

FINAL PERFORMANCE REPORT

AWARD YEARS 2016 FORWARD

A Final Performance Report must be received within 90 days after the end of the grant agreement. You are required to report on the administration of the agreement. The completed Final Performance Report will be posted to the AMS website.

Project Title	Integrated Approaches to Managing Cone Diseases in Michigan Hopyards			
Recipient Organization Name:	Hop Growers of Michigan			
Period of Performance:	Start Date:	11/1/2020	End Date:	8/31/2022
Recipient's Project Contact				
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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.

Michigan ranks 4th in US hop production with about 1000 acres planted in the state. Michigan's humid climate is favorable for disease development, which makes production challenging for growers. The primary disease in Michigan has historically been downy mildew; it mostly infects leaf material and shoots but can also affect cone development if disease is severe. However, Michigan growers are becoming increasingly concerned about cone diseases caused by fungi. These diseases are known to affect hop cone quality, aromas, and can induce shatter. In 2018 and 2019 Michigan hop growers, along with MSU researchers, identified hop cones blighted with three different fungal pathogens: *Alternaria*, *Fusarium*, and *Diaporthe*, the causal agent of a newly identified disease called halo blight. Halo blight is of particular concern as it can cause over 50% yield loss due to cone shatter and has not been reported in the Pacific Northwest (PNW). Furthermore, most hop fungicide products are labeled for powdery mildew, the predominate disease in the PNW and not the diseases present in more humid growing regions like Michigan. Growers are struggling with yield losses due to cone diseases and need improved management strategies.

ACTIVITIES PERFORMED

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

OBJECTIVES

Provide the approved project's objectives.

#	Objective	Completed?	
		Yes	No*
1	Conduct a targeted survey of specific hopyards for <i>Diaporthe</i> spp.	X	

2	Determine the most effective fungicide products at controlling cone diseases in Michigan hopyards	X	
3	Identify resistant cultivars and critical time periods for <i>Diaporthe</i> control	X	
4	Communicate this information utilizing extension talks and updating extension information	X	

*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	Hopyards have been surveyed across Michigan for the presence of <i>Diaporthe</i> . 339 isolates were collected in 2019 and 393 in 2020 through grower led sampling efforts. <i>Alternaria</i> and <i>Diaporthe</i> species were identified as the most abundant pathogens causing cone blight in the two years. The results are being developed into a publication on halo blight.	Objective 1: Conduct a targeted survey of specific hopyards for <i>Diaporthe</i> spp.
2	Small plot fungicide efficacy trials were conducted at the MSU Plant Pathology Farm in 2021 and 2022. All of the major FRAC codes labeled on hop powdery mildew were tested to determine their effectiveness on halo blight and downy mildew. We have identified FRAC 3 and FRAC 11 fungicides, as well as some biological products as the most effective against halo blight. The results of the trials will be presented at 2022/2023 winter meetings to Michigan hop growers.	Objective 2: Determine the most effective fungicide products at controlling cone diseases in Michigan hopyards
3	We have identified burring as a critical period to control halo blight as cones are most susceptible during that time. We also found that early season management is important (foliar lesions occur as early as late May in Michigan and likely contribute to burr infection). A best management practice trial was conducted where we inoculated at various times after burring to identify the critical infection period of halo blight. We also learned that <i>Diaporthe</i> forms overwintering structures, thus we identified early season as another key timepoint to control initial inoculum. We have gathered preliminary data on resistant cultivars through a detached leaf assay and found that Tettanager and Sterling are among the most susceptible, while Chinook, Super Saaz and Magnum appear to have some resistance.	Objective 3: Identify resistant cultivars and critical time periods for <i>Diaporthe</i> control
4	We hosted our first ever Hop Field Day at MSU in July 2022, in which over 60 hop growers and industry members attended. We gave updates on our current hop management findings and conducted tours of our hopyards. MSU extension materials have been updated because of this	Objective 4: Communicate this information utilizing extension talks and updating extension information

#	Accomplishment or Impact	Relevance to Objective, Outcome, and/or Indicator
	project, such as the Michigan Hop Management Guide. We will also present our data to stakeholders during the 2022/2023 winter hop meetings, like the Michigan Great Beer State Conference.	

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	Cultivar susceptibility has not been confirmed in the field for multiple years.	A 0.25 acre variety block of 25 varieties was planted in 2019 at the MSU Plant Pathology Farm and a field halo blight trial will be conducted. Unfortunately, the plants were too small to assess in 2021 but they were assessed in 2022. This will be shown at upcoming winter meetings but we may repeat the evaluation in 2023 prior to preparing it for publication.
2		

LESSONS LEARNED

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

This project has been highly informative and has provided growers with information and management strategies for a new hop disease. There is still much we do not know about the biology of *Diaporthe*, but we have made great progress through lab experiments and field trials. A huge proponent of this project has been the large grower involvement, from participating in our Hop Field Day to providing samples in the survey, they have been a key part of our work.

CONTINUATION AND DISSEMINATION OF RESULTS (IF APPLICABLE)

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

We plan on continuing this project through several ways. There is a USDA-CARE project that will strongly benefit from this work. The proposal is focused on developing diagnostic tools for hop cone diseases and distributing the assays to several university diagnostic clinics for widespread use. Being able to identify the specific pathogen or pathogens in grower's hopyards will facilitate better management decisions. Miles is the Co-PI on this project.

