USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY07 Final Performance Report (approx. May 07 – April 08)
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Cover Page

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Fiscal Year:	2007
USDA-ARS Agreement ID:	59-0790-4-112
USDA-ARS Agreement Title:	Splash Dispersal, Innoculum Level and Fungicide Effects on Fusarium Head Blight.
FY07 ARS Award Amount:	$ 83,158

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
CBCC	Integration and Economic Analysis of Control Strategies for FHB and DON in wheat.	$39,256
EEDF	Factors of Influencing Infection, DON Content, and FHB/DON Relationship in Wheat.	$ 43,902
	Total Award Amount	**$ 83,158**

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
IIR – Integrated/Interdisciplinary Research
PGG – Pathogen Genetics & Genomics
VDUN – Variety Development & Uniform Nurseries

(Form FPR07)

Project 1: *Integration and Economic Analysis of Control Strategies for FHB and DON in wheat.*

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

Efforts to minimize the impact of Fusarium head blight (FHB) and its associated toxin (DON) have been based on the use of management strategies such as host resistance, crop rotation, tillage, and fungicide application. However, none of these methods used alone have been fully effective against FHB and DON. The effects of fungicide application, genetic resistance, and residue management (through crop rotation or tillage) are highly variable and strongly influenced by the environment. Moderately resistant varieties may still become infected, with DON contamination exceeding critical threshold levels. Fungicide efficacy varies from one trial to another, with mean percent control of approximately 50% for FHB and 40% for DON, and yield and quality gains are not always enough to offset the cost of fungicide application. Coordinated research is needed to evaluate the efficacy and economics of using multiple approaches to management FHB and DON. Following a standard protocol, field experiments were conducted across major US wheat-growing regions to evaluate the integrated effects of genetic resistance and fungicide application on FHB and DON. In Ohio, pairs of plots of six soft red winter wheat varieties were planted in a split-plot treatment layout in a randomized complete block design, and one plot of each variety was treated with a fungicide (3 fl oz/A Proline + 3 fl oz/A Folicur) at anthesis (Feekes growth stage 10.5.1). Incidence and severity ("index") of FHB were assessed in each plot at early dough (Feekes GS 11.2) and a sample of harvested grain was tested for DON.

A second experiment was conducted to evaluate the effects of seeding rate (18, 23, and 28 seeds per foot of row), row spacing (7- and 15-inch rows), and fungicide application on FHB and DON. The experimental design was a split-split plot with 3 replicate blocks. Row spacing served as the whole-plot factor, seeding rate as the sub-plot factor, and fungicide application (with and without a single application of Prosaro at 6.5 fl. oz/a + 0.125% Induce) as the sub-sub plot factor.

Data from all integrated management trials were sent to Ohio for analysis and synthesis.

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

<u>**Accomplishment:**</u> Due of unfavorable weather conditions during flowering and early grain fill, disease levels were low in Ohio. During the first two weeks of May, between 0 and 0.8 inches of rainfall were recorded. At the OARDC where the trials were conducted, the wheat crop flowered between May 22 and 29, a period of warm, dry weather conditions. FHB intensity and grain DON content were very low in all plots, with incidence less that 1% and mean DON contamination less than 0.2 ppm.

A total of 14 additional FHB integrated management trials were conducted across the US in 2007. Based on the results from those trials in which some level of FHB developed (more that 5% index in the untreated check), both the main and interaction effects of variety and fungicides were statistically significant ($P < 0.005$). In general, moderately resistant variety + fungicide treatment combination resulted in the highest percent control of FHB and DON. For those trials with cropping sequence as a treatment factor, none-host crop + moderately resistant variety + fungicide generally resulted in the highest percent control

Linear mixed model analysis of the results from experiment 2 (conducted in Ohio) revealed that the main effects of row spacing (7 and 15 inches between rows) and planting density (seeds per foot of row) on yield, test weight, and spike counts (number of spikes per foot of row) were not statistically significant. However, the effect of row spacing on spring stand count (tillers per foot of row) was significant ($P < 0.05$), suggesting that row spacing and planting density may be manipulated to alter the architecture of the crop canopy under conditions in Ohio (in some years) without negatively impacting grain yield.

Impact: The 2007 growing season was the first in which coordinated FHB integrated management trials were conducted across the US. Findings from trials with disease clearly indicated that the integration of multiple (and potentially complementary) approaches such as crop rotation, resistance, and fungicide application would provide the most effect control of FHB and DON. Results from the row-spacing x planting density study suggest that the architecture of the wheat canopy may be altered without negatively impacting yield and quality. Modifying these cultural practices may improve fungicide coverage, and as such, the overall FHB and DON control efficacy with fungicide.

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 ultimate goal of the integrated management program is to develop and provide growers with a series of ***best management*** **strategies** for FHB and DON to help minimize yield and quality losses. A quantitative synthesis of the results from these trials will be made available via the internet and extension publications. Trials conducted at multiple locations will allow for the evaluation of similar integrated strategies under a range of environmental conditions, potentially reducing the time needed for the establishment of the ***best management*** **strategies**. Findings from these trials may also lead to the development of location- or region-specific management recommendations for FHB and DON.

