USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY13 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:	FY13
USDA-ARS Agreement ID:	59-0206-1-120
USDA-ARS Agreement Title:	Interactions of Fusarium graminearum, the Head Scab Pathogen, with Wheat and Barley.
FY13 USDA-ARS Award Amount:	$ 96,746

USWBSI Individual Project(s)

USWBSI Research Category*	**Project Title**	**ARS Award Amount**
BAR-CP	Understanding Routes for Barley Infection.	$ 50,515
PBG	Elucidating Alsen Resistance to Fusarium Ingress.	$ 46,231
	FY13 Total ARS Award Amount	**$ 96,746**

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 Routes for Barley Infection.*

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

Our previous studies have focused attention on the colonization of the lemma and palea margins and the growth of hyphae in this area. We showed that the fungus differentiates when it associates with trichomes on the lemma and palea. The trichomes somehow trigger a response in the fungus to form a large cell, which then initiates penetration. Resistant and susceptible barley cultivars exhibit quantitative differences at this point of colonization. The focus of this proposal was to understand the role of trichomes in barley susceptibility and to progress towards using this fungal entry-point as a target for control of scab disease. Trichomes are silica-filled cells which are part of a larger family of cells called phytoliths.

We initially were going to silence a gene for trichomes that was published in rice. However, that publication ended up being faulty, as shown by a subsequent publication from another group. Therefore, we chose a gene that is important in mycotoxin regulation, VeA in Fusarium and generated transgenic barley plants designed to silence that gene in infecting fungus. Lynn Dahleen helped us by generating the transgenic plants, which are now being tested for resistance.

2. **List the most important accomplishments and their impact (i.e. how are they being used) to minimize the threat of Fusarium Head Blight or to reduce mycotoxins. Complete both sections; repeat sections for each major accomplishment:**

Accomplishment:

1. We examined the impact of Fusarium on cultivars with a variety of phytoliths, and it appears that *Fusarium graminearum* interacts preferentially with specific kinds, particularly round phytoliths that may be important infection sites.

2. We generated transgenic barley with the capacity to silence VeA in *F. graminearum.* We are currently growing the transgenic plants for testing.

Impact:

1. Trichomes and phytoliths vary in varieties of barley, by knowing those that confer increased susceptibility, we can use this knowledge to screen for increased resistance to scab.

2. Silencing VeA in *F. graminearum* effectively would eliminate DON production in infected barley.

Project 2: *Elucidating Alsen Resistance to Fusarium Ingress.*

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

Building resistance to head blight into wheat and barley is the main strategy for improving the disease outcome. The most powerful resistance source currently available is derived from Sumai 3. We currently use the spring wheat variety Alsen, which carries Sumai3 based resistance. Alsen resistance limits colonization of the seed, arrests the spread of the fungus, and cures kernels of fungal infection late in grain development. Our work focused on teasing apart stages of resistance to understand the fungal-plant interaction that results in resistance and using in comparison colonization of Wheaton.

2. List the most important accomplishments and their impact (i.e. how are they being used) to minimize the threat of Fusarium Head Blight or to reduce mycotoxins. Complete both sections; repeat sections for each major accomplishment:

Accomplishment:

Alsen, in comparison to Wheaten, following inoculation with *F. graminearum*, develops a brown plug in the top of the rachis segment immediately below the inoculation point, visible after 5-6 days of post inoculation. The plug arrests further infection and colonization. The brown material forms within the cells, in the cell walls, and in the apoplast of the epidermis, parenchyma, and vascular tissue. The reaction appears to consist of phenolic material, although pectic plugs are present in the vascular tissue. No fungal extension has been observed beyond this “plug”. In Wheaten, no plug is formed and the fungus travels rapidly down the rachis. We are currently performing RNASeq analysis of Alsen that is just beginning to undergo this reaction to try to determine what genes are being upregulated in comparison to Wheaten.

Impact:

To identify the mechanism of this resistance response will allow us to better identify similar resistance mechanisms in other lines of wheat, and during crosses. We will determine a pattern of gene expression that characterizes this response and can be used to screen for similar responses in other lines.

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 FY13 grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

Reports relevant to this proposal:

Imboden, L, Afton, D., and Trail, F. 2014. *Fusarium graminearum* ingress of the barley palea via phytoliths. Poster presented at the Mycological Society of America meeting in E. Lansing, June.

Related articles:

Wang Z, F Lopez-Giraldez, N Lehr, M Farre, R Common, F Trail, JP Townsend. 2014. Global gene expression and knockout analysis reveals genes associated with fungal fruiting body development in *Neurospora crassa*. Eukaryotic Cell 13:154-169.

Trail, F, DM Gardiner. 2014. Application of genomics to the study of pathogenicity and development in *Fusarium.* Invited review to The Mycota series. *In press.*

Ma, L-J, DM Geiser, RH Proctor, AP Rooney, K O'Donnell, F Trail, DM Gardiner, JM Manners, K Kazan. 2013. Fusarium Pathogenomics, Annual Review of Microbiology, 67:399-416.

Trail, F. 2013. Sex and Fruiting in Fusarium. *In, Fusarium*: genomics, molecular and cellular biology. Daren Brown and Robert Proctor, *eds.* Horizon Scientific Press and Caister Academic Press, Norwich, UK.

Harrison, N., Cavinder, B., Townsend, JP, and Trail, F. 2013. Optimized primers and other critical conditions for efficient fusion PCR to generate knockout vectors in filamentous fungi. Fungal Genetics Reports 60: 1 – 10.