

Grant Agreement
791N5500425

**Pest ID and Scouting Guidelines for the Hop Greenhouse and
Nursery Industry**

Final Report
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Dr. Mary K. Hausbeck
Michigan State University
Department of Plant, Soil and Microbial Sciences

GOAL: Develop disease identification and management tool resources for growers of Michigan’s growing hop nursery industry.

This project was funded at 50% of the requested amount and the funds received were used for diagnostics only.

OBJECTIVES:

Develop a greenhouse/nursery hop disease scouting guide with photos.

Pictures of diseased hop plants were taken during grower visits throughout the growing season, and the diseases identified.

Develop a greenhouse fungicide reference of products registered for growing hop in the greenhouse or nursery.

Reference were prepared:

Hausbeck, M.K., and Harlan, B.R. 2015. Control of foliar diseases of hop plants in the greenhouse, 2015-2016. Publication prepared for use by growers in Michigan who produce hop plants in the greenhouse.

Brown-Rytlewski, D., Hausbeck, M., Higgins, D., Lizotte, E, and Serrine, R. 2016. Pesticides registered for use on hops in Michigan, 2016. Michigan State University Extension (in preparation). This publication includes pest descriptions and photos, and rates and recommendations for pesticides registered in the state of Michigan.

Establish guidelines for plant sampling for greenhouse nursery hop growers.

From May to October of 2015, 57 farm visits were made to 13 Michigan hop growers in Barry, Berrien, Grand Traverse, Genesee, Kalamazoo, Kent, Leelanau and Ottawa Counties to sample diseased plants (Fig. 1). Foliar infections were determined in the field according characteristic signs and symptoms. Cones with brown to reddish brown speckling or premature browning of bracts were collected. Diseases diagnosed in Michigan included downy mildew, powdery mildew and viruses.

Viruses/Viroid: Hop plants from three primary Michigan propagators were sampled and tested for five common viruses and a viroid: hop latent virus (HLV), apple mosaic virus (ApMV), hop mosaic virus (HMV), American hop latent virus (AHLV), and hop stunt viroid (HSVd). Leaves were removed from individual plants and sent overnight to the Washington State University ELISA Laboratory. Only leaves from samples 10007-1, 10018-1 and 10018-2 displayed symptoms (Fig. 2), while the remaining samples were asymptomatic. Out of 41 plants sampled 78% tested positive for at least one virus or viroid.

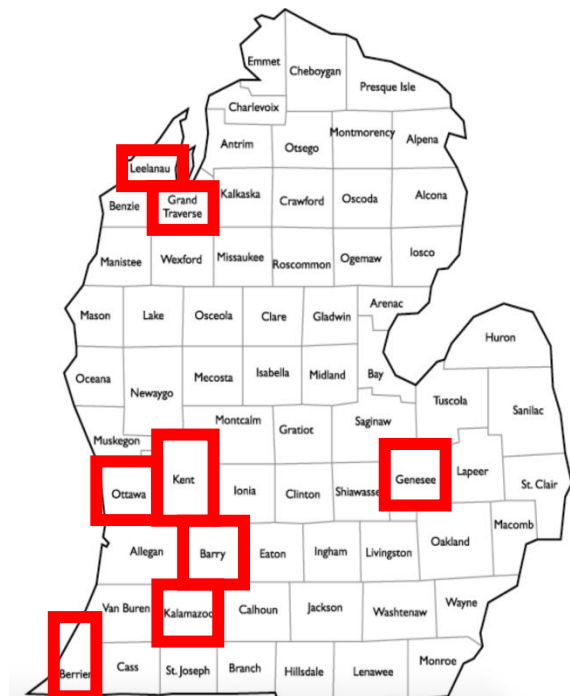


Fig. 1. Counties with commercial hop growers scouted for disease in 2015.

The occurrence of each virus or viroid was 31.7% ApMV, 41.5% HLV, and 68.3% AHLV, and 7.3% HSVd (Table 1).

Three *Carlavirus* viruses, HLV, HMV and AHLV, may or may not readily express diagnostic symptoms. Symptoms are reported to occur as chlorotic mosaic pattern (HMV) or chlorotic speckling (HMV and HLV). Chlorotic speckling symptoms are more commonly reported in HMV-sensitive plants from the cultivar Golding lineage. Of the varieties tested, Nugget, Chinook and Centennial have been bred from descendants of Golding. This group of *Carlavirus* is transmitted mainly by the damson-hop aphid although HMV and HLV may also be transmitted by the potato peach aphid. Mechanical transmission has also occurred under laboratory conditions.

The ApMV is either symptomless or on affected leaves can display chlorotic ringspots, that may become necrotic, or form an oak-leaf line patterns. The virus is reported to be transmittable to from hop to cucumber. ApMV has a wide host range and no known vector, although it is likely spread via mechanical transmission. The virus is regarded as having the greatest impact on yield, among the common occurring virus, and can decrease the survival of propagated hop softwood cuttings.