Project 2: *Factors of Influencing Infection, DON Content, and FHB/DON Relationship in Wheat.*

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

Critical for the epidemiology group's goals of adding a DON module to the FHB risk assessment model and developing mechanistic FHB and DON models are an understanding of the relationship between visual symptoms of FHB and DON accumulation and a quantitative measure of differences among varieties in terms of DON accumulation. Through the cooperative epidemiology effort, valuable information has been gathered about temperature and moisture effects on perithecia development and inoculum abundance, and the influence of rainfall intensity on splash dispersal of inoculum within wheat canopies. However, less is known about specific conditions required for spore survival, deposition, colonization, and DON accumulation. It is widely known that moderate to high temperatures, high relative humidity, and rainfall during anthesis favor FHB development (manifestation of visual symptoms) and DON contamination. However, conditions favorable for infections associated with moderate to low symptom manifestation and disproportionately high DON accumulation is less clearly understood. DON may exceed threshold levels even when disease symptoms are low or absent. In addition, the relative response of commercial varieties to DON accumulation has not been characterized under field conditions. Two experiments were designed to investigate factors influencing FHB infection and DON accumulation and the FHB/DON relationship. In the first, a split-split plot design was used with planting date (Hessian Fly-safe date and two weeks later) as the whole plot, variety (Truman, resistant; Cooper, susceptible; and Hopewell, moderately susceptible) as the sub plot, and inoculation timing (early and late anthesis) as the sub-sub plot. In the second, three plots each of six soft red winter wheat varieties were planted in each of three blocks, in a split plot design. One plot of each variety was left untreated, one treated with Folicur 3.6F (4 fl. oz./A + 0.125% Induce), and the third treated with Prosaro (6.5 fl. oz/A + 0.125% Induce). Incidence and severity ("index") of FHB were assessed within each plot at early dough (Feekes GS 11.2) and a sample of harvested grain was tested for DON. In addition, spikes in each of 11 disease index categories (0, 5, 10, 15, 20, 25,…, and 50%) were tagged in each plot and harvested for DON and RT-PCR analysis.

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:**__ Due of unfavorable weather conditions during flowering and early grain fill, disease levels were low in non-inoculated plots. However, FHB developed well in inoculated plots. For experiment one, the main effects of inoculation timing, planting date, and variety and all interactions involving these factors on FHB index were statistically significant ($P < 0.05$). However, for incidence and DON, the effect of planting data was not significant (at the 5% level of probability). Significant interaction between variety and inoculation timing suggest that, depending on when infection occurs relative to anthesis, varieties with different levels of resistance to FHB may have similar levels of disease and toxin accumulation. For instance, the difference in DON accumulation between Cooper, the susceptible variety, and Truman, the moderately resistance variety, was not statistically significant when Truman was inoculated at late anthesis and Cooper was inoculated at early anthesis, however, when Truman was inoculated at early anthesis and Cooper inoculated at late anthesis, the difference in DON contamination between the two varieties was statistically significant ($P < 0.005$).

For the second experiment, results from an analysis of covariance showed that DON content (ppm) increased with increasing FHB index in all three varieties. However, the rate of change in DON with change in severity (the regression slope) was generally greater for the susceptible varieties than the resistant variety. The magnitude of the difference in DON content among the varieties, at a given level of severity, was higher at high severity (30% index) than at low severity (5% index). Contrastingly, estimated slopes for relationships between fungal biomass (log-transformed ng/mg) and DON (ppm) were similar for the three varieties, suggesting similarity among the varieties in the rate of increase in DON content with increase in fungal colonization. However, the heights of the regression lines for the fungal biomass/DON relationships differed among the varieties, indicating that for a similar level of fungal colonization, DON accumulation differed among the varieties. Although based on visual symptoms Cooper is more susceptible to FHB than Truman, Cooper had DON content that was lower than, or comparable to, that of Truman for a given fungal biomass, under the conditions of this study.

Impact: Data from these experiments are being used to validate and refine existing risk assessment models for FHB and to develop mechanistic FHB and DON risk assessment models. The web-based FHB models are currently being used in 24 US states as an early warning system to prepare producers, grain buyers, and the milling industry for possible epidemics of FHB and to help producers make fungicide application decisions. Results from experiment two will serve as the basis for further investigations of the associations among FHB, DON and variety. This may provide insight as to the mechanisms involved in resistance to FHB and DON in soft red winter wheat varieties. The findings from experiment two suggest that resistance to FHB does not necessarily parallel resistance to DON accumulation.

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?:

With new and fairly effective fungicides recently registered for FHB and DON management, the web-based risk assessment models are now an important part of integrated management programs for this disease and toxin. More growers and crop consultants will routinely refer to these models to make management and marketing decisions. Improving the prediction accuracy of the risk models, adding a DON prediction module to the web-based risk tool, and characterizing varieties in terms of their differential DON accumulation will all contribute to improving the efficacy FHB and DON management.

