USDA-ARS / USWBSI
FY04 Final Performance Report
July 15, 2005

Cover Page

PI:	**Ruth Dill-Macky**
Institution:	**University of Minnesota**
Address:	**Department of Plant Pathology** **495 Borlaug Hall** **St. Paul, MN 55108**
E-mail:	**ruthdm@umn.edu**
Phone:	**612-625-2227**
Fax:	**612-625-9728**
Year:	**FY2004** (approx. May 04 – April 05)
FY04 ARS Agreement ID:	**59-0790-4-096**
FY04 ARS Agreement Title:	**Crop Residue Management and Screening Techniques for Approved Management of FHB.**
FY04 ARS Award Amount:	**$ 106,823**

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
EDM	Characterizing Barley Near-Isogenic Lines for a QTL Conditioning DON Accumulation.	$ 29,308
EDM	Crop Residues and the Survival, Production and Control of Fusarium Inoculum.	$ 68,293
VDUN	A Dryland Inoculation Screen for Spring Wheat Reaction to Fusarium Head Blight.	$ 9,222
	Total ARS Award Amount	**$ 106,823**

_____

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: ***Characterizing Barley Near-Isogenic Lines for a QTL Conditioning DON Accumulation.***

1. What major problem or issue is being resolved and how are you resolving it?
The accumulation of deoxynivalenol (DON) in barley is the principal concern of the barley industry related to Fusarium head blight (FHB) epidemics. The barley improvement program at the University of Minnesota (UM) has observed higher DON accumulation, within 72 hours of inoculation, in barley genotypes demonstrating resistance to point-inoculation with *Fusarium graminearum* in greenhouse experiments. Further studies led to the identification of a single quantitative trait loci (QTL) on chromosome 3 in a Frederickson/Stander mapping population that explained 18 and 35% of the variation in DON accumulation in barley spikes within the first 72 hours after inoculation in two respective experiments. This QTL was validated in subsequent greenhouse experiments using near-isogenic lines (NILs). Given the importance of DON to the malting barley industry it is essential to develop a better understanding of the biology of toxin accumulation in Fusarium-infected barley. In this project we are conducting experiments using these NILs to: examine toxin accumulation in barley spikes from anthesis till harvest in greenhouse and field conditions, compare DON accumulation to ergosterol accumulation, examine the stability of the QTL with experiments using a wider range of Fusarium isolates.

2. What were the most significant accomplishments?
Near isogenic lines (NIL) for a QTL, on chromosome 3 in a Frederickson/Stander mapping population, for DON accumulation within 72 hours of infection were studied in a field experiment. The NIL's were planted in an inoculated, mist irrigated field experiment in St Paul. The trial was a randomized complete block with three replicates. Inoculation treatments were used; five isolates of *F. graminearum* and a non inoculated control. Tissue samples were collected 0, 36, 48, 72, 96, 120 and 240 hours after inoculation and at maturity. Samples were analyzed for DON, 3-acetyldeoxynivalenol (3ADON), 15acetyldeoxynivalenol (15ADON), nivalenol and ergosterol (ERG). FHB incidence and severity were assessed 17 day after inoculation. FHB severity ranged from 1-23% and differences between the NIL's were evident, with the NIL carrying the Stander allele having lower FHB severities than the NIL carrying the Fredrickson allele, although the differences (3-8%) were not always significant. DON was not detected in any tissues sampled prior to 240 h post inoculation. DON levels in grain at harvest were numerically greater in the NIL carrying the Fredrickson allele, but not significantly so. Differences in FHB severity and DON were also evident among the F. graminearum with one of the five isolates being significantly less aggressive than the other four tested. The levels of 3ADON, 15ADON and nivalenol were significantly lower than for DON and differences among treatments for these toxins were not readily detected. Ergosterol levels correlated to DON. **These results suggest that this QTL, while conferring lower DON accumulation in controlled experiments, will not provide adequate protection to DON accumulation in barley under field conditions – these results are preliminary and will be confirmed in 2005.**

A greenhouse experiment established in January 2005 with a similar design as the field experiment has been undertaken. The purpose of this experiment was to examine the relationship between ergosterol and mycotoxin production and to confirm the efficacy of the identified QTL across a wider range of isolates. The samples are currently being analyzed for DON, 3ADON, 15ADON and ERG. Data from the analysis should be available August 2005.

