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:	**59-0790-4-118**
Agreement Title:	**Breeding Soft Winter Wheat with Multiple FHB Resistance.**
FY05 ARS Award Amount:	**$ 115,713**

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
BIO	Mapping Novel FHB Resistance in Wheat Transferred from Lophopyrum ponticum.	$ 33,724
VDUN	Improvement of Soft Winter Wheat for Resistance to Fusarium Head Blight.	$ 81,989
	Total Award Amount	**$ 115,713**

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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: *Mapping Novel FHB Resistance in Wheat Transferred from Lophopyrum ponticum.*

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

Fusarium head blight resistance derived from species related to wheat (*Triticum aestivum*) is potentially useful in wheat breeding because few resistance genes/QTLs with large and consistent effects have been reported in wheat. We identified a FHB QTL in *Lophopyrum ponticum* chromosome $7el_2$ and located its position by molecular linkage mapping. The objectives of this project are to: 1) verify the location and genetic effects of the FHB resistance QTL in F_5 and F_6 recombinant inbred (RI) populations, 2) develop DNA markers closely linked to the QTL, and specific to $7el_2$, 3) develop a line with a shorter segment of the $7el_2$ chromosome than the original Robertsonian translocation in the donor parent line KS24-2, and 4) verify that this shortened chromosome segment has the FHB resistance, in two segregating populations.

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

Accomplishments: The mapping populations were F_2, F_3, and F_2-derived F_5 and F_6 RI populations from the cross of K2620 and K11463. Preliminary results from F_2 data revealed a QTL in the distal region of the long arm of chromosome $7el_2$. Subsequent phenotyping in the F_3 generation, and genotyping and phenotyping in F_5 and F_6 RI populations produced similar results (Fig. 1). On average, the resistance locus reduced the number of diseased spikelets by 3.3 at 25 days after point inoculation in the four experiments. Additional EST-derived PCR markers were developed around the QTL region. The QTL is delimited between markers *XBE445653* and *Cfa2240*, which are 10.4 cM apart.

A homoeologous recombination between wheat chromosome 7D and *Lophopyrum ponticum* chromosome $7el_2$ was obtained using a ph1bph1b deletion line. Characterization using DNA markers located on 7D and $7el_2$ showed that the break point was between *XBE406148* and *Xpsr129*, about ½ to 2/3 from the centromere. This recombinant line was crossed to two elite lines P981312A1-6-2-2-1 and P981359C1-4-2-8. In the two backcross populations the FHB severity was associated with the two flanking markers *XBE445653* and *Cfa2240* following point inoculation (p value = 0.0009 and 0.004, respectively), showing that the resistance was retained in this shortened chromosome segment, and was expressed in two different genetic backgrounds. Reduction of infected spikelets ranged from 2.4 to 3.4, by comparing the means of the heterozygotes ($7D7el_2$) and means of the 7D7D homozygotes. We also documented that the FHB resistance QTL on $7el_2$ augments FHB resistance in wheat when combined with different levels of partial resistance of different wheat lines.

Impact: This is the first report of a FHB resistance QTL with strong effect that is on a different chromosome than other FHB resistance QTL reported in wheat, so it can be combined with resistance QTL in wheat; and it augments FHB resistance when combined with resistance genes/QTL in wheat.

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?:
Wheat breeders now have a valuable and useful genetic resource for FHB resistance from a related species of wheat that augments FHB resistance in wheat.

Project 2: *Improvement of Soft Winter Wheat for Resistance to Fusarium Head Blight.*

1. What major problem or issue is being resolved and how are you resolving it?
Fusarium head blight (FHB) is an important disease of wheat in Indiana and many wheat production areas of the USA. Wheat production losses in Indiana have been significant most years and have been devastating in some seasons since the late 1980s with the advent of the widespread practice of reduced tillage for soil conservation and to reduce input costs to crop production. Associated with these production losses, harvested grain is also contaminated with the toxin, deoxynivalenol, which results in severe marketing losses. Genetic resistance to FHB in commercial wheat varieties is an effective and economical means of reducing crop production and grain quality losses due to FHB. We are developing wheat varieties that have multiple genes for resistance/protection against the disease. We are pyramiding genes for type 2 resistance (inhibition of disease spread after infection) and we are pyramiding genes for type 2 resistance and for low incidence (having flowers that open less during flowering than those of varieties that have higher incidence of the disease) and type 1 resistance (reduced infection frequency).

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

Accomplishments: The soft red winter wheat varieties, INW0411 (tested as P97397E1-11-2-4-1-14) that has moderate type 2 resistance from the cultivar Freedom and low incidence to FHB, and INW0412 (tested as 981359C1-4-2-1-8) that has moderate type 1 and type 2 resistance from the donor parent Huapei 57-2 were grown by seed producers in 2005-2006. INW0411ranked among the 10-20% and INW0412 among the 10-30% of lines for low FHB disease index in regional trials and continue to rank among the lowest for disease index in Indiana tests. INW0411 is also very early in maturity, fitting into the important cropping practice in southern Indiana and surrounding region, of seeding soybeans the same season after wheat harvest. INW0412 is adapted to northern Indiana and adjacent regions. INW0411 has resistance to Ug99 stem rust and INW0412 has resistance to stripe rust. Although yield figures are not available as of early July 2006, production fields of INW0411 and INW0412 were excellent, with significantly less FHB than fields of varieties without resistance to FHB. We have developed many advanced breeding lines in various stages of performance testing in multi-location trials in Indiana, and in regional trials including the NUWWSN and PNUWWSN, that have two or more QTL for type 2 resistance and/or low incidence and type 1 resistance pyramided, verified by phenotyping in the greenhouse and field testing, and genotyping by associated DNA markers. Lines with various combinations of genes/QTLs for type 1, type 2 and low incidence have the lowest FHB disease index in our point inoculated and natural infection nurseries. We have identified what is likely type 1 resistance in Huapei 57-2, a line from China that also has type 2 resistance, and are continuing to refine our screening for type 1 resistance both in greenhouse and field tests by spray-inoculation. We have developed recombinant wheat lines that have *Fhb1*

and *Sr2* in coupling, and recombinant lines that have QSng.sfr-3BS and *Stb2* in coupling, and we have F_2 seeds from crosses to combine the desired allele of all four loci. Lines with *Fhb1* and *Sr2* are in tests in Kenya to verify the presence of *Sr2*, which is effective against Ug99 whereas Alsen, the donor parent of *Fhb1*, is susceptible.

