USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY18 Performance Report
Due date: September 23, 2019

Cover Page

Cooperating Principle Investigator (CPI):	Ce Yang
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Fiscal Year:	2018
USDA-ARS Agreement ID:	58-5062-8-018
USDA-ARS Agreement Title:	Color and spectral imaging for High-Throughput Phenotyping to Assess FHB Severity.
FY18 USDA-ARS Award Amount:	$ 72,578
Recipient Organization:	Regents of the University of Minnesota Suite 450 Sponsored FIN RPT-P100100001 Minneapolis, MN 55455-2003
DUNS Number:	555917996
EIN:	41 -6007513
Recipient Identifying Number or Account Number:	CON000000076065
Agency PI:	H. Corby Kistler
Project/Grant Reporting Period:	9/1/18 - 8/31/19
Reporting Period End Date:	08/31/19

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
EC-HQ	Color and Spectral Imaging for High-Throughput Phenotyping to Assess FHB.	$ 72,578
	FY18 Total ARS Award Amount	$ 72,578

09/23/2019

Principal Investigator Date

* MGMT – FHB Management
FST – Food Safety & Toxicology
GDER – Gene Discovery & Engineering Resistance
PBG – Pathogen Biology & Genetics
EC-HQ – Executive Committee-Headquarters
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

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Project 1: *Color and Spectral Imaging for High-Throughput Phenotyping to Assess FHB.*

1. **What are the major goals and objectives of the project?**
   The major goal is to increase the accuracy, efficiency, and cost-effectiveness of FHB phenotyping in the field.

   The specific objectives for this 2018/19 technology proposal are to:

   1) develop an efficient pipeline for assessing FHB severity on wheat and barley in the field based on image processing;
   2) compare the efficiency and cost-effectiveness of this FHTP system to conventional visual assessment protocols in the field; and
   3) investigate the feasibility of hyperspectral imaging for assessing DON content in wheat and barley grain under controlled laboratory conditions.

2. **What was accomplished under these goals?** *Address items 1-4) below for each goal or objective.*

   1) major activities

   - Collected three years' image set, field FHB scoring data, collected DON hyperspectral images and obtained DON GC-MS measurements of >2000 seed samples.
   - Developed a pipeline for assessing FHB severity in the field based on color imaging
   - Developed band selection on hyperspectral imaging for assess FHB severity.
   - Designed and fabricated a phenocart with sensors to carry out image collection for both color and hyperspectral images
   - Analyzed the DON hyperspectral images for 780 seed samples from variety trials and prove the DON assessment capability of hyperspectral imaging.

   2) specific objectives

   The specific objectives listed in Q1 are achieved (details in the above sub-question 1).)

   3) significant results

   - Field FHB assessment accuracy of ~80% can be achieved using deep learning and color image processing techniques. A larger dataset with newly collected images from season 2019 is being processed.
   - Lab DON assessment accuracy of > 80% can be achieved using the spectrum of 800 seed sample hyperspectral images. More work with the full image set is now being handled by the postdoc Dr. Wenhao Su, who works on this project.
   - Selected six spectral bands that work the best for in-door FHB assessment on the wheat/barley spikes

4) key outcomes or other achievements

Two conference papers have been published and one peer-reviewed paper is under review for the journal Remote Sensing:

- Qiu, R., Yang, C., Moghimi, A., Anderson, J., Steffenson, B. and Marchetto, P., 2018, December. Detection of Fusarium Head Blight in small grains using hyperspectral imaging. In *Proceedings of the 2018 National Fusarium Head Blight Forum, St. Louis, Missouri, USA, 2-4 December 2018* (pp. 32-36). US Wheat & Barley Scab Initiative (USWBSI).

- Moghimi, A., Yang, C., Anderson, J.A. and Reynolds, S.K., 2019. Selecting informative spectral bands using machine learning techniques to detect Fusarium head blight in wheat. In *2019 ASABE Annual International Meeting* (p. 1). American Society of Agricultural and Biological Engineers.

- Ruicheng Qiu, Ce Yang, Ali Moghimi, Man Zhang, and Brian Steffenson. Detection of Fusarium Head Blight in Wheat Using a Deep Neural Network and Color Imaging.*Remote Sens.* 2019, Under Review.

3. What opportunities for training and professional development has the project provided?

- PIs attended the USWBSI FHB forum and presented posters.
- PIs presented the work during the International Conference of American Society of Agricultural and Biological Engineering (ASABE).
- PIs attended the USWBSI Barley-CP Planning Workshop meeting
- PI Yang provided a full-day drone hyperspectral imaging training to the UMN G.E.M.S. (Genetics. Environment. Management. Socioeconomics) colleagues to learn about using airborne hyperspectral imaging for high-throughput phenotyping.