Project 2: ***Crop Residues and the Survival, Production and Control of Fusarium Inoculum.***

1. **What major problem or issue is being resolved and how are you resolving it?**
Fusarium-infested residues from cereal plants left in field after harvest are known to provide the inoculum for the development of subsequent Fusarium head blight (FHB) epidemics. This project aims to improve our understanding of the role of crop residues in the survival of *Fusarium* and production of primary inoculum and to evaluate management strategies aimed at the reduction of primary inoculum. Such strategies may include the use of colonization-resistant cultivars and residue management to reduce primary inoculum.

In this project we have conducted field experiments to determine; the relative ability of the residues of newly released wheat cultivars (with improved levels of FHB resistance) to harbor inoculum of *F. graminearum*; the field-scale movement of inoculum by examining the patterns of spread of *F. graminearum* into burned plot areas from adjacent areas with higher levels of infested residues; and the effect of severity of burning on the survival of *Fusarium* in wheat residues.

2. **What were the most significant accomplishments?**
We showed that the incidence of kernel colonization by *F. graminearum* (*Gz*), *F. poae, F. sporotrichioides* and *F. avenaceum*, in sixteen wheat and eight barley entries grown at five locations in 2003 and three locations in 2004 was affected by cultivar, location and the interaction of cultivar by location. Overall, moderately FHB-resistant wheat cultivars, such as Alsen, had lower levels of *Gz*-colonized kernels than susceptible or moderately susceptible cultivars such as Alsen, had lower levels of *Gz*-colonized kernels than susceptible or moderately susceptible cultivars such as Oxen, Reeder, Mercury or Norpro. Hanna also had low levels of *Gz*-colonized kernels. Consistent differences were observed in barley entries for the incidence of Fusarium-colonized kernels at the four locations tested. Robust and Conlon barleys having the lowest levels of *Gz*-colonized kernels.

We were able to demonstrate the stratified colonization of plants by *F. graminearum*. Generally F. graminearum infested kernels and the first and second nodes more than nodes higher on the plants or crowns and sub-crown internodes. We were also able to demonstrate that there is a greater level of *Fusarium* infestation of residues that over-wintered in the field (sampled in the spring), compared to residues sampled at harvest. Despite the higher levels of colonization of over-wintered residues the relative ranking of cultivars, with respect to FHB-resistance, was still evident. Increased colonization of upper nodes and kernels, colonized to a lesser extent at harvest, was a major component of the overall increase in colonization observed. Residue management by burning was demonstrated to significantly reduce the number of nodes and the *F. graminearum* population of surface soil in comparison with unburned treatments. Patterns of *F. graminearum* incidence in a burned area surrounded by a non-burned area did not show any distinct pattern of re-colonization.

These results suggest that the deployment of wheat cultivar with moderate levels of FHB may provide the additional benefit of reducing the reservoir of inoculum in subsequent seasons.

Project 3: ***A Dryland Inoculation Screen for Spring Wheat Reaction to Fusarium Head Blight.***

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

Most, if not all, breeding and pathology programs in the Upper Midwest utilize mist-irrigation to provide moisture to establish Fusarium head blight (FHB) infection for germplasm screening purposes. These irrigation systems are expensive and require significant labor resources to assemble and manage. In this project we sought to demonstrate that the establishment and subsequent screening of wheat nurseries for reaction to FHB need not require the use of mist-irrigation. We hypothesize that this is specifically true in environments that are generally conducive enough for the development of the disease without irrigation. However, many researchers are wary of not using mist-irrigation for fear of not being able to discriminate between resistance and susceptible germplasm. In this project we proposed the use of standard FHB inoculation procedures, similar to those used in our irrigated nurseries, to establish disease plots that were not mist-irrigated.

