USDA-ARS / USWBSI
FY04 Final Performance Report
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Cover Page

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Year:	**FY2004** (approx. May 04 – April 05)
FY04 ARS Agreement ID:	**59-0790-4-118**
FY04 ARS Agreement Title:	**Breeding Soft Winter Wheat with Multiple FHB Resistance.**
FY04 ARS Award Amount:	**$ 111,718**

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
BIO	Mapping of Novel FHB Resistance Transferred from Lophopyrum ponticum to Wheat.	$ 30,020
VDUN	Breeding Soft Winter Wheat for FHB Resistance by Phenotype and Marker-Assisted Selection.	$ 81,698
	Total ARS Award Amount	**$ 111,718**

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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 of Novel FHB Resistance Transferred from Lophopyrum ponticum to Wheat.***

1. What major problem or issue is being resolved and how are you resolving it?
There are a limited number of Fusarium head blight resistance genes that have been identified in wheat. Thus, it is imperative to identify and transfer into wheat, resistance genes from species that are related to wheat. We have identified a strong QTL for FHB resistance on chromosome $7el_2$ of *Lophopyrum elongatum*. Chromosome substitution and translocation lines of chromosome $7el_2$ in wheat backgrounds already exist, making the utilization of this resistance possible. We have localized the FHB resistance QTL near the terminal end of the long arm of chromosome $7el_2$, and we have developed wheat lines in which the $7el_2$ chromosome segment length has potentially been reduced, making this resistance more useful in commercial wheat.

2. What were the most significant accomplishments?
We mapped the FHB resistance of *Lophopyrum elongatum* chromosome $7el_2$ near the terminal end of the long arm and flanked by markers Xpsr121 and Xcfa2240 that are 16 cM apart. The QTL in this region accounted for 27% of phenotypic variation for FHB disease spread in the F_2 population.
A cross was made between KS24-2, a wheat-*Lophopyrum ponticum* translocation line 7DS-$7el_2$L having FHB resistance, and Chinese Spring with a deletion at the homoeologous pairing locus, *phph*. Six hundred F_2 plants were screened for the *ph* locus deletion, and a total of 44 homozygous *phph* plants were identified. These 44 plants were then screened with DNA marker GWM333 specific to $7el_2$L, and marker GDM150 specific to 7DL to identify plants heterozygous for the translocation. These plants were also phenotyped for FHB resistance. Three plants with resistant phenotype, heterozygous translocation, and *phph* deletion were identified. In F_4, one potential chromosome recombinant, 275-4, losing the marker *Xgwm333* but retaining the interval of *Xpsr121* and *Xcfa2240*, and heterozygous, was identified. Crosses were made between this plant as female and two advanced breeding lines. Selfed seeds were also harvested. DNA genotype and FHB resistance was evaluated in the selfed F_5 plants and F_1 plants from the two crosses. All of the 15 selfed plants are either heterozygotes or homozygous for $7el_2$, showing preferential transmission of the $7el_2$ chromosome. In the two crosses, the segregation ratio for wheat: heterozygotes is 5:6 and 15:16, indicating that transmission of the alien chromosome segment as female is normal. Data from analysis of variance suggests significant difference between means of the two groups with and without the *L. elongatum* chromosome segment in F_1 plants, indicating that the shortened chromosome carries the FHB resistance. Backcrosses between heterozygous F_5 plants and Chinese Spring *ph* mutant were conducted to obtain more recombinants. Screening of potential recombination with markers will be conducted in fall, 2005.

3. Impact
This is the first FHB resistance QTL of strong effect mapped in a related species of wheat. In a manuscript submitted to Theor Appl Genet, we show augmentation between FHB resistance of *L. elongatum* and FHB resistance QTL of Ning 7840. Given the paucity of FHB resistance genes of strong effect reported in wheat, that resistance of QTL reported to date is partial and that the resistance of *L. elongatum* is on a different chromosome than resistance QTL that have been reported in wheat, the potential value of this FHB resistance in *L. elongatum* is significant.

Project 2: ***Breeding Soft Winter Wheat for FHB Resistance by Phenotype and Marker-Assisted Selection.***

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. In 2004, like many years particularly with the advent of widespread practice of reduced tillage, wheat production losses to FHB in Indiana ranged from 10-20%. Associated with these production losses, harvested grain is also contaminated with the toxin, deoxynivalenol, which results in severe marketing losses. Fortunately, likely due to unusually dry weather conditions in August-September 2004 (limiting corn residue infection by *Gibberella zeae*) and dry conditions in April-July 2005 (reducing conidia production of *Fusarium graminearum*), FHB was neglible in wheat in 2005 in most areas of Indiana. 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.

2. What were the most significant accomplishments?

We released a soft red winter wheat variety, INW0411 (tested as P97397E1-11-2-4-1-14) that has moderate type 2 resistance and low incidence to FHB. This line ranked among the 10-20% of lines for low FHB disease index in regional trials and continues 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. INW0411 is also very winterhardy, being adapted to the northern areas of soft winter wheat production. INW0411 also has resistance to other important foliar fungal diseases and soilborne mosaic, and has excellent soft wheat milling and baking qualities. All available seed of INW0411 produced by Ag Alumni Seeds in 2005 has already been sold to seed growers. We have developed many advanced breeding lines in various stages of performance testing that have two or more QTL for type 2 resistance and/or low incidence pyramided, verified by phenotyping in the greenhouse and field testing and genotyping by associated DNA markers. 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 Qfhs.ndsu-3BS and *Sr2* in coupling, and recombinant lines that have QSng.sfr-3BS and *Stb2* in coupling. These lines will be tested again in the greenhouse in fall 2005 to verify the phenotypes, after which we will initiate research to develop a line that has all four genes in coupling.

3. Impact

INW0411 is the first variety with low incidence (closed flowers) and type 2 resistance to FHB. INW0411 has ranked among the best lines for FHB disease severity in regional and Indiana tests, and has ranked among the best lines for agronomic performance, earliness, winterhardiness, resistance to important foliar diseases and soft wheat milling and baking qualities. Given the high demand for seed in its first year of availability to seed producers, it is expected to have significant commercial benefit.

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.

Gilsinger J, Kong L, Shen X, and Ohm H. 2005. DNA markers associated with low Fusarium head blight incidence and narrow flower opening in wheat. Theor Appl Genet 110:1218-1225.

Kong L, Anderson JM, and Ohm HW. 2005. Induction of wheat defense and stress-related genes in response to *Fusarium graminearum*. Genome 48:29-40.

Shen X, Kong L, and Ohm H. 2004. Fusarium head blight resistance in hexaploid wheat (*Triticum aestivum*)-*Lophopyrum* genetic lines and tagging of the alien chromatin by PCR markers. Theor Appl Genet 108:808-813.

Shen X and Ohm H. 2005. Augmentation between Fusarium head blight resistance derived from *Lophopyrum elongatum* and a resistance QTL in wheat. Purdue Journal Article No. 2005-17703 (submitted to Theor Appl Genet).