FINAL PERFORMANCE REPORT

The completed Final Performance Report will be posted to the AMS website.

FINAL PROJECT REPORT TEMPLATE

Final Performance Reports must illustrate the completion of the project within the grant agreement.

PROJECT INFORMATION

Project Title	Optimizing fungicide inputs for disease management in barley and hops			
Recipient Organization Name:	Michigan State University			
Period of Performance:	**Start Date:**	4/1/2020	**End Date:**	7/31/2021
Recipient's Project Contact				
Name:	Martin Chilvers and Timothy Miles			
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PERFORMANCE NARRATIVE

PROJECT BACKGROUND

Provide enough information for the reader to understand the importance or context of the project. This section may draw from the background and justification contained in the approved project proposal.

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, 145 million dollars in wages, and 277 million dollars in economic output (Brewers Association, 2014). The two major components of craft beer, hop and barley, are grown in the state, but currently there are very few MSU extension resources available for plant diseases. Additionally, very little field research on best management practices for diseases is being conducted on either crop. Hops suffer from a variety of diseases, but most importantly downy mildew (DM), caused by the oomycete pathogen *Pseudoperonospora humuli*. Even less is known about barley disease management, but there is significant concern about head blight caused by the fungus *Fusarium graminearum.* Last fiscal cycle, MSU partnered with the Michigan Craft Beverage Council to help build infrastructure to conduct plant disease management research on campus. The goal of this proposal is to continue to develop an infrastructure at MSU for a second year in order to develop control strategies for the most important diseases faced by both Michigan industries under our state's growing conditions. Furthermore, in this proposal seeks to give grower presentations discussing our progress as well as update IPM information in various MSU extension publications such as the Michigan Hop Management Guide and the MSU Small Grains for Brewing and Distilling website.

ACTIVITIES PERFORMED

Address the below sections as they relate to the entire project's period of performance.

OBJECTIVES

Provide the approved project's objectives from your approved proposal/grant agreement.

#	Objective	Completed?	
		Yes	No*
1	**Determine the main fungicide efficacy program and problem diseases in barley**	Y	
2	**Investigate reduced pesticide inputs for downy mildew control in Michigan hopyards**	Y	
3	**Conduct a survey of hop cone diseases in Michigan**	Y	
4	**Develop extension materials for MI hop and barley farmers**	Y	

**If no is selected for any of the listed objectives, you must expand upon this in the challenges and lessons learned sections.*

ACCOMPLISHMENTS

List your accomplishments for the project's period of performance, including the impact they had on the project's beneficiaries, and indicate how these accomplishments assist in the fulfillment of your project's objective(s), outcome(s), and/or indicator(s).

#	Accomplishment or Impact	Relevance to Objective, Outcome, and/or Indicator
1	Barley head scab management trials were completed, and harvested grain quality data was returned for the 2020 harvest season. 2021 harvest has taken place, and samples are being prepared for shipment for mycotoxin and quality analysis. Barley head scab was the most critical disease affecting grain quality in Michigan fields based on our discussions with the industry. Trials completed in 2020 and 2021 also incorporated foliar disease management.	Objective 1. Determine the main fungicide efficacy program and problem diseases in barley
2	We identified several biological compounds that had efficacy against hop downy mildew and are in the process of analyzing this data. Some compounds/products were capable of controlling the new pathogen halo blight in our research trials. These results have been presented at several field days and the information has been directly shared with >20 Michigan hop growers through platforms like the 2021 "Hop Chats"	Objective 2. Investigate reduced pesticide inputs for downy mildew control in Michigan hopyards
3	Cone surveys in 2019, 2020 and 2021 indicate that the most important pathogen is Halo blight (caused by a *Diaporthe* sp.). This was recently	Objective 3. Conduct a survey of hop cone diseases in Michigan.

