

# What's bugging your bines?

## Pest management in the hopyard

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Eastern Ontario Hops Producer Workshop  
March 21, 2016

# Hop Pests in Northeastern North America – a history

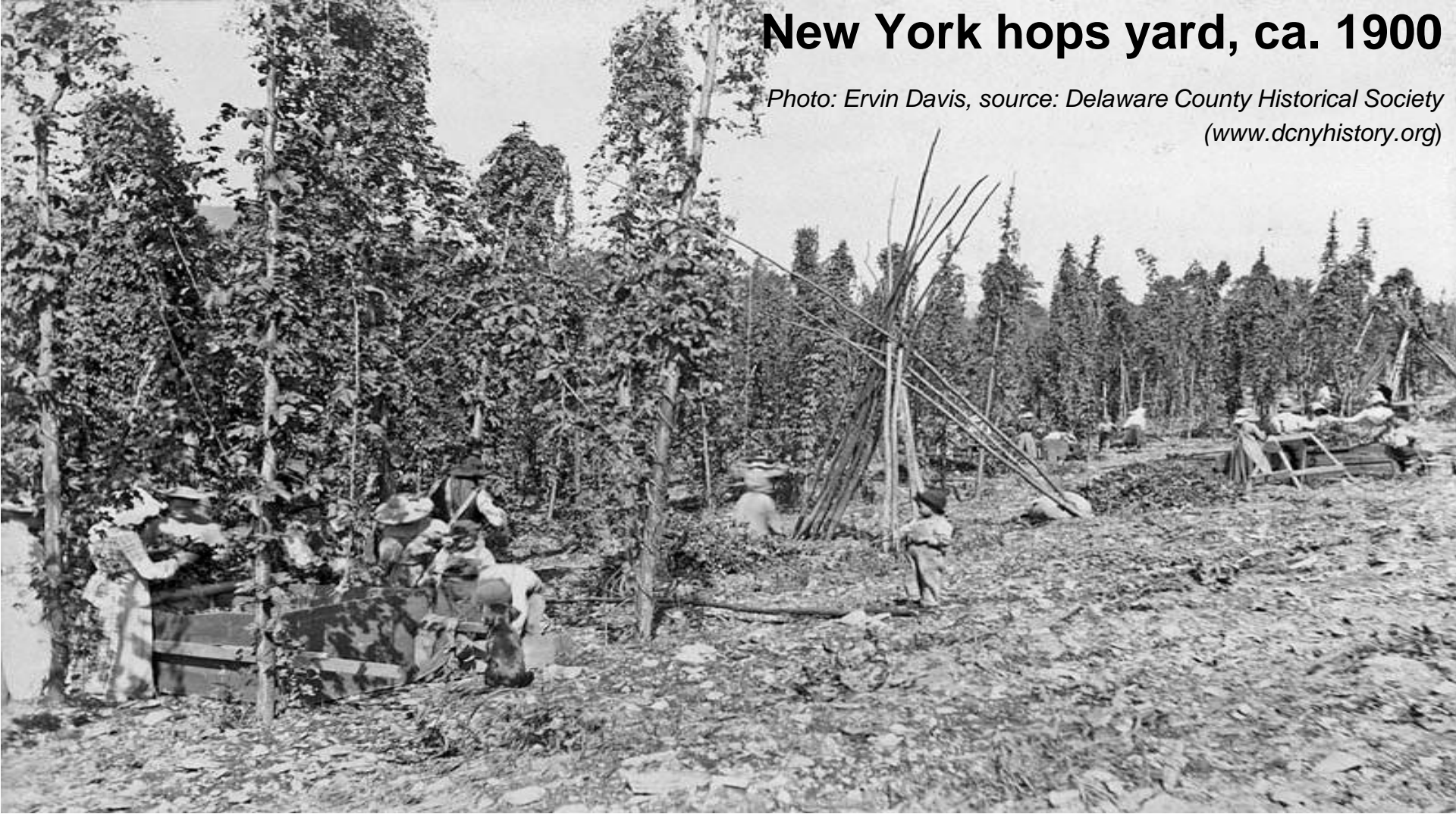


*Photo: Claude Taylor, source: Delaware County Historical Society ([www.dcnycnyhistory.org](http://www.dcnycnyhistory.org))*

