

USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY19 Final Performance Progress Report
Due date: November 30, 2021

Cover Page

Agency PI:	H. Corby Kistler
Cooperating Principle Investigator (PI):	Yanhong Dong
Institution:	University of Minnesota
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Phone:	612-625-2751
Fiscal Year:	2019
USDA-ARS Agreement ID:	58-5062-8-017
USDA-ARS Agreement Title:	Diagnostic Screening for Deoxynivalenol
FY20 USDA-ARS Award Amount:	\$ 250,978
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:	CON000000075991
Project/Grant Reporting Period:	9/1/19 - 8/31/21
Reporting Period End Date:	8/31/2021

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
FST-S	Diagnostic Services for DON	\$ 250,978
FY19 Total ARS Award Amount		\$ 250,978

11/23/2021

Principal Investigator

Date

* MGMT – FHB Management
FST – Food Safety & Toxicology
 R – Research
 S – Service (DON Testing Lab)
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

Project 1: *Diagnostic Services for DON*

1. What are the major goals and objectives of the research project?

The goal of this project is to provide rapid, cost-effective, and accurate mycotoxin analysis - especially deoxynivalenol (DON) - for Fusarium Head Blight (FHB or scab) research projects.

2. What was accomplished under these goals or objectives? *(For each major goal/objective, address these three items below.)*

a) What were the major activities?

Analyzed DON and related mycotoxins in wheat, barley and fungal culture extract using GC-MS; grinded grain seeds; extracted DON from grain samples; derivatized DON for GC-MS analysis; and prepared purification columns.

b) What were the significant results?

Despite the lab closure between March 16 and June 10, 2020 due to COVID -19 pandemic, our laboratory was able to analyze 49,140 USWBSI samples (**Table 1**) from September 2019 to August 2021. The samples were submitted by 43 scab research groups from 22 states including Arkansas, California, Georgia, Idaho, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Missouri, Montana, New York, North Carolina, North Dakota, Ohio, Pennsylvania, Texas, Washington, and Wisconsin. The samples included 45,053 regular mature grain samples (4-100 g) and 4,087 small size samples such as grain samples less than 4 g, single kernel, single spikelet, single head, small stem, and fungal culture extract. The target toxins included DON, 15-Acetyl-DON, 3-Acetyl-DON, and nivalenol. Zearalenone, ergosterol, and novel trichothecene toxins NX-3 and NX-2 were analyzed for several groups.

Table 1. Samples from USWBSI Projects Analyzed between September 2019 – August 2021

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PI	Number of Samples	Institution
Allison Krill Brown	300	UC Davis
Andrew Green	951	North Dakota State University
Anne McKendry	853	university of Missouri
Brian Steffenson	3797	University of Minnesota
Carl Bradley	406	University of Kentucky
Clay Sneller	533	Ohio State University
Corby Kistler	485	University of Minnesota
Christina Cowger	869	USDA-ARS, Raleigh, NC
Damon Smith	680	University of Wisconsin-Madison
Darcy Telenko	218	Purdue University
David Van Sanford	1195	University of Kentucky
Deven See/Karol Marlowe	210	Washington State University
Don Obert	515	Limagrain Cereal Seeds, IN
Elias Elias	2266	North Dakota State University
Eric DeWolf	144	Kansas State University
Eric Olson	2229	Michigan State University
Frances Trail	599	Michigan State University
Frankie Crutcher	191	Montana State University
Gary Bergstrom	360	Cornell University
Gary Muehlbauer	300	University of Minnesota
Gongshe Hu	295	USDA-ARS, Idaho
Guihua Bai	2451	USDA-ARS, KS
Jana Murche	159	KWS Cereals, IL
Jessica Rutkoski	3894	UIUC
Jianli Chen	629	University of Idaho
Jim Anderson	1677	University of Minnesota
Juliet Marshall	1829	University of Idaho
Jyoti Shah	70	University of North Texas
Kaitlyn Bissonnette	168	university of Missouri
Kevin Smith	1906	University of Minnesota
Mark Sorrells	1113	Cornell University
Martin Chilvers/Martin Nagelkirk	845	Michigan State University
Mohamed Mergoum	2559	University of Georgia
Mohsen Mohammadi	989	Purdue University
Nathan Kleczewski	431	UIUC
Nidhi Rawat	2390	University of Maryland
Paul Esker/Alyssa Collins	441	Pennsylvania State University
Paul Murphy	2750	North Carolina State University
Pierce Paul	1324	Ohio State University
Richard Esten Mason	1257	University of Arkansas
Ruth Dill-Macky	970	University of Minnesota
Stephen Harrison	3062	Louisiana State University
Vijay Tiwari	776	University of Maryland
QA	54	
Total	49140	

c) List key outcomes or other achievements.

