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Introduction to Hop Integrated Pest Management

Erin Lizotte, IPM Educator
Michigan State University Extension
Overview

- Scouting protocol
- Primary pests
- Beneficials
- IPM resources
Scouting protocol

- The more you look-the more you see
- How many leaves you collect or evaluate should depend on the pest
- Find what works for you!
General protocol
Walking a transect and an edge

• Walking a transect ensures you get a look at the interior and edge of the hopyard
• Change your route each time to make sure you cover new ground
• Once you locate an issue—consider whether a more thorough evaluation is warranted
General protocol
What am I looking for?

• This becomes more clear over time
• Look for anything out of the ordinary
  • Stunted plants
  • Damaged or cupped leaves
  • Discoloration, chlorosis, bronzing
  • Failure to thrive
• A huge group of insects (usually it’s not valuable to sweat the individual insect you spot munching on a leaf)
General Protocol

• Remove leaves as you move through the yard—turn them over and give a close inspection using a hand lens
• Check leaves from all reachable heights, but favor the lower, denser portion of the canopy
• If checking for a specific pest threshold follow sampling protocol
Primary Pests for MI growers

- Downy Mildew
- Potato leafhopper
- Mites
- Damson hop aphid
- Beetles (chafer and Japanese)
Primary pests – Downy Mildew

- Caused by the fungi *Pseudoperonospora humuli*
- Can cause significant yield and quality losses depending on variety and when infection becomes established
- In extreme cases cones can become infected and the crown may die
Disease cycle of *Pseudoperonospora humuli*, the causal agent of downy mildew in hop. (Cred. V. Brewster, Compendium of Hop Diseases and Pests)
Downy mildew

- Infection is favored by mild to warm temperatures (60 to 70 F) when free moisture is present for at least 1.5 hours
- Leaf infection can occur at temperatures as low as 41°F when wetness persists for 24 hours or longer
- Initially, downy mildew appears early in the season on the emerging basal spikes
- Spikes then appear stunted, brittle and distorted
**Downy mildew**

- Spore masses appear fuzzy and black on the underside of infected leaves.
- As bines expand new tissue becomes infected and fail to climb the string.
- Can retrain new shoots but often incur yield loss as a result.
- Appearance may vary based on variety and timing.
Downy mildew
Downy mildew
Downy mildew
Downy mildew management

- Utilize a protectant fungicide management strategy SEASON LONG to mitigate the risks of early and severe infections (weekly application)
- Varietal susceptibility is important
- Clean planting materials should be selected
- All plant materials removed in pruning should be removed from the hopyard and covered up or burned
Downy mildew management

• Begin fungicide applications just after the first spikes emerge to minimize infection levels season long

• Subsequent applications should be made in response to conducive environmental conditions every 7-10 days

• Copper, boscalid, fosetyl-AL, pyraclostrobin, and a number of biopesticides have varying protectant activity against downy mildew

• Potential resistance to fosetyl-AL?
Downy mildew, post infection

- Weather conditions that increase disease pressure and prevent application necessitates the use of “curative” applications in addition to preventative sprays
- *Cymoxanil* has about 2d post-infection activity and provides 3d of protection
- *Cymoxanil+famoxadone* provides 2d post infection activity and 5-7d protection
- *Dimethomorph* and *mandipropamid* have the same mode of action and offer 7d of protectant activity and 1-2d of post-infection activity
- *Phosphorous acid* fungicides have been shown to provide about 4-5d protection and post-infection activity of 5-7d
Know thy enemy!

