



## Project 1: Analyzing Commercial Barley Cultivars for FHB Reaction in MD/DE

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

- **Project Goals:** Evaluation of Fusarium head blight (FHB) reaction in popular local varieties of barley is critical for management of scab by growers. The aim of this project is to conduct misted nursery to assess variety response to FHB in Maryland (MD) and Delaware (DE) cultivars. In field, the most significant losses due to FHB occur when flowering heads get exposed to spores of the FHB pathogen, resulting in yield loss and elevation in DON levels. In natural conditions, flowering times of cultivars vary due to differences in their genetic background. Therefore, varieties may not be at a highly susceptible stage in development when environmental conditions favoring FHB infections occur in natural conditions. In addition, weather conditions for FHB may not be favorable in all the years, resulting in little FHB and DON. The misted nursery will help to avoid these issues by prolonging the conditions that may be favorable for FHB infection, reducing the chance that varieties will escape infection due to sub-optimal environmental conditions for disease development. In addition, for commercial varieties, the seed companies provide their ratings based only on their own standards, the misted nursery allows for head to head comparison of FHB responses across variable seed sources.
- **Project Objectives:**
  1. Conduct misted nursery for local barley varieties from Maryland and Delaware.
  2. Make the results available to the growers in a timely manner so that they can use them in making planting decisions in the growing season.
  3. Organize field day to make growers aware of the importance of planting resistant varieties in management of FHB.

The misted nursery data made available here will help guide growers in Maryland and Delaware in selecting high-yielding barley varieties with moderate resistance to FHB and DON. Field visits/ field days will be organized to make growers aware of the importance of selecting resistant varieties to manage FHB.

### 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?

Misted nursery was conducted at Beltsville Research station of the University of Maryland for local barley varieties from Maryland and Delaware. FHB indices and DON contents data were collected on the varieties.

#### b) What were the significant results?

FHB Data was analyzed and presented to the growers.

#### c) List key outcomes or other achievements.

Results were presented in the Commodity Classic meeting in July, 2021 and were disseminated via the UMD extension system.

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

Over the two years of the project five graduate students (3 PhD and 2 Masters students) plus 10 undergraduate students were involved in the field work in 2021. All the trainees worked with the PI to conduct the nursery, collect and analyze data. The graduate students also presented the results to the stakeholders in commodity board meetings.

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

The PI presented the results in oral presentations. The graduate students in the team presented the results as posters and handouts to the stakeholders in commodity board meetings. The results were also disseminated via the UMD extension system to the broader grower community.

## Project 2: Analyzing Commercial Soft Winter Wheat Cultivars for FHB Reaction in MD/DE

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

- Project Goals: Evaluation of Fusarium head blight (FHB) reaction in popular local varieties of soft red winter wheat is critical for management of scab by growers. The aim of this project is to conduct misted nursery to assess variety response to FHB in Maryland (MD) and Delaware (DE) cultivars. In field, the most significant losses due to FHB occur when flowering heads get exposed to spores of the FHB pathogen, resulting in yield loss and elevation in DON levels. In natural conditions, flowering times of cultivars vary due to differences in their genetic background. Therefore, varieties may not be at a highly susceptible stage in development when environmental conditions favoring FHB infections occur in natural conditions. In addition, weather conditions for FHB may not be favorable in all the years, resulting in little FHB and DON. The misted nursery will help to avoid these issues by prolonging the conditions that may be favorable for FHB infection, reducing the chance that varieties will escape infection due to sub-optimal environmental conditions for disease development. In addition, for commercial varieties, the seed companies provide their ratings based only on their own standards, the misted nursery allows for head to head comparison of FHB responses across variable seed sources.
- Project Objectives and Expected Outcomes:
  1. Conduct misted nursery for local wheat varieties from Maryland and Delaware.
  2. Make the results available to the growers in a timely manner so that they can use them in making planting decisions in the growing season.
  3. Organize field day to make growers aware of the importance of planting resistant varieties in management of FHB.