2. What were the most significant accomplishments?

In 2003 and 2004, at two-locations (2003, St Paul & Barnesville; 2004, St Paul and Crookston), we demonstrated that we could adequately differentiate resistant from susceptible reactions among the wheat entries in the Uniform Regional Scab Nursery (URSN). This indicated that breeding programs would be able to establish disease nurseries and conduct successful screening without the use or expense of implementing mist-irrigation systems. The URSN has previously been conducted only at locations with mist-irrigation. Our results suggest that dryland screening provides a less severe disease intensity while still differentiating among FHB resistant and susceptible genotypes. In mist-irrigated nurseries the high intensity of disease may limit the ability of cooperators to identify intermediate levels of scab resistance as high FHB levels can obscure intermediate levels of FHB resistance. Genotypes with intermediate levels of resistance frequently possess desirable agronomic characteristics. Thus dryland screening techniques provide an opportunity to identify genotypes with improved agronomic characteristics and intermediate levels of FHB-resistance. **Thus, the use of dryland nurseries may augment the breeders' ability to identify germplasm appropriate for selection and crossing aimed at improving FHB resistance in conjunction with agronomic quality. The dryland screening also has the advantage of requiring fewer resources than traditional FHB resistance screening nurseries.**

Results from 2004 are presented in the 2004 Uniform Regional Scab Nursery for Spring Wheat Parent Report (usrn04_fhb-report.pdf) available for downloading at the USWBSI website (www.scabusa.org).

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.

Canci, P.C., Nduulu, L.M., Muehlbauer, G.J., Dill-Macky, R., Rasmusson, D.C., and Smith, K.P. (2004). Validation of quantitative trait loci for Fusarium head blight and kernel discoloration in barley. *Molecular Breeding*, **14**:91-104.

Smith, K.P., Evans, C.K., Dill-Macky, R., Gustus, C.,. Xie, W., and Dong, Y. (2004). Host genetic effect on deoxynivalenol accumulation in Fusarium head blight of barley. *Phytopathology*, **94**:766-771.

Evans, C.K., Dill-Macky, R. and Smith, K.P. (2004). Characterizing barley near-isogenic lines for a QTL conditioning deoxynivalenol accumulation for Fusarium head blight severity and deoxynivalenol accumulation using five isolates of *Fusarium graminearum* under field conditions. In: *Proceedings of the 2nd International Symposium on Fusarium Head Blight, incorporating the 8th European Fusarium Seminar*, Orlando, Florida, USA, December 11-15, 2004, p. 54-55.

Salas, B. and Dill-Macky, R. (2004). Incidence of *Fusarium graminearum* in pre-harvest and overwintered residues of wheat cultivars differing in Fusarium head blight resistance. In: *Proceedings of the 2nd International Symposium on Fusarium Head Blight, incorporating the 8th European Fusarium Seminar*, Orlando, Florida, USA, December 11-15, 2004, p. 502-503.

Salas, B., Dill-Macky, R. and Wiersma, J.J. (2004). Stratified colonization of wheat plants by *Fusarium graminearum*. In: *Proceedings of the 2nd International Symposium on Fusarium Head Blight, incorporating the 8th European Fusarium Seminar*, Orlando, Florida, USA, December 11-15, 2004, p. 504-505.

Salas, B., Dill-Macky, R., and Wiersma, J.J. (2003). Incidence of *Fusarium graminearum* in kernels of wheat and barley cultivars at four locations in Minnesota. In: *Proceedings of the 2003 National Fusarium Head Blight Forum*, Bloomington, Minnesota, USA, December 13-15, 2003, p. 170.

Salas, B., Dill-Macky, R., and Wilhelm, K.P. (2003). Previous crop affecting soil populations of Fusarium head blight pathogens in Minnesota. In: *Proceedings of the 2003 National Fusarium Head Blight Forum*, Bloomington, Minnesota, USA, December 13-15, 2003, p. 171.

Evans, C.K. Garvin, D.F., and Dill-Macky, R. (2003). Comparative evaluation of the uniform regional scab nursery for spring wheat parents under dryland and mist-irrigated conditions. In: *Proceedings of the 2003 National Fusarium Head Blight Forum*, Bloomington, Minnesota, USA, December 13-15, 2003, p. 245.

Salas, B., Dill-Macky, R., and Wilhelm, K.P. (2003). Previous crop affecting soil populations of Fusarium head blight pathogens in Minnesota. *Phytopathology*, **93**:S75.