• Downy AND Powdery mildew
• Downy mildew = *Pseudoperonospora humuli*
• Powdery mildew = *Podosphaera macularis*
• Powdery mildew has a much lower incidence in Michigan, likely due to environmental factors
• It is important that growers do not mistake downy mildew for powdery mildew as the effective pesticide classes are very different
Powdery mildew

David Gent, USDA-ARS
Primary pests – Potato leafhopper

- PLH feeding on hops causes what growers have termed “hopper burn”, a v-shaped necrosis of the leaf margin
- Scouting for PLH should be performed weekly as soon as leaf tissue is present to ensure detection early and prevent injury
- More frequent spot checks should be done following rain storms which carry the first populations north
Scouting for PLH

- Shake the bine
- Flip leaves and shoots over
- PLH move in all directions when disturbed
- Hop plants can tolerate some level of feeding and growers should be conservative in the application of insecticides
- At this time there is no set economic threshold for PLH in hops
- Stay tuned—VT research results coming in 2015
PLH Management

- PLH can be managed with neonicitinoids (imidacloprid or thiamethoxam), pyrethroids (bifenthrin or beta-cyfluthrin), organophosphates (malathion) or spinosyns (spinosad)
- Consider that pyrethroids have been shown to cause increases in mite populations
- Neonicitinoids are longer lasting and narrow spectrum
- Pyganic, Entrust and Trilogy are OMRI approved insecticides organic growers might consider for PLH management
Primary pests
Two-spotted spider mites

• A significant pest of hop in Michigan and can cause complete economic crop loss
• TSSM feed on the liquid in plant cells, decreasing the photosynthetic ability of the leaves and causing direct mechanical damage to the hop cones
• Also a contaminate pest

Photo credit: David Cappaert, MSU. Bugwood.org
Two spotted spider mite

- Leaves take on a white appearance and will eventually defoliate under high pressure conditions
- Intense infestations weaken the plant and reduce yield and quality
- Infested cones develop a reddish discoloration, do not hold up to the drying process, and commonly have lower alpha levels and shorter storage potential
TSSM
TSSM
• In the spring only mated females are present, they have overwintered in a dormant stage from the previous season and are ready to lay fertilized eggs.
• She appears particularly orange in color this time of the year and has overwintered on debris and trellis structures in the hop yard.
• As temperature warm the females feed and begin laying eggs.
• Larvae emerge from the eggs in 2-5 days (depending on temperatures) and develop into adults in 1-3 weeks (again depending on temperature).
TSSM

- TSSM like it hot, with the pace of development increasing until an upper threshold around 100F is reached, conversely, cold and wet weather is not conducive to development
- TSSM are very small but can be observed on the underside of leaves using a hand lens
- As the season progresses cast skins and old webbing give infested leaves a dusty and dirty appearance
- The eggs look like tiny clear spheres and are most commonly found in close proximity to adults and larvae
- The larvae themselves are small, translucent versions of the adults
- Adults and larvae also have two dark spots
Photo credit: David Cappaert, MSU. Bugwood.org
Scouting for TSSM

- Take leaf samples from 3-6’ up the bine, as the season progresses samples should be taken from higher on the bine as the mites migrate.
- Use a hand lens to evaluate 2 leaves from 20 plants per yard.
- Thresholds developed in the Pacific Northwest:
  - 2 adult mites/leaf in June
  - By mid-July, the threshold increases to 5-10 mites/leaf
- The goal is to prevent cone infestation, not 100% control.
TSSM Management

- Only manage for mites when absolutely necessary—management disturbs beneficial populations that help keep numbers in check
- There are a lot of labeled miticides including those in the avermectin, acequinocyl, organophosphate, hexythiazox, propagite, tetronic acids, dicofol, etoxazole and fenazaquin insecticide classes
- OMRI-approved products containing oils, befenazate, and azadirachtin are labeled for mites
- Consider the PHI (quality?) if close to harvest
Primary Pest
Damson hop aphid

- Hop aphids can reduce plant productivity
- DHA excrete ‘honeydew’ which makes an excellent growth medium for sooty mold and can greatly reduce the quality and salability of a crop
- Under heavy infestations defoliation can occur
- Aphids may also feed within cones and cause economic damage to the crop even at low levels
**Damson hop aphid**

- Hop aphids overwinter as eggs on Prunus species.
- In early spring eggs hatch into stem mothers which give birth to wingless females that feed on the Prunus host.
- In May winged females are produced and travel to hop plants where additional generations of wingless females are produced.
- As cold weather approaches winged females and males are produced, move back onto a Prunus host, mate and lay eggs for before winter.
Damson hop aphid
Damson hop aphid