### 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?

The misted nursery was conducted at Beltsville Research station of the University of Maryland. Data on FHB severity, incidence, and DON content was collected. The data was made available to the stakeholders in Maryland and Delaware.

#### b) What were the significant results?

FHB Data was analyzed and presented to the growers and stakeholders.

#### c) List key outcomes or other achievements.

Results were presented in the Commodity Classic meeting in July, 2021 and were disseminated via the UMD extension system.

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

Over the two years of the project five graduate students (3 PhD and 2 Masters students) plus 10 undergraduate students were involved in the field work in 2021. All the trainees worked with the PI to conduct the nursery, collect and analyze data. The graduate students also presented the results to the stakeholders in commodity board meetings.

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

The PI presented the results in oral presentations in Commodity board meetings. The graduate students in the team presented the results as posters and handouts to the stakeholders in commodity board meetings. The results were also disseminated via the UMD extension system to the broader grower community.

### **Project 3:** Evaluation of Fungicide Performance for FHB Management on SRW Wheat and Barley Varieties

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

- Overall project goal(s)

FHB has been a major challenge to small grain farmers in the state of Maryland due to several compounding factors. Maryland has wet spring seasons, which is the time of highest susceptibility to *Fusarium graminearum* infections. Farmers practice No-Tillage agriculture, and often follow corn: wheat or corn: barley rotations. Miravis-Ace is a new product and farmers still do not know: If it can be applied early to their crop and hope it works equally well as a regular application; What is the need of planting a resistant variety if Miravis-Ace is really as good as the company claims. Also, they are interested in knowing how this fungicide will work on barley. The overall project goal is to provide research-based recommendations to wheat and barley farmers for managing FHB.
- Project Objectives and Expected Outcomes:
  1. Evaluate the combined effect of fungicide treatment and genetic resistance on FHB and DON in SRW wheat varieties and barley, with emphasis on Miravis Ace:
  2. Compare the efficacy of Miravis Ace when applied at heading or at anthesis to that of standard anthesis application of Prosaro or Caramba.

#### **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?**

Field evaluation of efficacy of Miravis-Ace and a standard fungicide with different genetic resistance levels of wheat and barley cultivars was performed in 2020 and 2021 at two locations. The experiment was conducted in randomized complete block design (RCBD), with a split-plot arrangement having moderately resistant and a susceptible cultivar as the whole-plot, and fungicide treatment in wheat (Table 1) and barley (Table 2) as the sub-plot. All treatments will be applied with NIS @ 0.125 v/v. Experiments were done in five replicate blocks following corn with No-Till. The data on FHB incidence, severity, DON content, yields and grain weight was collected and presented to the regional stakeholders. The results were also shared with the IMCP coordinator Dr. Pierce Paul as part of the network for his overarching analysis.

##### **b) What were the significant results?**

We found that Miravis-Ace provided significant control of FHB and associated mycotoxin DON at flowering similar to the standard FHB fungicides both for wheat and barley. The 50% head emergence application also was effective in controlling FHB and DON significantly. The control was better in the case of genetically resistant varieties as compared to susceptible varieties.

**c) List key outcomes or other achievements.**

We were able to provide recommendations to Maryland wheat and barley farmers about spray timing of Miravis-Ace, and the effect of different genetic resistance levels on the fungicide efficacy. In addition, the results were also shared with IM team led by Dr. Pierce Paul, who will be able to determine the degree to which baseline FHB and DON levels influence the efficacy of the tested fungicide treatments and treatment x cultivar combinations across locations and grain classes.

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

Over the two years of the project five graduate students (3 PhD and 2 Masters students) plus 10 undergraduate students were involved in the field work in 2021. All the trainees worked with the PI to conduct the nursery, collect and analyze data. The graduate students also presented the results to the stakeholders in commodity board meetings.

