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:	**59-0790-4-123**
Agreement Title:	**Fusarium Head Blight: Epidemiology and Management by Genetic and Chemical Means.**
FY05 ARS Award Amount:	**NCE**

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
CBC	Uniform Fungicide Trials for Control of Fusarium Head Blight.	0
EDM	Effect of Inoculum, Host Resistance, Fungicide and Weather on FHB.	0
GIE	Characterization of New Sources of Resistance to Fusarium Head Blight of Wheat.	0
	Total Award Amount	**NCE**

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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: *Uniform Fungicide Trials for Control of Fusarium Head Blight.*

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

The shift to conservation tillage methods of crop production was a major contributor to destructive epidemics of *Fusarium* head blight (FHB) of wheat and barley in the U.S. in the 1990s. Production of susceptible cultivars and favorable weather also contributed to these epidemics. Control of FHB will require several disease management strategies, coupled with greater understanding of its epidemiology. Reduction of crop residue through tillage has not been widely used because efficacy has not been clearly demonstrated or because of negative impacts on soil conservation. Genetic resistance may provide only partial control. Cultivars with some degree of resistance are only now becoming available. Other disease management practices may be needed to augment partial resistance, especially under conditions very favorable for FHB.

Fungicides would provide growers with a management option when susceptible cultivars are grown, and may help protect grain yield and quality of cultivars with partial resistance under conditions particularly favorable for disease. A few fungicides have shown some efficacy against FHB, but do not provide complete control or the desired consistency. Some fungicides reduce DON contamination of grain, but others may cause an increased amount of DON.

The purpose of this cooperative study is to compare a core set of fungicide treatments at several locations throughout the Corn Belt and upper Midwest for their efficacy against FHB of wheat and barley and for their ability to preserve grain quality and prevent accumulation of DON.

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:
The efficacy of various fungicides for control of head blight on soft red winter wheat was evaluated in Tippecanoe County (ACRE) and Jennings County (SEPAC). The ACRE site had mist irrigation to promote disease development. No head blight symptoms developed at either location, owing to dry weather. Mist irrigation at ACRE was insufficient to overcome these dry conditions. There were no visibly *Fusarium*-damaged kernels in the grain from any plot. Although there were significant differences in DON content among treatments at both locations, all DON levels were far below the level of concern (2 ppm). Yields were high at ACRE. No treatment resulted in a yield significantly more or less than the untreated check. Yields were lower at SEPAC, and there was no significant difference among treatments. Test weight was only fair at ACRE, but was good at SEPAC.

Impact:
Owing to uncontrollable weather conditions, there was no head blight in these trials, so the study contributed nothing to knowledge about efficacy of the various fungicides tested. The experiments did reveal that even in the absence of head blight, some DON developed in grain, but well below levels of concern.

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 results of this study reinforce the general understanding that weather is the major controlling element in development of head blight. Even when the fungus is present in corn

residue and a susceptible cultivar of wheat is grown, there will be no disease if weather conditions are not conducive for spore production and infection.

Project 2: *Effect of Inoculum, Host Resistance, Fungicide and Weather on FHB.*

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

Weather has a strong influence on development of head blight. Moisture and temperature control production of spores by *Gibberella zeae* and infection of wheat and barley. Abundance of the fungus presumably determines how many spores may be produced under any given weather conditions. Conservation tillage leaves much more corn residue on the soil surface than conventional tillage, and is thought to be a major contributor to destructive epidemics of *Fusarium* head blight (FHB) of wheat and barley in the U.S. in the 1990s. For whatever amount of inoculum that is in the air when wheat or barley is vulnerable to infection, the degree of cultivar susceptibility will influence the severity of head blight. Farmers now have the option of using a foliar fungicide to suppress head blight. Because of the influence of weather, abundance of the pathogen in crop residue, and degree of cultivar susceptibility on head blight intensity, it would be desirable to use a fungicide only when these factors all combine to result in a high enough risk for disease to justify the additional cost. This epidemiological study, part of a multi-state program, is generating data that can be used to develop and refine weather-based models of the risk of infection. Weather data are collected at 30-min. intervals in order to relate how weather affects disease development in plantings of susceptible or moderately resistant wheat cultivars, treated or not treated with a fungicide, and susceptible barley, all with or without corn residue on the soil surface. Disease variables monitored are inoculum production, head blight severity, frequency of scabby kernels, and DON content.