The DON data has been used in all areas of scab research. By analyzing mycotoxins, the project provided support to barley and wheat breeding programs to develop resistant varieties, and to researchers to study disease mechanisms and to develop effective chemical and biological disease controls. Mycotoxin data provided to scab researchers by our laboratory gave them a means to evaluate the effectiveness of their efforts in fighting Fusarium Head Blight.

3. Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns and/or restrictions, reduced or lack of support personnel, etc.)? If yes, please explain how this research was impacted or is continuing to be impacted.

The lab was closed between March 18 and June 10, 2020 due to COVID-19 pandemic. All the lab activities were stopped during this period, which caused a three-month delay for some researchers to receive their DON data. Due to social distancing requirements, we couldn't put more work hours on the project as we would like to. Fortunately, PIs have started sending ground samples to the lab since late August 2020, which has facilitated DON analysis process and ensured researchers to receive data in a timely manner.

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

Nothing to report.

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

The results were emailed to researchers and were then disseminated to communities of interest via conference papers and presentations, and journal publications.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY20 award period (9/1/19 - 8/31/21). 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 FY19 award period?**

Yes No Not Applicable

If yes, how many? [Click to enter number here.](#)

- 2. Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY19 award period?**

Yes No Not Applicable

If yes, how many? [Click to enter number here.](#)

- 3. Have any post docs who worked for you during the FY19 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?**

Yes No Not Applicable

If yes, how many? [Click to enter number here.](#)

- 4. Have any post docs who worked for you during the FY19 award period and were supported by funding from your USWBSI grant gone on to take positions with private ag-related companies or federal agencies?**

Yes No Not Applicable

If yes, how many? [Click to enter number here.](#)

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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 **FY19 award period (9/1/19 - 8/31/21)**. 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	FHB Rating (0-9)	Year Released
N/A	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year

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

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Publications, Conference Papers, and Presentations

Instructions: Refer to the PR_Instructions for detailed more instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY20 grant award. Only citations for publications published (submitted or accepted) or presentations presented during the **award period (9/1/19 - 8/31/21)** should be included. If you did not publish/submit or present anything, state 'Nothing to Report' directly above the Journal publications section.

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

Winn, Z.J., Acharya, R., Lyerly, J., Brown-Guedira, G., Cowger, C., Griffey, C., Fitzgerald, J., Mason R.E., and Murphy, J.P. (2020, Dec 7-11). Mapping of Fusarium Head Blight Resistance in NC13-20076 Soft Red Winter Wheat. p. 12. In: Canty, S., Hoffstetter, A. and Dill-Macky, R. (Eds.), *Proceedings of the 2020 National Fusarium Head Blight Forum*. https://scabusa.org/pdfs/NFHB20_Proceedings.pdf.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: YES (Abstract and Poster)

Journal publications.

Singh, L., Schulden, T., Wight, J.P., Dong, Y., Rawat, N. "Evaluation of a new SDHI Chemistry Based Fungicide product: Miravis Ace for efficacy on control of Fusarium Head Blight and Deoxynivalenol content in wheat", *Plant Health Progress*, **2021**, 22, 94-100 (<https://doi.org/10.1094/PHP-01-21-0007-RS>).

Status: Published.

Acknowledgement of Federal Support: Yes

Gaire, R., Brown-Guedira, G., Dong, Y., Ohm, H., Mohammadi, M. "Genome-wide association studies for Fusarium head blight resistance and it's trade-off with grain yield in soft red winter wheat", *Plant Disease*, **2021**, (<https://doi.org/10.1094/PDIS-06-20-1361-RE>).