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

The results were published in peer-reviewed journals for wider dissemination to the wider scientific community. The PI presented the results in oral presentations. The graduate students in the team presented the results as posters and handouts to the stakeholders in commodity board meetings. The results were also disseminated via the UMD extension system to the broader grower community.

## Project 4: Wheat Variants Deficient in a FHB Susceptibility Factor

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

- Project Goals: The goal of this project is to identify native wheat gene variants that improve FHB resistance and reduce DON accumulation. Wheat genes that contribute to susceptibility by facilitating fungal growth, development and virulence provide excellent targets for controlling disease. With previous support from the USWBSI, the PI's lab identified wheat 9-lipoxygenases (9-LOXs) as susceptibility factors, which when knocked-down by RNA-interference (RNAi) in the cv Bobwhite, limit spread of *Fusarium graminearum* infection and limit DON accumulation. The goals of the proposed work are to establish whether (i) the FHB resistance promoting effect of Lpx3 knockdown is also effective in wheat backgrounds other than Bobwhite, (ii) one or more Lpx3 homeolog(s) in wheat contribute towards susceptibility to *Fusarium graminearum*, and (iii) nonsense and/or missense Lpx3 variants can provide a non-GMO strategy that in the future can be utilized by breeding programs to enhance FHB resistance in wheat. As a first step in this direction, several TILLING mutants that cover all three Lpx3 homeologs on chromosomes 4A, 4B and 4D have been identified in the hexaploid and tetraploid wheat varieties Cadenza and Kronos, respectively. Mutations in these TILLING lines are predicted to yield prematurely truncated Lpx3 protein, or strong missense alleles.
- The specific objectives of this project are to:
  1. Characterize the response to *F. graminearum* in backcrossed progeny of Lpx3 variants.
  2. Develop wheat lines containing mutant combinations at more than one Lpx3 homeologous loci and characterize their response to *F. graminearum*

### 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?

1. Knock out mutants were identified for the 4A and 4B copy of the Lpx3 gene: Kronos-2644 and Kronos-265 contain non-sense mutation that create stop codons at amino acid 197 and 649, respectively in the Lpx3 homeolog on Chromosome 4A, and Kronos-3671 and Kronos-4443, contain non-sense mutations that create stop codons at amino acid 107 and 150, respectively in the Lpx3 homeolog on chromosome 4B.
2. The mutants were genetically combined to analyze the effect of full null mutations on the plant's response to the pathogen
3. To clear the background mutations of the mutants and their crosses, two back-crosses were made.

#### b) What were the significant results?

Initial results without backcrossing of the hybrids indicated towards lower susceptibility of these mutants. However, robust results will be obtained in Fall 2022 after background mutations are reduced.

**c) List key outcomes or other achievements.**

The mutants were combined. The full null mutants with cleared background were obtained towards the end of spring 2021. These genotypes will be robustly analyzed for the effect on disease resistance in Fall 2022.

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

One PhD student and an undergrad student have been working on this project. They have received hands on training with inoculum preparation, growing wheat plants, crossing, DNA extraction, sequencing, analysis of sequencing data, genetics of mutation inheritance, statistical analysis of data and presentation of results.

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

The results have been shared with Dr. Jyoti Shah, who is coordinating this project collaboratively. By the end of Fall 2022 we will be able to get robust data on our developed genotypes that will be combined with his Cadenza data. Collective results will be published in a peer-reviewed journal for sharing with the scientific community.

## Publications, Conference Papers, and Presentations

Please include a listing of all your publications/presentations about your FHB work that were a result of funding from your FY21 grant award. Only citations for publications published (submitted or accepted) or presentations presented during the **award period** should be included.

### Did you publish/submit or present anything during this award period?

- Yes, I've included the citation reference in listing(s) below.  
 No, I have nothing to report.

### Journal publications as a result of FY21 grant award

List peer-reviewed articles or papers appearing in scientific, technical, or professional journals. Include any peer-reviewed publication in the periodically published proceedings of a scientific society, a conference, or the like.