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.

Peer-Reviewed Articles

Paul, P. A., Lipps, P. E., De Wolf, E., Shaner, G., Buechley, G., Adhikari, T., Ali, S., Stein, J., Osborne, L., and Madden, L. V. 2007. A distributed lag analysis of the relationship between *Gibberella zeae* inoculum density on wheat spikes and weather variables. **Phytopathology** 97:1608-1624.

Paul, P. A., Lipps, P. E., Hershman, D. E., McMullen, M. P., Draper, M. A., and Madden, L. V. 2007. A quantitative review of tebuconazole effect on Fusarium head blight and deoxynivalenol content in wheat. **Phytopathology** 97:211-220.

Abstracts

Paul, P. A., Lipps, P. E., Hershman, D. E., McMullen, M. P., Draper, M. A., and Madden, L. V. 2007. Relative efficacy of triazole-based fungicides for Fusarium head blight and deoxynivalenol control in wheat. Phytopathology 97:S90.

Nita, M., DeWolf, E., Madden, L., **Paul, P.**, Shaner, G., Adhikari, T., Ali, S., Stein, J. and Osborne, L. 2007. Integrated management of Fusarium head blight (FHB) and deoxynivalenol contamination. Phytopathology 97:S85.

Proceedings and Presentations

Paul, P., Lipps, P., Hershman, D., McMullen, M., Draper, M., and Madden, L. 2007. A Quantitative synthesis of the relative efficacy of triazole-based fungicides for FHB and DON control in wheat. Pages 115-116 in: Proc. 2007 Natl. Fusarium Head Blight Forum, Kansas City, MO.

Salgado, J. D., Broders, G., Madden, L., and **Paul, P.** 2007. Characterization of DON accumulation in SRWW cultivars with different levels of type II resistance to FHB. Page 137 in: Proc. 2007 Natl. Fusarium Head Blight Forum, Kansas City, MO.

Wallhead, M., Madden, L., and **Paul, P.** 2007. Differential sensitivity to triazole-based Fungicides among Isolates of *Fusarium graminearum*. Page 141 in: Proc. 2007 Natl. Fusarium Head Blight Forum, Kansas City, MO.

Paul, P., Madden, L., McMullen, M., Hershman, D., Sweets, L., Wegulo, S., Bockus, W., Halley, S., and Ruden, K. 2007. An integrated approach to managing FHB and DON in wheat: uniform trials 2007. Pages 117-122 in: Proc. 2007 Natl. Fusarium Head Blight Forum, Kansas City, MO.

Paul, P. A., Madden, L. V., Wegulo, S., Adhikari, T., Ali, S., and De Wolf, E. 2007. Influence of SRWW, HRSW, and HRWW varieties on the relationship between FHB and DON. Page 128 in: Proc. 2007 Natl. Fusarium Head Blight Forum, Kansas City, MO.

Paul, P., Madden, L., McMullen, M., Hershman, D., Brown-Rytlewski, D., Sweets, L., Adee, E., Padgett, B., and Ruden, K. 2007. Fungicide effects on FHB and DON in wheat across multiple locations and wheat classes: uniform fungicide trials 2007. Pages 123-127 in: Proc. 2007 Natl. Fusarium Head Blight Forum, Kansas City, MO.

Nita, M., DeWolf, E., Madden, L., **Paul, P.**, Shaner, G., Adhikari, T., Ali, S., Stein, J., Osborne, L., and Wegulo, S. 2007. Mechanistic simulation models for Fusarium head blight and deoxynivalenol. Page 108 in: Proc. 2007 Natl. Fusarium Head Blight Forum, Kansas City, MO.

Sneller, C., **Paul, P.**, Herald, L., Sugerman, B., Johnston, A. 2007. Report on the 2006-2007 northern uniform winter wheat scab nurseries (NUWWSN and PNUWWSN). Pages 237-242 in: Proc. 2007 Natl. Fusarium Head Blight Forum, Kansas City, MO.

Extension Newsletters (Electronic)

Pierce Paul and Dennis Mills - Problems with Planting Wheat After Wheat or Wheat After Corn. Crop Observation and Recommendation Network (C.O.R.N.). 2007-29. http://agcrops.osu.edu/.

Pierce Paul and Dennis Mill - Risk of Head Scab Low. Crop Observation and Recommendation Network (C.O.R.N.). 2007-14. http://agcrops.osu.edu/.

Pierce Paul and Dennis Mill - Conditions not Favorable for Foliar Disease Development. Crop Observation and Recommendation Network (C.O.R.N.). 2007-13. http://agcrops.osu.edu/.

Pierce Paul and Dennis Mill - Managing Wheat Diseases with Fungicides. Conditions not Favorable for Foliar Disease Development. Crop Observation and Recommendation Network (C.O.R.N.). 2007-12. http://agcrops.osu.edu/.

Pierce Paul and Dennis Mill - Wheat Scab Risk Prediction 2007. Crop Observation and Recommendation Network (C.O.R.N.). 2007-9. http://agcrops.osu.edu/.