- Symptoms of hop aphid feeding include leaf cupping and the appearance of honeydew and the associated black sooty mold
- Hop aphids can be found on the upper and lower surface of the leaves
- Currently we are observing nymphs primarily on the underside and unwinged adults on the upper and lower leaf surface
Management
Damson hop aphid

- Control before the flowering stage may be important to protect crop quality when populations are high
- 8-10 per leaf are tolerated in the Pacific Northwest until cones are present
- Insecticides containing neem (some of which are organic), neonicitinoids (imidacloprid or thiamethoxam), flonicamid or spirotetramat all have activity against hop aphid
Primary Pests
Rose chafer and Japanese beetle

• Both beetles are generalists and feed on dozens of plants
• Beetles are prevalent near grassy areas, particularly irrigated turf
• Grubs feed on grass roots in early spring and again in the fall and can cause significant damage to turf
• Larvae prefer moist soil conditions and do not survive prolonged periods of drought
Rose chafer and Japanese beetle

- RC emerge in June, JB emerge in early July, each are active for around 6 weeks
- They feed on leaves skeletonizing the tissue
- If populations are high, they can remove all of the green leaf material from a plant
- Visual observation of adults or feeding damage is an effective scouting technique
- Because of their aggregating behavior, they tend to be found in larger groups and are typically relatively easy to spot
European rose chafer
European rose chafer
Japanese beetle
Japanese beetle
Rose chafer and Japanese beetle

- No established treatment thresholds
- Malathion is effective, but can take up to 3 days to take effect and provides 10-14 days of residual control
- Pyrethroids (bifenthrin or beta-cyfluthrin) have good knockdown activity, and 7-10 days of residual control, but can be problematic in hopyards where mites are a concern
- Neonicitonoids (imidacloprid or thiamethoxam) have contact toxicity for 2-5 days, and residual anti-feedant activity
- OMRI approved options include neem-based products (azadirachtin) which have a 1-2 day residual and good knockdown activity as well as Surround (kaolin clay) which has had good results in blueberry and grape and acts as a physical barrier and irritant
Registered pesticides

Pesticides registered for use on hops in Michigan 2015

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**Fungicides registered for use on hops in Michigan 2015**

<table>
<thead>
<tr>
<th>Trade name</th>
<th>Common name</th>
<th>FRAC group/ resistance risk</th>
<th>Downey or powdery mildew</th>
<th>Rate/notes</th>
<th>PHG</th>
<th>REF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azmune</td>
<td>spiroxamine</td>
<td>5/ low to med</td>
<td>PM</td>
<td>18 fl oz/A</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>Agri-Fos</td>
<td>phosphorous acid, mone &amp; di-potassium salts</td>
<td>33/ low</td>
<td>DM</td>
<td>1.25 qty A in 10 gal water. Apply when shoots are 0.5-1 ft long, post training, 20 d post training, bloom, when conditions favor disease.</td>
<td>not listed</td>
<td>4</td>
</tr>
<tr>
<td>Aliette WDGI</td>
<td>fosetyl-Al</td>
<td>33/ low</td>
<td>DM</td>
<td>2.5 lb/A. Apply when shoots are 6-12 in tall, after training when vines are 5-6 ft tall, 3 wks after 2nd application, at bloom. Maximum 10 lb/A/year. Do not use with copper compounds. See label.</td>
<td>24</td>
<td>12</td>
</tr>
<tr>
<td>Badge SC</td>
<td>copper oxichloride copper hydroxide</td>
<td>M1/low</td>
<td>DM</td>
<td>1.0 pt/A. Make crown treatment after pruning but before training. After training additional treatments are needed at 10 d intervals.</td>
<td>14</td>
<td>48</td>
</tr>
<tr>
<td>Champ Dry Prill</td>
<td>Champ Formula 2 Flowable, Nu-Cop 3L, Kanten DF, Kocide 2000, Kocide 3000</td>
<td>copper hydroxide</td>
<td>M1/low</td>
<td>DM</td>
<td>1.33 lb/A, no more than 7.07 lb/A/yr. 1.33 pt/A, no more than 7.3 pt/A/yr. 1.33 pt/A, no more than 7 pt/A/yr. 1.33 lb/A, no more than 7.57 lb/A/yr. 0.75-1.5 lb/A, no more than 8.6 lb/A/yr. Apply as a crown treatment after pruning but before training. After training, additional fungicide treatments are needed at about 10 d intervals. Minimum retreatment interval: 10 d.</td>
<td>14</td>
</tr>
</tbody>
</table>