BENEFICIARIES

Number of project beneficiaries:100

OUTCOME(S) AND INDICATOR(S)/SUB-INDICATOR(S)

Provide the results of the project outcome(s) and indicator(s) as approved in your application and project proposal. The results of the outcome(s) and indicator(s) will be used to evaluate the performance of the Program on a national level.

OUTCOME MEASURE(S)

Select the Outcome Measure(s) that were approved for your project.

- Outcome 1:** Enhance the competitiveness of specialty crops through increased sales

- Outcome 2:** Enhance the competitiveness of specialty crops through increased consumption
- Outcome 3:** Enhance the competitiveness of specialty crops through increased access
- Outcome 4:** Enhance the competitiveness of specialty crops through greater capacity of sustainable practices of specialty crop production resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources
- Outcome 5:** Enhance the competitiveness of specialty crops through more sustainable, diverse, and resilient specialty crop systems
- Outcome 6:** Enhance the competitiveness of specialty crops through increasing the number of viable technologies to improve food safety
- Outcome 7:** Enhance the competitiveness of specialty crops through increased understanding of the ecology of threats to food safety from microbial and chemical sources
- Outcome 8:** Enhance the competitiveness of specialty crops through enhancing or improving the economy as a result of specialty crop development

OUTCOME INDICATOR(S)

Provide the indicator approved for your project and the related quantifiable result. If you have multiple outcomes and/or indicators, repeat this for each outcome/indicator (add more rows as needed).

#	Outcome and Indicator	Quantifiable Results
4.a	Number of growers/producers indicating adoption of recommended practices	50 growers
4.b	Number of growers/producers reporting increased dollar returns per acre or reduced costs per acre	50 growers
4.c	Number of producers reporting increased dollar returns per acre or reduced costs per acre	50 producers
4.d	Number of acres with optimized best management practices	875 acres
5.1	Number of new or improved innovation models, technologies, networks, products, processes, etc. developed for specialty crop entities	5 models/processes
5.2	Number of innovations adopted	4 innovations
5.3	Number of specialty crop growers/producers that have increased revenue expressed in dollars	50 growers
5.4	Number of new diagnostic systems analyzing specialty crop pests and diseases	2 diagnostic systems
5.5	Number of new diagnostic technologies available for detecting plant pests and diseases	2 diagnostic technologies
5.6	Number of first responders trained in early detection and rapid response to combat plant pests and diseases	10 responders
5.7	Number of viable technologies/processes developed or modified that will increase specialty crop distribution and/or production	2 processes
5.8	Number of growers/producers that gained knowledge about science based tools through outreach and education programs	60 growers
4.6b	Improving reliability	65 producers
4.6c	Expanding capability	25 producers
4.6d	Increasing testing	65 producers

DATA COLLECTION

Explain what data was collected, how it was collected, the evaluation methods used, and how the data was analyzed to derive the quantifiable indicator.

Isolates and metadata from Michigan and Great Lakes' growers were collected and stored. Additionally, impact data was collected through grower surveys distributed at hop grower meetings. Responses were summarized to compile the indicator numbers.

FEDERAL PROJECT EXPENDITURES

EXPENDITURES

Cost Category	Amount Approved in Budget	Actual Federal Expenditures (Federal Funds ONLY)
Personnel	\$0.00	\$0.00
Fringe Benefits	\$0.00	\$0.00
Travel	\$0.00	\$0.00
Equipment	\$0.00	\$0.00
Supplies	\$0.00	\$0.00
Contractual	\$73,258.00	\$73,258.00
Other	\$0.00	\$0.00
Direct Costs Sub-Total	\$73,258.00	\$73,258.00
Total Federal Costs	\$73,258.00	\$73,258.00

PROGRAM INCOME (IF APPLICABLE)

Source/Nature (i.e., registration fees)	Amount Approved in Budget	Actual Amount Earned
1.		
2.		
3.		
Total Program Income Earned		

Use of Program Income

Describe how the earned program income was used to further the objectives of this project.

ADDITIONAL INFORMATION

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

Peer Reviewed Publications:

Higgins, D.S., Hatlen, R.J., Byrne, J.M., Sakalidis, M.L., Miles, T.D., and Hausbeck, M.K. 2121. Etiology of Halo Blight in Michigan Hopyards. Plant Disease. 105(4):859-872. doi:10.1094/PDIS-05-20-0924-RE

Hatlen, R.J., Higgins, D.S., Venne, J., Rojas, J.A., Hausbeck, M.K., and Miles, T.D. 2022. First Report of Halo Blight of Hop (*Humulus lupulus*) Caused by *Diaporthe humulicola* in Quebec, Canada. Plant Disease. doi:10.1094/PDIS-06-21-1332-PDN.

Extension Publications:

Lizotte, E., Serrine, R., Miles, T., and Chaudhari, S. 2022. Michigan Hop Management Guide.

Professional Presentations:


Hatlen, R.J., Sysak, R., Serrine, R., Lizotte, E., and Miles, T.D. Determining baseline sensitivity of *Diaporthe humulicola* isolates to chemical products labeled in hops. Poster presentation, August 2022. Annual American Phytopathological Society Meeting, Pittsburgh, PA.

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:



10-3-2022