Status: Published

Acknowledgement of Federal Support: Yes

Su, W., Yang, C., Dong, Y., Johnson, R., Page, R., Szinyei, T., Steffenson, B.J., Hirsch, C.D. "Hyperspectral imaging and improved feature variable selection for automated determination of deoxynivalenol in various genetic lines of barley kernels for resistance screening", *Food Chem.*, **2021**, 343, 128507 (<https://doi.org/10.1016/j.foodchem.2020.128507>).

Status: Published

Acknowledgement of Federal Support: Yes

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Carmack, W.J., Jesse, W., Clark, A.J., Lyerly, H.J., **Dong, Y.**, Brown-Guedira, G., Van Sanford, D. "Optical Sorter-Augmented Genomic Selection Lowers DON Accumulation in Wheat", *Crop Sci*, **2021**, 61 (5), 3254-3263 (<https://doi.org/10.1002/csc2.20494>).

Status: Published

Acknowledgement of Federal Support: Yes

Chhabra, B., Tiwari, V., Gill, B.S., **Dong, Y.** Rawat, N. "Discovery of a susceptibility factor for Fusarium head blight on chromosome 7A of wheat", *Theoretical and Applied Genetics*, **2021**, 134, 2273-2289 (<https://doi.org/10.1007/s00122-021-03825-y>).

Status: Published

Acknowledgement of Federal Support: Yes

Chhabra, B., Singh, L., Schoen, A., Wallace, S., Dong, Y., Tiwari, V., Rawat, N. "Screening of an EMS mutagenized population of a wheat cultivar susceptible to Fusarium head blight identifies resistant variants", *Plant Disease*, **2021**, DOI: [10.1094/PDIS-03-21-0670-RE](https://doi.org/10.1094/PDIS-03-21-0670-RE)

Status: Published

Acknowledgement of Federal Support: Yes

Huang, Y. Yin, L., Sallam, A.H., Heinen, S., Li, L., Beaubien, K., Dill-Macky, R., **Dong, Y.**, Steffenson, B.J., Smith, K.P., Muehlbauer, G.J. "Genetic dissection of a pericentromeric region of barley chromosome 6H associated with Fusarium head blight resistance, grain protein content and agronomic traits", *Theoretical and Applied Genetics*, **2021**, 134(12), 3963-3981 (DOI: [10.1007/s00122-021-03941-9](https://doi.org/10.1007/s00122-021-03941-9)).

Status: Published

Acknowledgement of Federal Support: Yes

Larkin, D.L., Holder, A.L., Mason, D.E., Brown-Guedira, G., Price, P.T., Harrison, S., Dong, Y. "Genome-Wide Analysis and Prediction of Fusarium Head Blight Resistance in Soft Red Winter Wheat", *Crop Science*, **2020** (DOI: [10.1002/csc2.20273](https://doi.org/10.1002/csc2.20273))

Status: Published

Acknowledgement of Federal Support: Yes

Carmack, W.J., Clark, A.J., Dong, Y., Brown-Guedira, G., Van Sanford, D. "Optical Sorter-Based Selection Effectively Identifies Soft Red Winter Wheat Breeding Lines with *Fhb1* and Enhances FHB Resistance in Lines with and without *Fhb1*", *Frontiers in Microbiology*, **2020**, 11, article 1318 (<https://doi.org/10.3389/fpls.2020.01318>)

Status: Published

Acknowledgement of Federal Support: Yes

Verges, V.L., Lyerly, J., Dong, Y., Van Sanford, D. "Training Population Design with the Use of Regional Fusarium Head Blight Nurseries to Predict Independent Breeding Lines for FHB Traits", *Frontiers in Plant Science*, **2020**, 11, article 1083 (doi: [10.3389/fpls.2020.01083](https://doi.org/10.3389/fpls.2020.01083))

Status: Published

Acknowledgement of Federal Support: Yes

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O'Mara, S.P., Broz, K., Boenisch, M., Zhong, Z., Dong, Y., Kistler, H.C. "The *Fusarium graminearum* t-SNARE *Sso1* is involved in growth, defense, and DON accumulation and virulence", *Molecular Plant-Microbe Interactions*, **2020**, 33(7), 888 (doi.org/10.1094/MPMI-01-20-0012-R).