Compiled by:
Diane Brown-Rytlewski, Erin Lizotte, and Rob Sirrine, Extension Educators

Hops.msu.edu
Beneficials
Don’t forget about the good guys!

- As research into beneficial insects (natural enemies) continues, our understanding of the importance of these partners continues to grow.

Insect predators and parasites, known as natural enemies, can control pest populations in agricultural crops and landscapes.

D. Landis, MSU
Common Natural Enemies

Braconid wasps-Parasitoid

• Parasitize larvae of beetles, caterpillars, flies and sawflies

• Adults usually are less than \(\frac{1}{2}\) inch long with an abdomen that is slender and longer than the head and thorax combined
Common Natural Enemies

Soldier beetle-Predator

- Adults of some species feed on nectar and pollen and are often found at flowers, other adults eat aphids, insect eggs and larvae or feed on both flowers and insects

- Larvae are dark, flattened and elongate, and feed in soil, leaf litter or under bark, primarily on eggs and larvae of beetles, butterflies, and moths
Common Natural Enemies

Green Lacewing-Predator

- Adults of many species are not predaceous
- Predaceous larvae have long, curved mandibles that they use to pierce and suck the fluids out of their prey
- The larvae are about 1/8 inch long, look like tiny alligators, and prey on most small soft bodied insects, often pale with dark markings
- Eggs are laid on individual silken stalks
Common Natural Enemies

Lady Beetles—Predator

- Most adults and larvae feed on soft-bodied insects
- These may be important in aphid population control
- Adults are rounded, and range in size from tiny to medium-sized (about ¼ inch long), color ranges from black to brightly colored
- Larvae are active and elongate with long legs, and look like tiny alligators
Common Natural Enemies

Crab spiders-Predator

- Crab spiders stalk and capture insects resting on surfaces or walking, they do not spin webs
- The front two pairs of legs are enlarged and extend to the side of their body, giving them a crablike appearance
- Over 200 species in North America
Common Natural Enemies

Damsel bugs-Predator

- These bugs prey on aphids, leafhoppers, mites, caterpillars, and other insects
- Most often yellowish, gray or dull brown, they are a little over ¼ inch long
- Slender insects with an elongated head and long antennae
Common Natural Enemies

Predatory mites

• Predatory mites are often translucent, larger than pest mites and move at a much faster speed across the leaf surface

• Predatory mites play an important role in balancing the pest mite populations and should be protected when possible
Attracting Natural Enemies

• Natural enemies are more likely to thrive in undisturbed areas that provide overwintering habitat, flowers to support their survival and reproduction, and refuge from pesticide applications in crops

• Natural enemies may be conserved with the same plantings that support pollinators
Resources for beneficial insects

• MSU Native Plants Website: www.nativeplants.msu.edu
• Identifying Natural Enemies in Crops and Landscapes, MSU Bulletin, MSUE Bookstore Online
Resources for scouting

- Hops.msu.edu—includes downloadable copies of the registered pesticide guide
- Sign up to receive the MSU hop scouting reports News.msu.edu
- Facebook-Michigan State University Hop News
- Hop IPM Field Guide 2016
IPM Resources at MSU

- Enviroweather
- MSUE news and linked resources
- IPM website and associated pages
- Diagnostics lab
- Soil and nutrient testing
Real-time information

Enviroweather is a weather-based information system to help make pest, production and resource management decisions.
Enviroweather

- Access the MSU Agricultural Weather Office Forecasts
- Look up historical weather data and compare across years
- Reference for record keeping (wind speed, directions, temperature)
- Pest modeling
Information portal - msue.msu.edu
Organic Agriculture

Michigan State University Extension's focus on organic agriculture encompasses all aspects of organic farming ranging from fruit and vegetable production to animal agriculture. Through educational programs and research, MSU Extension helps farmers build sustainable organic farms through strong integrated pest management and enhancing soil health.