Impact: INW0411 and INW0412 are performing very well in seed production fields and will contribute significantly to reducing production and grain quality losses due to FHB in Indiana and surrounding regions. Wheat advanced lines currently in the breeding program (certain of which will likely be released as commercial varieties after additional testing for performance and resistance to important diseases) that have certain combinations of genes/QTLs for FHB resistance have developed even more reduced FHB disease frequency of infection and disease severity than INW0411.

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?:
Seed producers and wheat farmers have access to wheat varieties that significantly reduce losses to FHB. Wheat breeders have available to them via regional nurseries, wheat germplasm that has multiple genes/QTLs for FHB resistance. Wheat breeders also have the knowledge that combinations of FHB resistance QTL are more effective in reducing FHB losses than single resistance genes/QTL.

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:

Shen X and H Ohm. 2006. Fusarium head blight resistance derived from *Lophopyrum elongatum* chromosome 7E and its augmentation with *Fhb1* in wheat. Plant Breeding 12:(In press).

Shen X, H Sharma, L Kong, and H Ohm. 2006. Development of a chromosome recombinant line of wheat-*Lophopyrum ponticum* with resistance to Fusarium head blight. Plant & Animal Genome XIV, January 14-18, San Diego, CA.

Sharma H, L Kong, X Shen and H Ohm. 2005. Shortening the chromosome $7el_2$ segment from *Thinopyrum ponticum* in the wheat translocation line KS24-2. Annual meeting of American Society of Agronomy, November 6-10, Salt Lake City, UT.

Shen X, H Sharma, L Kong, and H Ohm. 2005. Molecular characterization of a chromosome recombinant carrying a FHB resistance QTL from *Lophopyrum ponticum*. National Fusarium Head Blight Forum, December 10-13, Milwaukee, WI.

Shen X and H Ohm. 2005. Development of STS and CAPS markers to tag the Fusarium head blight resistance on chromosome 7E. Annual meeting of American Society of Agronomy, November 6-10, Salt Lake City, UT.

Shen X and H Ohm. 2005. Mapping of a major Fusarium head blight resistance QTL in wheat derived from *Lophopyrum ponticum*. Plant & Animal Genome XIII, January 15-19, San Diego, CA.

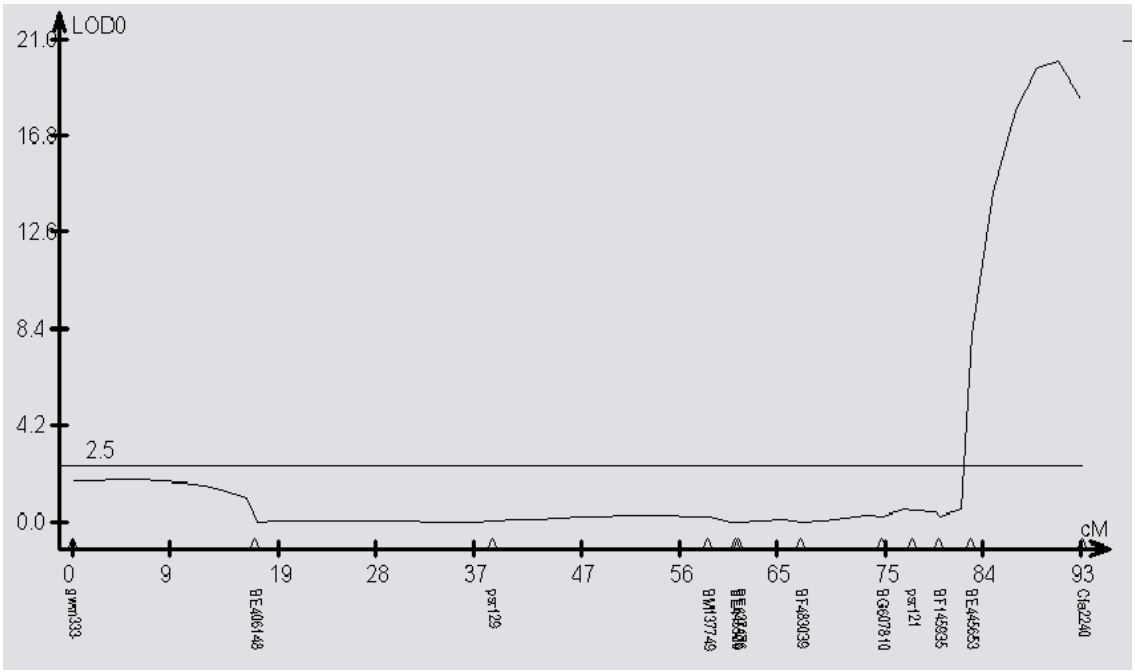

Fig. 1. The LOD score plot of the QTL for number of FHB-diseased spikelets on chromosome $7el_2$. Phenotypic data was from 280 recombinant inbred lines of the F_6 of the cross of K2620 x K11463 (spring greenhouse, 2006). The shape of the curves and the positions of the peak are similar for F_2, F_3, and F_5 data.