USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY06 Final Performance Report (approx. May 06 – April 07)
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Cover Page

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Fiscal Year:	2006
USDA-ARS Agreement ID:	59-0790-4-096
USDA-ARS Agreement Title:	Crop Residue Management and Screening Techniques for Improved Management of FHB.
FY06 ARS Award Amount:	$ 72,607

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Award Amount
EEDF	Factors Influencing the Accumulation of DON in Fusarium-infected Wheat.	$ 40,447
HGR	FHB Resistance QTLs in Hard Red Spring Wheat Near-isogenic Lines.	$ 32,160
	Total Award Amount	**$ 72,607**

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Principal Investigator Date

* CBCC – Chemical, Biological & Cultural Control
EEDF – Etiology, Epidemiology & Disease Forecasting
FSTU – Food Safety, Toxicology, & Utilization of Mycotoxin-contaminated Grain
GET – Genetic Engineering & Transformation
HGR – Host Genetics Resources
HGG – Host Genetics & Genomics
PGG – Pathogen Genetics & Genomics
VDUN – Variety Development & Uniform Nurseries

Project 1: *Factors Influencing the Accumulation of DON in Fusarium-infected Wheat.*

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

Few studies have closely examined the development of Fusarium head blight (FHB) and deoxynivalenol (DON) accumulation in relation to the resistance of wheat cultivars, the relative aggressiveness of *F. graminearum* isolates, and the competence and ability of *F. graminearum* isolates to produce DON, or the impact of environmental conditions, especially moisture on the accumulation of DON in Fusarium-infested wheat. This project aims to examine these factors on the development of FHB and the accumulation of DON in wheat. To do this field and greenhouse experiment have been conducted in the summer of 2006 and over the fall, winter and spring months of 2006/2007.

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: An inoculated, mist irrigated field experiment examining FHB development and DON accumulation was established in St. Paul in 2006. Treatments included four irrigation regimes (inoculation + 14 days; inoculation + 21 days; inoculation + 28 days; inoculation + 35 days). Subplots were host genetic background (Wheaton susceptible; 2375 moderately resistant; Alsen resistant). Sub-sub-plots were five *F. graminearum* isolates differing in their relative aggressiveness with respect to FHB severity and DON accumulation and a control mock-inoculated with water. Individual plots were two rowed plots, each row 2 m long. Plots were inoculated at anthesis with macroconidial inoculum. Entries were assessed 21 days after inoculation for FHB incidence and FHB severity. Grain was harvested at maturity and assessed for visually scabby kernels (VSK) and DON.

Impact: This study demonstrated that both the host genotype and individual *F. graminearum* isolates have a substantial impact on the incidence and severity of FHB and the accumulation of DON in Fusarium infected wheat. The study also demonstrated that moisture, provided here by irrigation but simulating rainfall, between the time of disease assessment (21 days after inoculation - as is usual in nurseries screening for resistance to FHB) and harvest can have a significant impact on the DON level. This may help explain the apparent variability in DON levels frequently observed among trials.

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?

Knowledge on the impact of moisture should also be of value to pathologists and wheat breeders, especially by improving our understanding of the conditions that result in discrepancies between visual evaluations of FHB, post harvest visual assessment of FHB damage to grain (VSK of TDK), and the DON content of harvested grain that are frequently observed in both dryland and mist-irrigated germplasm screening nurseries. It is also likely that this information may be of use to the epidemiologist in refining disease forecasting models with respect to the relative resistance of wheat cultivars.

Accomplishment: The effect of host resistance and pathogen aggressiveness on FHB severity and DON production was examined in wheat through a series of greenhouse experiments. Three wheats of differing levels of resistance (Alsen, resistant; 2375, moderately resistant; Wheaton, susceptible) were point or spray inoculated at anthesis in separate experiments. Five isolates with varying aggressiveness and DON production were tested. Inoculated spikelets were sampled for DON at 0, 3, 7, 11, 14 and 21 days after inoculation (dai) and used to determine FHB severity. FHB severity and DON differed significantly for each genotype. In the point inoculated materials FHB severity 21 days after inoculation ranged from 6-61%, 6-100% and 31-100% and DON concentrations averaged 121 ppm, 209 ppm, and 196 ppm for Alsen, 2375 and Wheaton, respectively. Overall the correlation between FHB severity and DON was significant ($r = 0.61$). The correlation was highest for Wheaton ($r = 0.71$), intermediate for 2375 ($r = 0.65$) and lowest for Alsen ($r = 0.48$). FHB severity and DON was also significantly effected by isolate. Two isolates (B45A, 49-3) were significantly less aggressive and these isolates resulted in lower DON.

