

Final Technical Report

**Grant 21\*1190 *Late Season Disease Management and its Effect on Michigan Hop and Barley Crop Quality***

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**Abstract**

The craft beer industry is a critical part of Michigan's economy, just in direct contributions alone, this industry accounts for over 5,000 jobs has 2,598 million dollars in economic output and there are 400 craft breweries within the state of Michigan. The two major components of craft beer, barley and hop are grown in the state, but each crop suffers from late season diseases that affect quality. This project focused on improving late season disease management to maximize crop quality of both barley and hops for both Michigan industries.

## Goals and Objectives

Objective 1. Determine the main fungicide efficacy program and problem diseases in barley

Objective 2. Investigate reduced pesticide inputs for downy mildew control in Michigan hopyards

Objective 3. Conduct a survey of hop cone diseases in Michigan.

Objective 4. Develop extension materials for MI hop and barley farmers

## Brief Literature Review

Barley has among others a well-known disease caused by *Fusarium graminearum* known as Fusarium head blight (FHB) that can introduce a mycotoxin in beer known as deoxynivalenol (DON). Hops suffer from a variety of diseases, but the main diseases so far appear to be a newly discovered disease known as halo blight caused by a *Diaporthe* sp. and downy mildew (DM), caused by the oomycete pathogen *Pseudoperonospora humuli*. These two diseases of hop induce cone shatter, alter hop aromas and can cause up to a 50% yield loss (Higgins et al., 2020). Over the last two grant cycles we have partnered with the Michigan Craft Beverage Council to identify best management practices and establish barley and hop plots at MSU. This proposal's focus is on late season diseases and maximizing crop quality of both barley and hops for both Michigan industries.

## Results, Conclusions and Outcomes

With respect to barley disease management trials, we are in the process of summarizing three years of fungicide and barley quality data. To date the following findings have been noted in the data:

- Regardless of visual head scab disease pressure, most fungicide products decreased DON levels, with two fungicide applications after head emergence having the greatest effect. Though two fungicide applications at heading may not be economical.
- Post Fks 10.5 (heading completed) applications reduced DON levels the most in both years of timing trials, compared to pre-heading timings such as Fks 10 (head in boot) and Fks 10.3 (half head emergence).
- Kernel plumpness increased and thinness decreased with fungicide application even when disease pressure was low, with the greatest effect when applications were made between Fks 10 and 10.5 or double fungicide applications
- Significant yield differences were rare, but the greatest increases in yield followed double fungicide applications. Greater yield differences would be expected with increased foliar disease severity.
- There were strong differences in DON accumulation between varieties regardless of visible head scab disease pressure.
- In a small plot hop trial, we have found that FRAC 7, 3, and 11 products (fluopyram, tebuconazole, and trifloxystrobin) are most effective against halo blight.

- LifeGard (*Bacillus mycooides*) is an effective organic option for halo blight in hops.
- We have identified a correlation between halo blight incidence and downy mildew incidence
- We are working on a fact sheet that will develop a halo blight disease cycle for growers/extension personnel
- We have found a variety of *Diaporthe humulicola* isolates that vary in their sensitivity to trifloxystrobin and are developing molecular diagnostic tools to detect this variation.
- The first MSU Hop Research Field Day conducted a survey on halo blight management among Michigan hop growers.
- We collected preliminary data on cultivar sensitivity towards *Diaporthe humulicola* in 2022. This will be continued in 2023 and 2024 at MSU's Plant Pathology Farm and the Clarksville Research Center.

### Time Span

1/1/2021 to 8/31/2022

### Work Accomplished/ Methods

No significant changes were made to the methods as described in the proposal.

### Communication Activities, Accomplishments, and Impacts

A hop field day was held on Jul 13<sup>th</sup> 2022, which included updates from this project on barley and hop disease management. Over 60 people participated from the Great Lakes region. Results from the project have been published in peer reviewed journals, in extension articles and presented to stakeholders.