Typical symptoms of HSVd including stunting, leaf curl and small cones. Visible stunting may not occur for several years after the plants become infected. Common foliar symptoms for HSVd may include a yellow speckling along the major leaf vein which could be similar to the observed symptoms in samples 10018-1 and 10018-2. Additionally, yellow-green leaves may be observed among basal foliage that develops early in the growing season. The link between symptom expression, cultivar and environment is not well understood. HSVd is usually introduced to hop yards via propagated material.



Fig. 2. Chlorotic, mosaic symptom of HMV (A) veinal chlorosis of HSVd (B).

Table 1. Virus and viroid test results of hop plants sampled from Michigan propagators.

Sample	Cultivar	HpLV	ApMV	HpMV	AHLV	HSVd
10007-1	Proprietary	-	-	+	+	-
10007-2	Centennial	+	-	+	+	-
10007-3	Nugget	-	-	+	+	-
10018-1	Nugget	-	-	-	-	+
10018-2	Zeus	-	-	-	-	+
10048-1	Proprietary	-	-	-	+	-
10048-2	Proprietary	-	+	-	+	-
10048-3	Proprietary	-	-	-	+	-
10048-4	Cascade	+	+	+	+	-
10050-1	Saaz	-	-	-	+	-
10057-1	Chinook	+	-	-	+	-
10057-2	Can. Redvine	+	+	-	+	-
10057-3	Cascade	+	-	+	+	-
10057-4	Nugget	-	-	-	+	-

Sample	Cultivar	HpLV	ApMV	HpMV	AHLV	HSVd
10057-5	Star	+	+	-	+	-
10057-6	Vojvodina	+	-	-	+	-
10057-7	Willamette	+	+	-	+	-
10057-8	Zeus	+	+	+	+	-
10057-9	Bitter Gold	+	-	-	+	-
10057-10	Brewers Gold	+	+	+	+	-
10057-11	Centennial	-	-	-	+	-
10057-12	Chinook	+	-	-	+	-
10057-13	Crystal	+	+	-	+	-
10057-14	Galena	-	-	-	-	-
10057-15	Magnum	-	-	-	-	-
10057-16	Nugget	-	+	-	-	-
10057-17	Saaz	-	-	-	-	-
10057-18	Zeus	+	+	+	+	-
10095-1	Brewers Gold	-	-	-	+	+
10095-2	Cascade	-	-	+	-	-
10095-3	Cashmere	-	-	-	+	-
10095-4	Centennial	-	-	-	-	-
10095-5	Chinook	-	-	-	-	-
10095-6	Crystal	-	-	-	-	-
10095-7	Glacier	-	-	-	+	-
10095-8	Sorachi Ace	-	-	-	-	-
10095-9	Tettnanger	-	+	-	-	-
10095-10	Zeus	-	-	-	-	-
10095-11	Cascade	+	+	+	+	-
10095-12	Centennial	+	+	+	+	-
10114-01	Chinook	+	-	+	+	-

Identify fungicides that are effective against downy mildew for use in greenhouse nursery production and sample spray programs.

A Crisis Exemption was obtained for an effective downy mildew fungicide for Michigan to limit the amount of damage that resulted with the favorable weather conditions for disease development that was experienced in the spring and summer of 2015. This Crisis Exemption took a considerable amount of time, data, and interaction with MDARD and EPA. A Section 18 request for this downy mildew fungicide was submitted in 2016 and is pending. A Pesticide Clearance Request Form was submitted to the USDA IR-4 Project for a newly developed downy mildew fungicide and it was selected as a national priority.

Host educational programs for specific target audiences to include MDARD inspectors and greenhouse nursery propagators.

Results and recommendations were presented/published:
 Del Castillo Munera, J., Higgins, D.H., Harlan, B.R. and Hausbeck, M.K. 2016. Occurrence and management of hop (*Humulus lupulus*) powdery mildew (*Podosphaera macularis*) in

- Michigan. American Phytopathological Society North Central Division Meeting, Roseville, MN, 7-9 June. Poster presentation.
- Higgins, D., and Hausbeck, M. 2016. Hop diseases. Great Lakes Hop and Barley Conference, Acme, MI, 16-17 March. Information on identifying and managing hop diseases was presented. Approximately 380 participants attended the GLHBC from Michigan, Nebraska, Wisconsin, Minnesota and Ontario, representing an agricultural land impact of 7,610 acres.
- Higgins, D., and Hausbeck, M. 2016. Michigan hop diseases. Hop Working Group Meeting, Burlington, VT, 24-16 April.
- Hausbeck, M., Higgins, D., and Lizotte, E. 2016. Controlling downy mildew on hop. Michigan State University Extension News for Agriculture: 6 May.
- Lizotte, E., and Hausbeck, M. 2015. New downy mildew fungicide available to Michigan hop growers. Michigan State University Extension News for Agriculture: 3 Jul.
- Hausbeck, M.K., and Harlan, B.R. 2015. Control of foliar diseases of hop plants in the greenhouse, 2015-2016. Publication prepared for use by hop growers in Michigan.

FINANCIAL SUMMARY:

The budget of the original grant was reduced from \$10,000 to \$5,000, and the revised budget was allocated for identification of virus pathogens of hop samples.