Status: Published

Acknowledgement of Federal Support: Yes

Cowger, C., Beccari, G., Dong, Y. "Timing of susceptibility to Fusarium head blight in winter wheat", *Plant Disease*, **2020**, 104(11), 2928-2939 (<https://doi.org/10.1094/PDIS-03-20-0527-RE>)

Status: Published

Acknowledgement of Federal Support: Yes

Singh, L., Wight, J.P., Crank, J., Thorne, L., **Dong, Y.**, Rawat, N. "Efficacy Assessment of a New Fungicide, Miravis Ace, for Control of Fusarium Head Blight in Wheat", *Plant Health Progress*, **2020**, 21, 365-368 (<https://doi.org/10.1094/PHP-06-20-0050-RS>).

Status: Published

Acknowledgement of Federal Support: Yes

Carmack, W.J., Clark, A.J., Dong, Y., Van Sanford, D. "Mass selection for reduced deoxynivalenol concentration using an optical sorter in SRW wheat", *Agronomy*, **2019**, 9 (12), 816 (<https://doi.org/10.3390/agronomy9120816>).

Status: Published

Acknowledgement of Federal Support: Yes

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

Su, W., Yang, C., **Dong, Y.**, Johnson, R., Page, R., Szinyei, T., Hirsch, C.D., Steffenson, B.J. "Hyperspectral Imaging and Machine Learning for Rapid Assessment of Deoxynivalenol of Barley Kernels", in the book titled: "*Nondestructive Evaluation of Agro-products by Intelligent Sensing Techniques*", Chapter 5, 120-137 (DOI:[10.2174/9789811485800121010007](https://doi.org/10.2174/9789811485800121010007)).

Status: Published

Acknowledgement of Federal Support: Yes

Other publications, conference papers and presentations.

Baldwin, B.A., Yimer, B.A., Baldwin, T.T., Dong, Y., Marshall, J.M. **2020**. "Determining Fusarium Head Blight Resistance of Spring Barley in Idaho." In: Canty, S., A. Hoffstetter, and R. Dill-Macky (Eds.), *Proceedings of the 2020 National Fusarium Head Blight Forum* (p.5), Virtual; December 7-11. Online: https://scabusa.org/pdfs/NFHB20_Proceedings.pdf

Status: Abstract Published and Poster Presented

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Page, R., Szinyei, T., Martin, M., Sallam, A., Matny, O., Wodarek, J., Dong, Y., Hayes, P., Steffenson, B. **2020**. “Quantitative trait loci associated with resistance to Fusarium head blight and DON accumulation in barley populations derived from moderately resistant six- and two-rowed parents” In: Canty, S., A. Hoffstetter, and R. Dill-Macky (Eds.), *Proceedings of the 2020 National Fusarium Head Blight Forum* (p.9), Virtual; December 7-11. Online: https://scabusa.org/pdfs/NFHBF20_Proceedings.pdf

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: Yes

Yimer, B.A., Baldwin, S.A., Baldwin, T.T., Dong, Y., Marshall, J.M. **2020**. “Evaluation of Winter Wheat Varieties and Selections for FHB Resistance in Southeast Idaho” In: Canty, S., A. Hoffstetter, and R. Dill-Macky (Eds.), *Proceedings of the 2020 National Fusarium Head Blight Forum* (p.53), Virtual; December 7-11. Online: https://scabusa.org/pdfs/NFHBF20_Proceedings.pdf

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: Yes

Su, W., Yang, C., Dong, Y., Johnson, R., Page, R., Szinyei, T., Hirsch, C.D., Steffenson, B.J. **2020**. “Non-Destructive Detection of Deoxynivalenol in Barley Kernels using Hyperspectral Imaging and Machine Learning” In: Canty, S., A. Hoffstetter, and R. Dill-Macky (Eds.), *Proceedings of the 2020 National Fusarium Head Blight Forum* (p.60), Virtual; December 7-11. Online: https://scabusa.org/pdfs/NFHBF20_Proceedings.pdf