1. Barley disease management. Presented virtually to MI beer conference. Jan 13, 2022. 40 participants
2. Hop disease management. Presented virtually to MI Beer Conference. Jan 13, 2022. 40 participants.
3. Halo blight management. Invited talk presented at Purdue University. November, 2022. 30 participants.
4. Hatlen, R.††, Sysak, R., Serrine, R., Lizotte, E. Miles, T.D. 2022. Determining baseline sensitivity of *Diaporthe humulicola* isolates to chemical products labeled in hops. Poster presentation, August 2022. Annual American Phytopathological Society Meeting Pittsburg, PA. S3.64

### Hop extension content:

- 1.) Serrine, R., Miles, T., Lizotte, E. Pruning for disease management and yield benefits in hops. April 29, 2022. <https://www.canr.msu.edu/news/pruning-for-disease-management-and-yield-benefits-in-hops>

- 2.) Lizotte, E., Surrine, R., **Miles, T.**, Chaudhari, S. 2022 Michigan Hop Management Guide now available. March 28, 2022. [https://www.canr.msu.edu/news/hop\\_management\\_guide\\_available\\_to\\_michigan\\_hop\\_growers](https://www.canr.msu.edu/news/hop_management_guide_available_to_michigan_hop_growers)
- 3.) Surrine, R., Lizotte, E., **Miles, T.**, Reinke, M., Hatlen, R., September 9, 2021. Michigan hop crop report for the week of Sept. 6, 2021. <https://www.canr.msu.edu/news/michigan-hop-crop-report-for-the-week-of-sept-6-2021>
- 4.) Surrine, R., Lizotte, E., **Miles, T.**, Reinke, M., Hatlen, R., August 27, 2021. Michigan hop crop report for the week of Aug. 23, 2021. <https://www.canr.msu.edu/news/michigan-hop-crop-report-for-the-week-of-aug-23-2021>
- 5.) Surrine, R., Lizotte, E., **Miles, T.**, Reinke, M., Hatlen, R., August 16, 2021. Michigan hop crop report for the week of Aug. 9, 2021. <https://www.canr.msu.edu/news/michigan-hop-crop-report-for-the-week-of-aug-9-2021>
- 6.) Surrine, R., Lizotte, E., **Miles, T.**, Reinke, M., Hatlen, R., July 29, 2021. Michigan hop crop report for the week of July 26, 2021. <https://www.canr.msu.edu/news/michigan-hop-crop-report-for-the-week-of-july-26-2021>
- 7.) Surrine, R., Lizotte, E., **Miles, T.**, Reinke, M., Hatlen, R., July 22, 2021. Michigan hop crop report for the week of July 19, 2021. <https://www.canr.msu.edu/news/michigan-hop-crop-report-for-the-week-of-july-19-2021>
- 8.) Surrine, R., Lizotte, E., **Miles, T.**, Reinke, M., Hatlen, R., July 15, 2021. Michigan hop crop report for the week of July 12, 2021. <https://www.canr.msu.edu/news/michigan-hop-crop-report-for-the-week-of-july-12-2021>
- 9.) Surrine, R., Lizotte, E., **Miles, T.**, Reinke, M., Hatlen, R., July 1, 2021. Michigan hop crop report for the week of June 28, 2021. <https://www.canr.msu.edu/news/michigan-hop-crop-report-for-the-week-of-june-28-2021>
- 10.) Surrine, R., Lizotte, E., **Miles, T.**, Reinke, M., June 23, 2021. Michigan hop crop report for the week of June 21, 2021. <https://www.canr.msu.edu/news/michigan-hop-crop-report-for-the-week-of-june-21-2021>
- 11.) Surrine, R., Lizotte, E., **Miles, T.**, Reinke, M., June 16, 2021. Michigan hop crop report for the week of June 14, 2021. <https://www.canr.msu.edu/news/michigan-hop-crop-report-for-the-week-of-june-14-2021>
- 12.) Surrine, R., Lizotte, E., **Miles, T.**, Reinke, M., June 10, 2021. Michigan hop crop report for the week of June 7, 2021. <https://www.canr.msu.edu/news/michigan-hop-crop-report-for-the-week-of-june-7-2021>
- 13.) Surrine, R., Lizotte, E., **Miles, T.**, Reinke, M., June 3, 2021. Michigan hop crop report for the week of May 31, 2021. <https://www.canr.msu.edu/news/michigan-hop-crop-report-for-the-week-of-may-31-2021>
- 14.) Surrine, R., Lizotte, E., **Miles, T.**, Reinke, M., May 26, 2021. Michigan hop crop report for the week of May 24, 2021. <https://www.canr.msu.edu/news/michigan-hop-crop-report-for-the-week-of-may-24-2021>
- 15.) Surrine, R., Lizotte, E., **Miles, T.**, Reinke, M., May 20, 2021. Michigan hop crop report for the week of May 17, 2021. <https://www.canr.msu.edu/news/michigan-hop-crop-report-for-the-week-of-may-17-2021>