4. How have the results been disseminated to communities of interest?

- PIs attended the USWBSI FHB forum and presented posters.
- PIs will attend again and give a talk to the community on the FY2018/19 findings in the 2019 FHB forum.
- PIs presented the work during the International Conference of American Society of Agricultural and Biological Engineering (ASABE) and communicated with the phenotyping community of ASABE.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY18 award period. The term "support" below includes any level of benefit to the student, ranging from full stipend plus tuition to the situation where the student's stipend was paid from other funds, but who learned how to rate scab in a misted nursery paid for by the USWBSI, and anything in between.

1. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their MS degree during the FY18 award period?**

   No.

   If yes, how many?

2. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY18 award period?**

   Yes.

   If yes, how many? 1. Dr. Ali Moghimi is now working as a postdoc at UC Davis in the area of high-throughput phenotyping.

3. **Have any post docs who worked for you during the FY18 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?**

   No. Postdoc continues working on this project and is actively applying for faculty positions.

   If yes, how many?

4. **Have any post docs who worked for you during the FY18 award period and were supported by funding from your USWBSI grant gone on to take positions with private ag-related companies or federal agencies?**

   No.

   If yes, how many?

Release of Germplasm/Cultivars

Instructions: In the table below, list all germplasm and/or cultivars released with full or partial support through the USWBSI during the FY18 award period. All columns must be completed for each listed germplasm/cultivar. Use the key below the table for Grain Class abbreviations.

NOTE: Leave blank if you have nothing to report or if your grant did NOT include any VDHR-related projects.

Name of Germplasm/Cultivar	**Grain Class**	**FHB Resistance** (S, MS, MR, R, where R represents your most resistant check)	**FHB Rating** (0-9)	**Year Released**

Add rows if needed.

NOTE: List the associated release notice or publication under the appropriate sub-section in the 'Publications' section of the FPR.

Abbreviations for Grain Classes

Barley - BAR
Durum - DUR
Hard Red Winter - HRW
Hard White Winter - HWW
Hard Red Spring - HRS
Soft Red Winter - SRW
Soft White Winter - SWW

Publications, Conference Papers, and Presentations

Instructions: Refer to the FY18-FPR_Instructions for detailed instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY18 grant. Only include citations for publications submitted or presentations given during your award period (9/1/18 - 8/31/19). If you did not have any publications or presentations, state 'Nothing to Report' directly above the Journal publications section.

NOTE: Directly below each reference/citation, you must indicate the Status (i.e. published, submitted, etc.) and whether acknowledgement of Federal support was indicated in publication/ presentation. See example below for a poster presentation with an abstract:

> Conley, E.J., and J.A. Anderson. 2018. Accuracy of Genome-Wide Prediction for Fusarium Head Blight Associated Traits in a Spring Wheat Breeding Program. In: Proceedings of the XXIV International Plant & Animal Genome Conference, San Diego, CA.
> Status: Abstract Published and Poster Presented
> Acknowledgement of Federal Support: YES (poster), NO (abstract)

Journal publications.

Ruicheng Qiu, Ce Yang, Ali Moghimi, Man Zhang, and Brian Steffenson. Detection of Fusarium Head Blight in Wheat Using a Deep Neural Network and Color Imaging. *Remote Sens.* 2019, Under Review.
Status: Submitted to the journal of Remote Sensing
Acknowledgement of Federal Support: YES

Books or other non-periodical, one-time publications.

Other publications, conference papers and presentations.

Qiu, R., Yang, C., Moghimi, A., Anderson, J., Steffenson, B. and Marchetto, P., 2018, December. Detection of Fusarium Head Blight in small grains using hyperspectral imaging. In *Proceedings of the 2018 National Fusarium Head Blight Forum, St. Louis, Missouri, USA, 2-4 December 2018* (pp. 32-36). US Wheat & Barley Scab Initiative (USWBSI).
Status: Paper Published and Poster Presented
Acknowledgement of Federal Support: YES (poster and paper), NO (abstract)

Moghimi, A., Yang, C., Anderson, J.A. and Reynolds, S.K., 2019. Selecting informative spectral bands using machine learning techniques to detect Fusarium head blight in wheat. In *2019 ASABE Annual International Meeting* (p. 1). American Society of Agricultural and Biological Engineers.
Status: Paper Published and Oral Presentation
Acknowledgement of Federal Support: YES (oral presentation), NO (paper)