#	Accomplishment or Impact	Relevance to Objective, Outcome, and/or Indicator
	published by our group in the journal Plant Disease in collaboration with MSU Plant & Pest Diagnostics and Dr. Mary Hausbeck's research program. We have found *Diaporthe* isolates of this pathogen across the entire eastern United States. Additional manuscripts are being prepared on this topic.	
4	For hops, we are in the process of developing a "Michigan Hop Facts" for downy mildew and halo blight that will be similar to what is developed from MSUE for grapes and blueberries. We have delivered several presentations on this topic at various extension events (i.e. Hop chats, and Bine and Dine). Additionally we have presented this work in 2021 at the annual American Phytopathological Society meeting and this poster will be shown at upcoming Hop and Barley conferences. Also this information was submitted as a Plant Disease Management Report in 2020. For barley, a PowerPoint slide deck regarding foliar disease and head scab management was developed, and this resource will be updated as additional data and research is conducted. We also regularly participated in MSU barley research virtual meetings, which allowed us to exchange and extend disease management information. A small grains for brewing and distilling field day was held on June 25, 2021 at KBS, for which a handout was produced and distributed, as well as being made electronically available.	Objective 4. Develop extension materials for MI hop and barley farmers

CHALLENGES AND DEVELOPMENTS

Provide any challenges to the completion of your project or any positive developments outside of the project's original intent that you experienced during this project. Also, provide the corrective actions you took to address these issues. If you did not attain an approved objectives, outcome(s), and/or indicator(s), provide an explanation in the Corrective Actions column.

#	Challenge or Development	Corrective Action or Project Change
1	COVID-19 shutdowns	We have focused on the field aspects of these projects in order to make progress on objective 3. Furthermore, we are developing extension materials that will be helpful remotely.
2		
3		
4		

LESSONS LEARNED

Provide recommendations or advice that others may use to improve their performance in implementing similar projects.

For barley disease management trials, we are going to incorporate a variety with greater susceptibility to scab to increase our odds of detecting differences between fungicide disease management programs.

For hops, we have noted significant differences between cultivar susceptibility in halo blight. This information will likely be an important component of future work and MSU is in the best position to collect this data because we have established several variety block yards on campus at the MSU Plant Pathology Farm and at the Clarksville Research Center.

CONTINUATION AND DISSEMINATION OF RESULTS (IF APPLICABLE)

Describe your plans for continuing the project (sustainability; capacity building) and/or disseminating the project results.

To increase the impact of our efforts, we are in communication with other university groups and will look to produce barley disease management materials on the Crop Protection Network.

We have established a collaboration with other hop researchers and did apply for a USDA Crop Protection Pest Management proposal in 2021 that wasn't funded. We plan to re-submit this proposal in 2022. There are significant extension aspects tied to this proposal. Also we have communicated our results to the Great Lakes Hop Working Group on several occasions.

BENEFICIARIES

Number of project beneficiaries: >100

ADDITIONAL INFORMATION

Provide additional information available (i.e., publications, websites, photographs) that is not applicable to any of the prior sections.

2020 barley yield and malting quality data indicates that spraying of a preferred fungicide at 4-6 post full heading gives the most yield protection and the best grain quality for malting (DON, crude protein, etc.). Foliar disease data also indicates that yield protection can be best achieved by managing these diseases that move in later in the season during heading rather than earlier in the season during node formation. The incorporation of more disease susceptible, commercially available varieties into 2021 and future trials will provide more robust, multi-year results that will be analyzed to aid in making the best disease management decisions for Michigan barley growers.

Within the next few months, we will be uploading the results of our hop trials to MSU's Small Fruit and Hop Pathology website and on the MSUE hop extension webpage so growers can utilize these results to make management decisions. Furthermore, we are planning a field demonstration day at MSU in 2022 at MSU's Plant Pathology Farm to show the results of efficacy trials.

The Authorized Individual must sign this statement after the applicable report form is completed.

I certify that the statements and information contained in these documents are true, accurate, and complete.

Signature of Responsible Official: Date:

8/15/21

8/15/21