USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY11 Final Performance Report
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Cover Page

PI:	Frances Trail
Institution:	Michigan State University
Address:	Department of Botany & Plant Pathology 342 Plant Biology Lab East Lansing, MI 48824
E-mail:	trail@msu.edu
Phone:	517-432-2939
Fax:	517-353-1926
Fiscal Year:	FY11
USDA-ARS Agreement ID:	59-0206-1-120
USDA-ARS Agreement Title:	Interactions of *Fusarium graminearum*, the Head Scab Pathogen, with Wheat and Barley.
FY11 USDA-ARS Award Amount:	$ 81,592

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
BAR-CP	Understanding Colonization Leading to DON Accumulation in Barley.	$ 40,011
PBG	Towards the Elimination of Scab Inoculum from Crop Residues.	$ 41,581
	Total ARS Award Amount	**$ 81,592**

Principal Investigator Date

* MGMT – FHB Management
FSTU – Food Safety, Toxicology, & Utilization of Mycotoxin-contaminated Grain
GDER – Gene Discovery & Engineering Resistance
PBG – Pathogen Biology & Genetics
BAR-CP – Barley Coordinated Project
DUR-CP – Durum Coordinated Project
HWW-CP – Hard Winter Wheat Coordinated Project
VDHR – Variety Development & Uniform Nurseries – Sub categories are below:
SPR – Spring Wheat Region
NWW – Northern Soft Winter Wheat Region
SWW – Southern Soft Red Winter Wheat Region

Project 1: *Understanding Colonization Leading to DON Accumulation in Barley.*

1. What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?

Our research addresses the Objective 7 of the Barley CP: Investigate host genotype x pathogen interaction for infection, disease development and DON accumulation. Previously, Lewandowski et al (2006) infections occurred via bract margins, but their study was based on early stage infections and gave no mechanism for establishment in those earlier stage infections. Thus, the mechanism of pathogen entry into the flower and developing seed is not clearly understood. We investigated infection and establishment pathway in both Stander (susceptible) and Quest (resistant) barley cultivars and determined the role of DON in infection.

2. List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):

Accomplishment:

We have clearly shown that very large trichomes on the surface of the paleas of the barley floret are the main entry points for fungal infection. These trichomes run along the two vascular bundles of the palea. The trichomes clearly trap conidia, attract germination hyphae and induce branching and differentiation of the hyphae. Hyphae penetrate the trichome, move from there into the vascular bundles and then sporulated in the substomatal cavities. There was no difference between infection of the two different cultivars, indicating resistance is not due to initial infection processes. In addition, a Tri5 mutant infected trichomes in a similar pattern, indicating DON does not assist during the infection process.

Impact:

Identification of trichomes as the major infection route of the fungus provides opportunities to direct control strategies towards that mechanism. We are currently working to generate transgenic barley without trichomes, which would rigorously test this strategy. Alternatively, trichomes and associated cells could be engineered to inhibit fungal colonization, thus having a very specific target for infection. We are currently working towards this strategy.

Project 2: *Towards the Elimination of Scab Inoculum from Crop Residues.*

1. What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?

Ascospores are a major source of inoculum for the head blight disease. These wind-dispersed propagules are borne in ephemeral perithecia derived from overwintering, lipid-filled hyphae. These lipid-filled hyphae form underneath the plant epidermis and perithecia form in association with specific host cells (stomates and silica cells). Located close to the surface of the crop residues, these hyphae are relatively accessible to physical and chemical treatments that may reduce their viability. This work explored the overwintering strategies of Fusarium on corn stalks.

We are still completing experiments on how light signals affect perithecium development. However, we have indications that the plant environment plays a strong, perhaps equally as significant a role as the light.

2. List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):

Accomplishment:

We have shown that corn stalks are colonized similarly to wheat, in that the fungus produces resting structures in association with stomates. However, additional overwintering hyphae are produced within the stalk. These hyphae can go dormant during freezing temperatures. The dormant hyphae are fairly fragile, particularly when they are desiccated.

Impact:

In areas where corn is not alternated with wheat, it is likely that a superficial treatment of the crop residue with fungicide would provide significant inoculum reduction, as the superficial overwintering mycelia are quite sensitive to treatments, particularly if treated when they are dry. In areas where wheat is alternated with corn, the corn provides a much hardier protection, as has been shown in a number of studies. In these areas, the treatment of residues would have to be more intensive.

If the plant environment plays a major role in where perithecia develop on the host, then breeding may be able to reduce perithecium production.

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.

Trail, F. Lessons learned from genomic studies of toxigenic Fusarium species. Invited talk. Mycored Conference. Ottawa, Canada, June 2012.

Trail, F., and H. Hallen-Adams. 2012. Establishing strategies for control of mycotoxins in corn. Corn Utilization Conference, Indianapolis, June.

Afton, D., and Trail, F. 2011. Interactions Between *Fusarium graminearum* and the Host Plant. USWBSI Fusarium Forum.

Trail, F. A whole plant/ whole fungus look at the head blight disease. Plenary talk, Canadian Workshop on Fusarium Head Blight. Winnepeg, Canada. November 2011.

Afton, D., and F. Trail. 2012. Host colonization leading to sporulation in *Fusarium graminearum.* Invited talk. To be presented at APS in August.

Afton, D., and F. Trail. 201-. Mechanism of surface establishment and colonization of barley florets by *Fusarium graminearum*. Manuscript to be submitted this month.

Funding applications in 2012 that use our USWBSI research results to leverage:
Submitted to NSF in June 2012 for renewal of a previous project on Fusarium fruiting bodies: The evolution of gene expression underlying sexual development in fungi. In collaboration with Jeff Townsend, Yale University. (Trail portion proposed: $369,436). Pending.

Submitted to USDA-NIFA in March, 2012:
Managing Fusarium and Aspergillus mycotoxins via gene regulation and symbiosis. PI: Trail, with 6 Co-PIs. Proposed $5,500,000. Pending.

Funded 2012 USDA Postdoctoral Fellowship for Lina Quesada:
Using systems biology to unravel gene and metabolite networks involved in mycotoxin production in the *Fusarium graminearum*-corn interaction. Mentors: Frances Trail and Robin Buell. $130,000