News

- **Landowners determine impacts of oil and gas leasing negotiation efforts in survey**
  
  October 10, 2014 | Curtis Talley Jr. | Results of a survey sent to 130 landowners in 19 Michigan counties determines their activities in oil and gas leasing and their sources of assistance information.

- **Farm Bill compliance dates announced**
  
  October 10, 2014 | Dennis Stein | 2014 Farm Bill safety net programs have several compliance dates now being announced by the USDA FSA that farm landowners and tenant operators need to know.

- **MSU Extension Beginning Farmer Webinar series continues online**
  
  October 7, 2014 | Jim Isbell | New topics of interest to beginning farmers and experienced farmers considering new enterprises will be offered in 2015. Recordings of past topics are now available.

- **MSU helps kids understand agriculture and natural resource sciences**

  October 3, 2014 | Michigan State University Extension | MSU Extension is working to help kids better understand agriculture and natural resource sciences.
Agriculture

Supporting agriculture is key to a brighter future. Michigan State University Extension works to increase farmers’ success while protecting the environment, ensuring food safety, reaching new markets and advancing agriculture through applied research. Agriculture is now one of the fastest growing sectors of the Michigan economy. MSU Extension works to ensure it has a thriving knowledge base to become more competitive in local, state, national and international marketing making Michigan’s economy stronger.

News

- Grand Rapids area apple maturity report – October 10, 2014
  October 13, 2014 | Phil Schwallier | Cooler weather has resulted in outstanding apple quality.

- The color of meat depends on myoglobin: Part 1
  October 10, 2014 | Jeannine Schwielhofer | Myoglobin is the iron-rich protein that gives meat its color.

- Landowners determine impacts of oil and gas leasing negotiation efforts in survey
  October 10, 2014 | Curtis Talley Jr. | Results of a survey sent to 130 landowners in 19 Michigan counties determines their activities in oil and gas leasing and their sources of assistance information.

- Southwest Michigan apple maturity report – October 8, 2014
  October 8, 2014 | Bill Shane | Harvest of Golden Delicious in southwest Michigan is well underway with Red Delicious ramping up. Rain has hampered harvesting somewhat. Fruit size is generally very good.
Receive customized MSUE News Digests!

- Agriculture and the Environment
- Agriculture Policy
- Aquaculture
- Beef Production
- Dairy Production
- Farm Management
- Field Crop Production
- Floriculture Production
- Fruit Production
- Horses
- Hops
  - Nursery & Christmas Tree Production
  - Turf & Landscape
  - Organic Agriculture Production
  - Pork Production
  - Poultry Production
  - Sheep & Goats
  - Vegetable Production

- Pest Management
- Turf
- Water Usage
- Energy
- Fisheries & Wildlife
- Forestry
- Green Energy
- Invasive Species
  - Lakes, Streams & Watersheds
  - Water Quality

AND MORE!
We’ve moved!

Welcome to the MSU Extension Bookstore!

Please note that although most of the products are now available on shop.msu.edu, we are still finalizing the transition. All MSU Extension items will be online and ready for purchase by Wednesday, October 8.
Events

Eat Healthy, Be Active nutrition series
Date: October 12, 2014 - November 17, 2014
Location: Private residence, Livonia, MI
Free 6 week nutrition series.

Eat Healthy, Be Active Nutrition Series
Date: October 13, 2014 - November 17, 2014
Private residence, Livonia, MI
Free 6 week nutrition series.

