fungus within infected spikes (type II resistance), which is a resistance derived almost exclusively from a Chinese source, 'Sumai-3'. This project has focused on rapidly developing specialty spring wheats with resistance to FHB, and it has also focused on combining different sources and types of resistance in order to develop cultivars with a more durable resistance.

Complex crosses have been made using specialty spring wheat parents and red spring wheat parents, which have the Sumai-3 source of resistance, a source originating from *Triticum dicoccoides*, and a source originating from 'Frontana'. The Frontana source represents resistance to initial FHB infection (type I resistance) and possibly resistance to the accumulation of fungal mycotoxins (type V resistance). In order to rapidly develop FHB cultivars and combine the different sources of resistance into a single genotype, the maize pollination technique has been used to produce doubled-haploid lines from these hybrids. Also, molecular markers for the different sources of resistance have been used to try to validate the presence of the various FHB genes for resistance. To identify the chromosome location of genes for resistance and possibly develop more effective markers for a type I or type V resistance, a reciprocal backcross monosomic analyses was performed to examine the FHB resistance of Frontana spring wheat.

2. List the most important accomplishment and its impact (how is it being used?). Complete all three sections (repeat sections for each major accomplishment):

Accomplishment:

A doubled-haploid line was developed from a cross between an advanced white spring wheat breeding line and a backcross line, which carries the *Triticum dicoccoides* source of FHB resistance and the Sumai-3 source of resistance from the cultivar 'Alsen'. This doubled-haploid line is currently being analyzed with markers to determine if it carries one or both sources of resistance. Three specialty wheat breeding lines developed with the Sumai-3 source of FHB resistance were selected and included in advanced yield trial nurseries, and three other specialty wheat breeding lines were developed with the Sumai-3 source of FHB resistance and included in preliminary yield trial nurseries. These lines are being tested for agronomic performance in the region and are possible candidates for release as either specialty wheat cultivars or germplasm lines with resistance to FHB. One advanced line is being evaluated in the 2006 Uniform Regional Spring Wheat Nursery and the 2006 Uniform Regional Scab Nursery.

A MS graduate student has successfully tested the performance of a wheat genotype carrying both the *T. dicoccoides* and Sumai-3 sources of Fusarium head blight resistance. In comparison with a genotype with a single source of resistance, initial results indicate that the two-gene resistance might confer an additional level of resistance, although this was not statistically significant. Presently, this comparison is being repeated in a greenhouse study and two field studies. A reciprocal backcross monosomic analysis of Frontana wheat was completed, and results were summarized in a manuscript submitted for publication in *Plant Breeding*. Frontana chromosomes 3A, 6A, and 4D were the only chromosomes to reduce visually diseased kernels, reduce disease severity, and reduce the accumulation of the mycotoxin DON across two greenhouse studies. Thus, these chromosomes represent possible carriers of genes for type I and/or type V resistance to FHB.

Impact:

Development of an advanced white spring wheat breeding line with either one or two sources of FHB resistance is significant. If it contains both sources of resistance, it would likely be the first hard white spring wheat genotype to combine two different sources of FHB resistance. Results of agronomic and molecular marker tests will be used to determine if this line is released as germplasm or as a cultivar. If it is released as germplasm, it would represent a valuable source for regional breeders trying to rapidly develop acceptable hard white wheat cultivars to meet the growing demand for whole wheat products made from white wheat. The advancement of six specialty wheat breeding lines with the Sumai-3 source of resistance is an indication that our breeding program is getting closer to the development and release of specialty wheat cultivars with acceptable levels of resistance to FHB.

If additional analyses of breeding lines combining the *Triticum dicoccoides* and Sumai-3 sources of resistance consistently indicate expression of a higher level of resistance, this would validate the approach of pyramiding genes for resistance to FHB. In addition, genotypes with two or more different sources of resistance can be released as germplasm so that regional breeders could begin to diversify and perhaps deploy more durable resistant cultivars. Identification of three chromosomes from Frontana as having an impact on FHB resistance is significant. This reciprocal backcross monosomic analysis represents the first analysis of this kind using Frontana, which exhibits a type I and/or a type V resistance to FHB.

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?:

Development of a hard white spring wheat line with either one or two sources of FHB resistance provides the breeding community with a unique germplasm source. If this line is entered into regional nurseries, breeders in the region can use it as a parental source to transfer these genes to other specialty wheat breeding lines. Ultimately, it will help farmers in the release of the first hard white spring wheat cultivars with adequate resistance to FHB. Confirmation that pyramiding different sources of resistance to FHB increases the level or durability of resistance is significant to the breeding community and farmers. Pyramiding host genes for resistance to a disease is often proposed as a way to delay or postpone a pathogen overcoming resistance. Empirical evidence that this approach can be successful is lacking. Thus, developing the plant materials with which to study this approach is valuable to the scientific breeding community, and it will help in the development of more durable FHB resistant cultivars for farmers. The discovery that Frontana chromosomes 3A, 6A, and 4D are involved in FHB resistance is significant. The type I and type V FHB resistance mechanisms in wheat are poorly understood in comparison to the type II resistance. Thus, the disomic lines produced during the reciprocal backcross monosomic analysis of Frontana will serve as excellent material to characterize the type I and V resistance mechanisms. For example, the disomic lines could be used to conduct more in-depth analyses of the differences observed when Frontana and Alsen leaves are exposed to the Fusarium pathogen and/or Fusarium toxins. Similarly, the three chromosomes identified as possibly carrying genes for resistance could be "dissected" on the molecular level to verify and identify useful markers of genes for resistance to FHB.

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.

2005: Gamotin, E.L., **W.A. Berzonsky**, B. L. Gebhard, G.D. Leach, and S. Ali. A Reciprocal Backcross Monosomic Analysis of the FHB Resistant Wheat Cultivar 'Frontana'. pg. 28 *In* S.M. Canty et al. eds., Proc. 2005 National Fusarium Head Blight Forum, Milwaukee, WI, 11-13 December (volunteered).