Impact: This information has improved our understanding of the development of DON in wheat tissues and the impact of host resistance and pathogen aggressiveness on DON accumulation. Based on our results it appears that FHB severity can be utilized to select resistance in wheat to both symptom development and DON accumulation, however, it should be noted that the correlation between FHB severity and DON may be lower for more resistant varieties and less aggressive isolates.

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?

An understanding of the impact of the variability within the pathogen population for DON toxin production, as defined by the aggressiveness of a strain and/or the ability of a given strain to produce DON, will shed light on the threat posed by isolates of the pathogen differing with respect to aggressiveness and/or the spectrum and quantities of mycotoxins they produce.

Project 2: *FHB Resistance QTLs in Hard Red Spring Wheat Near-isogenic Lines.*

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

In many instances presumptive unique Fusarium head blight (FHB) resistance quantitative trait loci (QTL) have been mapped in a diverse range of common wheat (*Triticum aestivum*) genotypes and related species, but they have not yet been introgressed into U.S. hard red spring wheat (HRSW). Thus, the utility of such QTLs for FHB resistance improvement often remains hypothetical. Our project goal is to develop wheat lines that are principally HRSW in genome composition, but are near-isogenic for the different reported novel QTLs (QTL NILs) from unadapted or alien germplasm. We are using the most rapid method available to introduce new FHB resistance QTLs into HRSW - marker-assisted backcrossing. Resultant materials can then be used to critically assess whether the new QTLs introgressed do in fact increase FHB resistance in HRSW. Further, pyramiding FHB resistance QTLs is expected to provide a greater opportunity to increase FHB resistance in HRSW. We will use the QTL NILs with different FHB resistance QTLs to pyramide different QTLs, to identify favorable QTL combinations for reducing FHB damage in HRSW.

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: We completed the development of NILs with five different QTLs in the susceptible HRSW cultivars Norm and Wheaton for use in disease evaluations. FHB evaluations of QTL NILs for four of the targeted QTLs was completed in the field and/or greenhouse. Our results to date suggest that we have introgressed the Sumai 3 QTLs *Qfhs-ndsu.3BS* and *Qfhs-ifa-5A* individually into separate NILs, and that we have transferred resistance from the soft red winter wheat Freedom to at least one Norm NIL. We are still evaluating resistance in NILs with additional putative QTLs from Frontana and from *Triticum dicoccoides*. F_2 populations were developed from crosses between selected Wheaton x Wheaton and Norm x Norm QTL NILs, as a starting point for evaluating epistatic interactions between FHB resistance QTLs.

Impact: Introgression of novel FHB resistance QTLs from exotic germplasm or even related species into adapted backgrounds such as HRSW is challenging because of 1) the possible erosion of performance and quality that comes with such efforts, 2) the time and labor required to accomplish this, and 3) the uncertainty of success. However, by not attempting to use reported markers for putative FHB resistance QTLs to introgress them into HRSW or other market classes, previous mapping studies will never move from an academic exercise to a real world solution. Further, FHB resistance improvement will rely upon combining resistance loci, but it is not known how novel QTLs for resistance will interact. By undertaking this research project, we have produced valuable new HRSW germplasm with novel FHB resistance QTLs that will allow breeders to sidestep the aforementioned problems and concerns, and we have generated genetic stocks that we can use to evaluate how best to combine novel resistance QTLs in HRSW.

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?

HRSW NILs that harbor new validated FHB resistance QTLs are released on request to breeding programs, as sources of new genes with which to increase FHB resistance. They are also being used for basic gene discovery research. These NILs are far more attractive as parents for crosses in breeding programs than the original sources of the QTLs, because their genomes will be primarily HRS in derivation. Introducing more FHB resistance QTLs in HRSW provides an avenue for further increasing FHB resistance, in turn reducing the large economic losses associated with this disease.

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.

Gautam, P. and Dill-Macky, R. 2007. Fusarium head blight infection and deoxynivalenol production by *Fusarium graminearum* in wheat. Phytopathology, **97**:S-abstract submission.