Identify for each publication: Author(s); title; journal; volume: year; page numbers; status of publication (published [include DOI#]; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).

1. Singh, L., Wight J.P., Crank, J., Thorne, L., Erwin, J.E., Dong, Y., Rawat, N.\* (2021). Evaluation of application timing of Miravis-Ace for control of Fusarium Head Blight in wheat. Plant Health Progress. 22: 94-100; DOI: 10.1094/PHP-01-21-0007-RS; acknowledgment of federal support - yes.
2. Chhabra, B.†, Singh, L.†, Wallace, S.†, Schoen, A., Dong, Y., Tiwari, V.K., Rawat, N.\* (2021). Screening of an EMS mutagenized population of a wheat cultivar susceptible to Fusarium head blight identifies resistant variants. Plant Disease DOI: 10.1094/PDIS-03-21-0670-RE; acknowledgment of federal support - yes.
3. Chhabra, B.†, Tiwari V.K., Gill, B.S., Dong, Y., Rawat, N.\* (2021). Discovery of a susceptibility factor for Fusarium head blight on chromosome 7A of wheat. Theoretical and Applied Genetics 134(7):2273-2289. DOI: 10.1007/s00122-021-03825-y; acknowledgment of federal support - yes.

### Books or other non-periodical, one-time publications as a result of FY21 grant award

Report any book, monograph, dissertation, abstract, or the like published as or in a separate publication, rather than a periodical or series. Include any significant publication in the proceedings of a one-time conference or in the report of a one-time study, commission, or the like.

Identify for each one-time publication: Author(s); title; editor; title of collection, if applicable; bibliographic information; year; type of publication (book, thesis or dissertation, other); status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).

None

### Other publications, conference papers and presentations as a result of FY21 grant award

Identify any other publications, conference papers and/or presentations not reported above. Specify the status of the publication.

1. Singh, L., Tiwari, V.K., Griffey, C., Brown-Guedira, G., Rawat, N. (2021). Towards fine mapping of a native FHB resistance QTL from soft red winter wheat cultivar 'Jamestown'. *Proceedings of the 2021 National Fusarium Head Blight Forum*; Virtual. December 6-7, 2021. Retrieved from: <https://scabusa.org/forum/2021/2021NFHBForumProceedings.pdf>

2. Wallace, S., Chhabra, B., Dong, Y., Ma, X., Coleman, G., Tiwari, V.K., Rawat, N. (2021). Exploring the genetic diversity of Fusarium head blight resistance in a diverse Triticale collection. *Proceedings of the 2021 National Fusarium Head Blight Forum*; Virtual. December 6-7, 2021. Retrieved from: <https://scabusa.org/forum/2021/2021NFHBForumProceedings.pdf>
3. Mittal, I., Alam, S., Chhabra, B., Shulaev, E., Mohan, V., Dong, Y., Scoffield, S., Rawat, N., Shah, J. (2021). Knockdown of Lpx3 function in wheat enhances FHB resistance and lowers DON content. *Proceedings of the 2021 National Fusarium Head Blight Forum*; Virtual. December 6-7, 2021. Retrieved from: <https://scabusa.org/forum/2021/2021NFHBForumProceedings.pdf>
4. Cinderella, J.A., Anderson, K., Bergstrom, G.C., Bockus, W.W., Bradley, C.A., Breunig, M., Byamukama, E., Chilvers, M.I., Cowger, C., Faske, T.R., Friskop, A.J., Kelly, J., Kleczewski, N.M., Mideros, S., Paul, P.A., Price, T., Rawat, N., Rupp, J., Shim, S., Stevens, J., Telenko, D, Koehler, A.M. (2021). Baseline Fungicide Sensitivity to Pydiflumetofen in Fusarium graminearum Isolated from Wheat Across 16 States. *Proceedings of the 2021 National Fusarium Head Blight Forum*; Virtual. December 6-7, 2021. Retrieved from: <https://scabusa.org/forum/2021/2021NFHBForumProceedings.pdf>