- 16.) Sirrine, R., Lizotte, E., **Miles, T.**, Reinke, M., May 13, 2021. Michigan hop crop report for the week of May 10, 2021. <https://www.canr.msu.edu/news/michigan-hop-crop-report-for-the-week-of-may-10-2021>
- 17.) Sirrine, R., Lizotte, E., **Miles, T.**, Reinke, M., May 6, 2021. Michigan hop crop report for the week of May 3, 2021. <https://www.canr.msu.edu/news/michigan-hop-crop-report-for-the-week-of-may-3-2021>
- 18.) Lizotte, E., Sirrine, R., **Miles, T.** April, 22, 2021. Updated 2021 hop management guide available to Michigan hop growers. [https://www.canr.msu.edu/news/hop\\_management\\_guide\\_available\\_to\\_michigan\\_hop\\_growers](https://www.canr.msu.edu/news/hop_management_guide_available_to_michigan_hop_growers)

### Research Publications

1. Hatlen, R. ††, Anthony, M., Sysak, R., Hausbeck, M., **Miles, T.** 2023. Chemical management strategies for halo blight of hops and in vitro fungicide sensitivity of *Diaporthe humulicola* populations to various fungicide classes. Plant Dis. (drafted, preparing to submit)
2. Havill, J., Hatlen, R. ††, Muehlbauer, G., **Miles, T.** 2023. First report of halo blight on hop (*Humulus lupulus*) caused by *Diaporthe humulicola* in Minnesota. Plant Dis. (in First Look)
3. Hatlen, R. ††, Higgins, D., Venne, J., Rojas, J.A., Hausbeck, M., **Miles, T.** 2022. First report of halo blight of hop (*Humulus lupulus*) caused by *Diaporthe humulicola* in Quebec, Canada. Plant Dis. 106 1750.
4. Hatlen, R.J.††, Gillett, J.M., Neugebauer, K., Sysak, R.W., **Miles, T.D.** 2022. Evaluation of fungicides for control of downy mildew and halo blight in hops, 2021. Plant Disease Management Reports. 16 (published in August) (PDMR)
5. Hatlen, R. ††, Higgins, D., Venne, J., Rojas, J.A., Hausbeck, M., **Miles, T.** 2022. First report of halo blight of hop (*Humulus lupulus*) caused by *Diaporthe humulicola* in Quebec, Canada. Plant Dis. 106 1750.

### Funding Partnerships

We leveraged funding from the U.S. Wheat and Barley Scab Initiative to conduct barley fungicide trials and assess the impact of disease, fungicides and variety selection on barley grain quality parameters. Additionally, we have been partnering with the USDA and have submitted proposals to the Crop Protection Pest Management Program and are planning a 2023 submission to the Specialty Crop Research Initiative which will have a strong hop disease element.



Hop Extension Figure (left): Dr. Timothy Miles discussing hop disease management at the MSU hop field day. Hop Disease Figure (right): Halo blight on hops on cones, which can cause 'shatter' and yield loss.



Figure: Barley fungicide applications using a high clearance GPS triggered plot sprayer to investigate fungicide efficacy, fungicide timing for disease management and barley quality.