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: Yes

Huang, Y., Yin, L., Sallam, A., Heinen, S., Li, L., Beaubien, K., Dill-Macky, R., Dong, Y., Steffenson, B.J., Smith, K.P., Muehlbauer, G.J. **2020**. “Genetic Dissection of Quantitative Trait Loci Associated with Fusarium Head Blight Resistance, Grain Protein Content and Agronomic Traits in the Pericentromeric Region of Chromosome 6H in Barley” (p. 69). In: Canty, S., A. Hoffstetter, and R. Dill-Macky (Eds.), *Proceedings of the 2020 National Fusarium Head Blight Forum* (p.69), Virtual; December 7-11. Online: https://scabusa.org/pdfs/NFHBF20_Proceedings.pdf

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: Yes

Yimer, B.A., Arcibal, S.S., Dong, Y., Marshall, J.M. **2019**. “Management of FHB and DON using Fungicides and Host Resistance in Hard Spring Wheat in Idaho” In: Canty, S.; Hoffstetter, A., Campbell, H., Dill-Macky, R. (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (P. 34). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.

Status: Abstract Published and Poster presented

Acknowledgement of Federal Support: Yes

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Huang, Y., Yin, L., Sallam, A., Heinen, S., Beaubien, K., Dill-Macky, R., Dong, Y., Steffenson, B., Smith, K.P., Muehlbauer, G.J. **2019**. "Genetic Analysis of Fusarium Head Blight Severity, Malting Quality and Agronomic Traits in the Centromeric Region of Chromosome 6H in Barley" In: Canty, S.; Hoffstetter, A., Campbell, H., Dill-Macky, R. (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (P. 51). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.

Status: Abstract Published and Poster presented

Acknowledgement of Federal Support: Yes

O'Mara, S.P., Broz, K., Boenisch, M., Zhong, Z., Dong, Y., Kistler, H.C. **2019**. "The *Fusarium graminearum* t-SNARE Sso1 is involved in Growth, Defense, and DON Accumulation and Virulence" In: Canty, S.; Hoffstetter, A., Campbell, H., Dill-Macky, R. (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (P. 75). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.

Status: Abstract Published and Poster presented

Acknowledgement of Federal Support: Yes

Carmack, W.J., Clark, A.J., Dong, Y., Van Sanford, D.A. **2019**. "Mass Selection for Reduced Deoxynivalenol Concentration using an Optical Sorter in SRW Wheat" In: Canty, S.; Hoffstetter, A., Campbell, H., Dill-Macky, R. (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (P. 89). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.

Status: Abstract Published and Poster presented

Acknowledgement of Federal Support: Yes

Page, R., Steffenson, B., Szinyer, T., Martin, M., Matny, O., Sallam, A., Wodarek, J., Dong, Y. **2019**. "Evaluation of Select Barley Accessions for Resistance to Fusarium Head Blight and DON Accumulation in Multi-Year, Multi-Environment Trails in the Upper Midwest" In: Canty, S.; Hoffstetter, A., Campbell, H., Dill-Macky, R. (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (P. 108). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.

Status: Abstract Published and Poster presented

Acknowledgement of Federal Support: Yes

Ward, B.P., Brown-Guedira, G., Cowger, C., Marshall, D., Dong, Y. **2019**. "Machine Learning Models for Predicting Deoxynivalenol Concentration from Grain Imaging Data" In: Canty, S.; Hoffstetter, A., Campbell, H., Dill-Macky, R. (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (P. 124). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative

Status: Abstract Published and Poster presented

Acknowledgement of Federal Support: Yes

PI: Dong, Yanhong

Project: Diagnostic Services for DON

**FY19-NCE NACA FPR – USWBSI ADDENDUM
DON Service Labs – Quality Control (QC) Data**

Note: What is being requested is the across lab quality control data (separate QC from Trilogy).

Insert below Quality Control Data/Results from the FY19-NCE Award Period (9/1/19 - 8/31/21):

	Check 1	Check 2	Check 3	Check 4
N^a	511	421	681	352
Mean (ppm)	3.10	9.91	6.76	5.18
SD^b	0.45	0.81	0.64	0.45
% CV^c	14.6	8.1	9.4	8.7

^aNumber of check samples. ^bStandard deviation. ^cCoefficient of variance