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:

Weather was dry throughout April and May of 2005 at the research site. Very few spores were detected either in volumetric spore samplers or in washings from wheat heads. No head blight developed in any treatment, and there were no scabby kernels in the harvested grain. There was no DON in the grain. The purpose of this multi-state study is to obtain data on epidemics of various intensity, ranging from no disease to severe disease. Our data for 2005 fell into the no disease category, and thus provided useful information for identifying weather conditions that do not support disease development, even when the fungus is present in crop residue and susceptible small grain cultivars are produced.

Impact:

The current risk model, run for hourly weather data for the test site in 2005 consistently showed a low risk until very late in the season when wheat and barley were mature. At that time, risk models rose to medium. Thus, growers who used the model and followed its

predictions would have saved the cost of an unnecessary fungicide application. The disease data from this experiment are being used to further refine the model.

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?:

Growers, grain buyers, and grain end users have a means for assessing the risk of head blight. Growers can use the model to determine the need for fungicide applications. Grain buyers can use the model to identify areas that might have a head blight problem, and take measures to check grain for scab and DON. Millers can use the model to identify areas where head blight may have reduced grain quality, and take steps to identify sources of sound grain.

Project 3: *Characterization of New Sources of Resistance to Fusarium Head Blight of Wheat.*

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

Resistant cultivars will be an essential component of management of FHB. Wheat breeders are using a few different sources of resistance, but none of these completely controls FHB or accumulation of DON (deoxynivalenol) in grain. Nearly all wheat breeding programs in the U.S. at first relied on the Sumai 3 resistance. Some additional sources of resistance are now being incorporated into breeding programs, although it is not clear to what extent these represent unique genes. Given the variability within *Fusarium*, if the same source of resistance were to be used widely in the U.S., strains of *F. graminearum* or other *Fusarium* species able to partially overcome this resistance may arise. It is prudent to seek other genes for resistance to diversify the genetic base of resistance.

We have identified several wheat lines with resistance to head blight. Some of these were intercrossed or crossed to a known source of resistance (Sumai 3), or to susceptible lines. The purpose of intercrossing resistant lines was to determine if genes from each parent would show additive or other types of interaction to provide a greater degree of resistance than found in either parent.

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:

Cultivar Chokwang has QTL for resistance to head blight that appear to be different from those in Sumai 3, Cultivar Paula VZ-434 has only a moderate degree of resistance, but when crossed to susceptible cultivar Norm, some recombinant inbred line (RIL) progeny had better resistance than shown by Paula. When Paula VZ-434 was crossed to moderately resistant cultivar Mentana, some RILs were more resistant than either parent, and some were more susceptible than either parent. When Paula VZ-434was crossed to Ning 7840 (a Sumai 3 source of resistance), many RILs were more resistant than Ning 7840. A cross of Mentana with Sumai 3 and a cross of Chokwang with Ning 7840 also produced many RILs with greater resistance than either parent. These findings suggest that genes that confer only moderate resistance may be interact to yield enhanced levels of resistance.

Impact:

This research indicates that wheat breeders can use lines with only moderate degrees of resistance to head blight to enhance the degree of resistance in adapted cultivars. A recurrent selection program would likely be effective for developing highly resistant cultivars.

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?:

It is now known that cultivar Chokwang has QTL for head blight resistance that have not been previously described.

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.

Nita M, DeWolf E, Madden L, Paul P, Shaner G, Adhikari T, Ali S, Stein J, Osborne L. 2005. Effect of corn residue level on the incidence of Fusarium head blight. Proc 2005 National Fusarium Head Blight Forum. Available at http://www.scabusa. Org

Shaner G, Buechley G. 2006. Control of leaf blotch and Fusarium head blight of wheat in Indiana with foliar fungicides, 2005. F&N Tests, Report No. 61:CF003.

Yang J, Bai G, Shaner GE.. 2005. Novel quantitative trait loci (QTL) for Fusarium head blight resistance in wheat cultivar Chokwang. TAG. 111:1571-1579.