Bullying Prevention
Date: October 13, 2014
Big Bear Arena, 2 Ice Circle, Sault Ste Marie, MI 49783
Career bullying behavior and strategies for prevention.

Mental Eating
Date: October 13, 2014
MSU Extension Kent County, 775 Boll Ave NE, Grand Rapids MI 49506
Benefits of eating with mindful awareness.

Strong Adolescents Parenting Series
Date: October 13, 2014 - November 24, 2014
Location: Monroe County MSU Extension, 903 S. Raisinville Rd., Monroe, MI 48161
A six-week parenting/caregiver program on parenting pre-teens and teenagers.

Season Extension to Expand Your Marketing Potential
Date: October 13, 2014
Join the Michigan Farmers Market Association in our Farm-Based Educational Field Day as we talk about season extension.

Backyard Gardener: Tree Fruit Workshop
Date: October 13, 2014
The new ipm.msu.edu

Welcome to Michigan State University's Integrated Pest Management (IPM) resources. The IPM Program collaborates with faculty and Extension educators to develop diverse information serving growers of many crops, the landscape/turf "green" industry, and those looking for home and garden pest solutions. Our website includes the resources offered by Pesticide Education and Safety Program.
On-demand webinar series

Integrated Pest Management Academy

Welcome to the online Integrated Pest Management Academy!

Online Integrated Pest Management Academy Webinars

The following prerecorded webinars are available for viewing at any time. Simply click on the webinar titles of your choice. At this time, no pesticide recertification credits are available for viewing these webinars.

Click on the titles below to view the described webinar:

**Introduction to Integrated Pest Management**

Learn about the history of pest management, the evolution of integrated pest management (IPM) and the tenants that define implementation in the field.

**Integrated Pest Management Resources**

Learn about the integrated pest management resources Michigan State University and Extension have to offer agricultural producers.

**Entomology 101**

In this compact primer on insects learn the vocabulary to help you properly identify insects and better understand the role of insects in the world.

**Plant Pathology 101**

This introductory webinar covers the basics of plant pathogens and introduces viewers to the some popular control methods.

**Soil Science 101**

This webinar highlights the importance of soil characteristics and their potential impacts on agricultural production. Due to some technical difficulties, you must follow this.
Webinars Coming in 2015

Understanding Organic insect management products
What is wrong with my vegetable plants?
Tactics for vegetable disease management
Understanding Late blight of tomatoes and potatoes
How to submit a sample for diagnosis
Understanding Cucurbit downy mildew
Understanding Organic disease management products
Pollinators 101
Vegetable Pollination 101
Beekeeping: Honeybee
Beekeeping: Natives
Protecting pollinators
Vegetable insect scouting
Enviroweather: Cabbage maggot
Enviroweather: Asparagus miner
Enviroweather: Seed corn maggot
Enviroweather: Squash vine borer
Enviroweather: Potato leaf hopper
Diagnostic Services
at Michigan State University

Providing high quality, timely, client-oriented services related to plant health and pest-related problems.

NEW ADDRESS
The mailing address for MSU Diagnostic Services has been changed to:

Diagnostic Services
578 Wilson Rd., Rm. 107
East Lansing, MI 48824-6469

Click for more info
- Environmental or Cultural Problems
- Herbicide/Pesticide Injury
- Insects and Arthropods
- Plant Diseases
Soil and Plant Nutrient Laboratory

MSU Soil and Plant Nutrient Laboratory (SPNL) operates as an integral part of Michigan State University providing support to teaching, research and extension programs. The SPNL offers a variety of analytical services on samples of soil, greenhouse growth media, composts, plant tissue, water and other materials related to the growing of plants (crops) received from commercial and part-time farmers, greenhouse operations, golf courses, homeowners, consultants, researchers, and others.

Many county extension operations use soil and plant tissue testing as the foundation for extension programs with their various clientele groups. Researchers in many departments within MSU and other universities have the SPNL analyze soil, plant and water samples as part of their research programs.

www.css.msu.edu/SPNL/
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