USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY08 Final Performance Report (approx. May 08 – April 09)
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Cover Page

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Fiscal Year:	2008
USDA-ARS Agreement ID:	59-0790-8-060
USDA-ARS Agreement Title:	Engineering Fusarium Head Blight Resistance and Plant Defense Signaling.
FY08 USDA-ARS Award Amount:	$ 46,073

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Adjusted Award Amount
GDER	Engineering Scab Resistance in Wheat with Plant Defense Signaling Genes.	$46,073
	Total Award Amount	**$ 46,073**

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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
HWW-CP – Hard Winter Wheat Coordinated Project
VDHR – Variety Development & Uniform Nurseries – Sub categories are below:
SPR – Spring Wheat Region
NWW – Northern Winter Wheat Region
SWW – Southern Sinter Wheat Region

Project 1: *Engineering Scab Resistance in Wheat with Plant Defense Signaling Genes.*

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

Fusarium graminearum is the leading agent of Fusarium head blight (FHB) disease of wheat and barley in the US. Annual losses to FHB have averaged $200-400 million per annum. In the absence of monogenic resistance against FHB current control methods utilize a combination of planting partially resistant varieties with fungicide application and crop rotation. Genetic engineering provides an alternative approach for developing germplasms with heightened resistance to FHB. Novel genes and chimeras can be introduced into wheat and barley, thus adding to the repertoire of genes that can be utilized in breeding programs for enhancing FHB resistance. Previously, ectopic expression of the *Arabidopsis thaliana NPR1* (At*NPR1*) gene from the maize ubiquitin promoter was shown to enhance FHB resistance in the partially FHB-resistant cv. Bobwhite. *NPR1* controls the activation of salicylic acid-dependent defense responses in plants, which our studies have demonstrated is important for resistance to *F. graminearum* in *Arabidopsis thaliana*. *PAD4* and WRKY18 are two additional genes from *Arabidopsis thaliana* that enhances resistance to *F. graminearum*. *PAD4* modulates salicylic acid synthesis in pathogen inoculated plants and production of antimicrobial phytoalexins, while *WRKY18* affects a subset of *NPR1* functions. As part of this USDA-ARS USWBSI-sponsored project we have engineered At*PAD4* expression in transgenic wheat and have generated a chimeric *Ubi*:At*WRKY18* construct for constitutive over-expression of At*WRKY18* in wheat.

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)**

(a) Accomplishment: A *Ubi*:At*PAD4* construct containing a Myc epitope tag has been transformed into the hexaploid wheat cv. Bowhite and the terraploid cv. Ben. Expression of the *PAD4* transcript is driven from the maize *Ubiquitin* (*Ubi*) gene promoter. Progeny plants have been screened for expression of the *Ubi*:At*PAD4* chimera. Two lines that constitutively express the chimera have been identified. The transgene is segregating in this population and efforts are underway to identify homozygous plants. Preliminary FHB studies on a few lines have been promising.

Impact: Homozygous progeny derived from these transgenic lines will be evaluated for gene expression, protein accumulation and FHB resistance in the greenhouse.

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?:
Homozygous *Ubi*:At*PAD4* lines that will be generated as a result of this work will provide germplasms that can be utilized in future FHB breeding programs. In addition, these germplasms can also be utilized to study the involvement of *PAD4* in wheat resistance to aphids, since *PAD4* controls aphid resistance, as well.

(b) Accomplishment: A chimeric *Ubi*:At*WRKY18* construct has been constructed in which the At*WRKY18* coding sequence has been cloned for expression from the *Ubi* gene promoter. This construct has been biolistically introduced into the hexaploid wheat cv Bobwhite. Four transgenic plants (T_0 generation) that contain the *Ubi*:At*WRKY18* chimera have been identified and are being propagated further.

Impact: Homozygous At*WRKY18* progeny will provide genetic material for evaluating the impact of At*WRKY18* expression on FHB resistance.

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?:

These At*WRKY18* lines will provide germplasms that can be utilized in future breeding programs for fungal resistant wheat.

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.

Publications:

Shah, J. (2009) Plants under attack: systemic signals in defence. Curr. Opin. Plant Biol. 12: in press

Shah, J., and Chaturvedi, R. (2008) Lipid signals in plant-pathogen interaction. In**:** Molecular Aspects of Plant Disease Resistance, ed: J. Parker. Annu. Plant Rev.34: 292-333, Wiley-Blackwell.

Makandar, R., Chaturvedi, R., Sparks, A., and Shah, J. *Fusarium graminearum* macroconidia germination is inhibited by a salicylic acid and *NPR1* (*NONEXPRESSER OF PR GENES 1*)-dependent mechanism. (under revision for resubmission to Mol. Plant-Microbe Interact.)

Makandar, R., Nalam, V., Jeannotte, R., Sparks, A., Trick, H., and Shah, J. Dual Role of Jasmonate Signaling in Plant Interaction with *Fusarium graminearum.* (under revision for resubmission to Mol. Plant-Microbe Interact).

Presentations:

Enhancing Fusarium head blight resistance in wheat by manipulating host defense signaling mechanisms. Poster presentation at the 'ASPB Southern Section Meeting, Austin', TX (Feb 28-March 2, 2009).
Authors: Vamsi Nalam, Ragiba Makandar, Harold N. Trick and Jyoti Shah

Identifying plant genes and mechanisms that contribute to defense and susceptibility to Fusarium graminearum. Poster presentation at the '2008 National Fusarium Head Blight Forum' Indianopolis, IN (Dec 2-4, 2008)
Authors: Vamsi Nalam, Ragiba Makandar, Harold N. Trick and Jyoti Shah

Interaction between salicylic acid and jasmonic acid signaling in Arabidopsis and wheat impacts macroconidia germination of the Fusarium head blight fungus, Fusarium graminearum. Poster presentation at the 'International Conference on Arabidopsis Research', Montreal, Canada (July 23 – 27, 2008).
Authors: Ragiba Makandar, Ratnesh Chaturvedi, Alexis Sparks, Ruth Welti and Jyoti Shah

Long distance signaling in systemic acquired resistance. Poster presentation at the 'International Conference on Arabidopsis Research', Montreal, Canada (July 23 – 27, 2008).
Authors: Ratnesh Chaturvedi, Kartikeya Krothapalli, Ragiba Makandar, Ruth Welti, and Jyoti Shah

Genes and mechanisms associated with plant interaction with F. graminearum. Oral Presentation at the '2008 National Fusarium Head Blight Forum', Indianopolis, Indiana; December 2008.
Presenter: Jyoti Shah

If your FY08 USDA-ARS Grant contained a VDHR-related project, include below a list all germplasm or cultivars released with full or partial support of the USWBSI. List the release notice or publication. Briefly describe the level of FHB resistance. If this is not applicable (i.e. no VDHR-related project) to your FY08 grant, please insert 'Not Applicable' below.

Not Applicable