- **1800s:** significant hops production in northeastern NA
- **Ca. 1909:** powdery mildew causes severe crop loss
- **1914:** hops aphid adds to demise
- **Early 1920s:** discovery of sulfur-based fungicides – revival of industry
- **Late 1920s:** industry is devastated by downy mildew

# New York hops yard, ca. 1900

*Photo: Ervin Davis, source: Delaware County Historical Society  
([www.dcnynhistory.org](http://www.dcnynhistory.org))*



**Davenport, NY Historical Society, “A History of Agriculture”**

“Poles, if not treated with tar, were often burned at the end of one season to kill the hop lice eggs that infested the bark”.



Photo Source: Ventures and Adventures, [www.historylink.org/File/7742](http://www.historylink.org/File/7742).

## 1892 Hop Lice disaster

"One evening in 1892, as I stepped out of my office and cast my eyes toward one group of hop houses, it struck me that the hop foliage of a field near by was off color -- did not look natural ... I walked down to the yards, a quarter of a mile away, and there saw the first hop louse. **The yard was literally alive with lice, and they were destroying the quality of the hops ...** At that time I had advanced to my neighbors and others **upon their hop crops more than a hundred thousand dollars, which was lost.** These people simply could not pay, and I forgave the debt, taking no judgments against them, and I have never regretted the action. **All my accumulations were swept away, and I quit the business -- or rather, the business quit me"**

*Ezra Meeker, Hops Grower  
Puyallup, Washington, 1938*

Source: E. Meeker and H. Driggs, for Oregon Trail Memorial Association, 1932.  
Covered Wagon Centennial and Ox-Team Days.



Photo Source: UW Special Collections, [www.historylink.org/File/7742](http://www.historylink.org/File/7742).



# Hop Pests in Northeastern North America – a history



Photo: H.E. Morrison and J.D. Vertrees,  
([www.thebrewstorian.tumblr.com](http://www.thebrewstorian.tumblr.com))



Photo: Agricultural Experiment Station Records 1889-2002  
([www.thebrewstorian.tumblr.com](http://www.thebrewstorian.tumblr.com))

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- **Late 1920s:** industry is devastated by downy mildew
- **Early 2000s:** Hops industry re-emerges in Ontario. Pests???

## Ontario versus US West coast INSECTS

<b>Pest</b>	<b>Oregon</b>	<b>2009</b>	<b>2012</b>	<b>2015</b>
Spider mite	Yes	Yes	Yes	Yes
Hop aphid	Yes	No	Yes	Yes
Hop looper	Yes	Yes	Yes	Yes
Slugs	Yes	Yes	Yes	Yes
Garden symphylan	Yes	No	No	Yes
Prionus beetle	Yes	No	No	No
Bertha armyworm	Yes	No	No	No
Japanese beetle	No	Some	Yes	Yes
Question mark caterpillar	No	No	Yes	Yes
Earwigs	No	Yes	Yes	Yes
Potato leafhopper	No	Some	Yes	Yes

## Survey results – Ontario versus US West coast DISEASES

<b>Pest</b>	<b>Oregon</b>	<b>2009</b>	<b>2012</b>	<b>2015</b>
Downy mildew	Yes	Some	Yes	Yes
Powdery mildew	Yes	No	Maybe	Yes
Virus/viroid complex	Yes	No	Maybe	Yes
Alternaria cone disorder	Yes	Yes	Yes	Yes
Fusarium canker/blight	Yes	No	No	Yes
Verticillium wilt	Yes	No	No	Yes
Red crown root rot	Yes	No	No	No
Black root rot	Yes	No	No	Yes
Phoma blight	No	No	Yes	Yes
Botrytis gray mold	Yes	No	No	Yes

If you grow it...



.....they will come





# The problem....

- Lots of things like to live on hops
- Not all of them are a problem
- Some are beneficial
- Symptoms can be similar



# Thresholds

- A determination of how much is too much
- **Economic Injury Level (EIL)**: pest density where cost of management tactics = value of the loss in yield
- **Economic/Action Threshold**: pest density at which control efforts are triggered to prevent populations from reaching the EIL

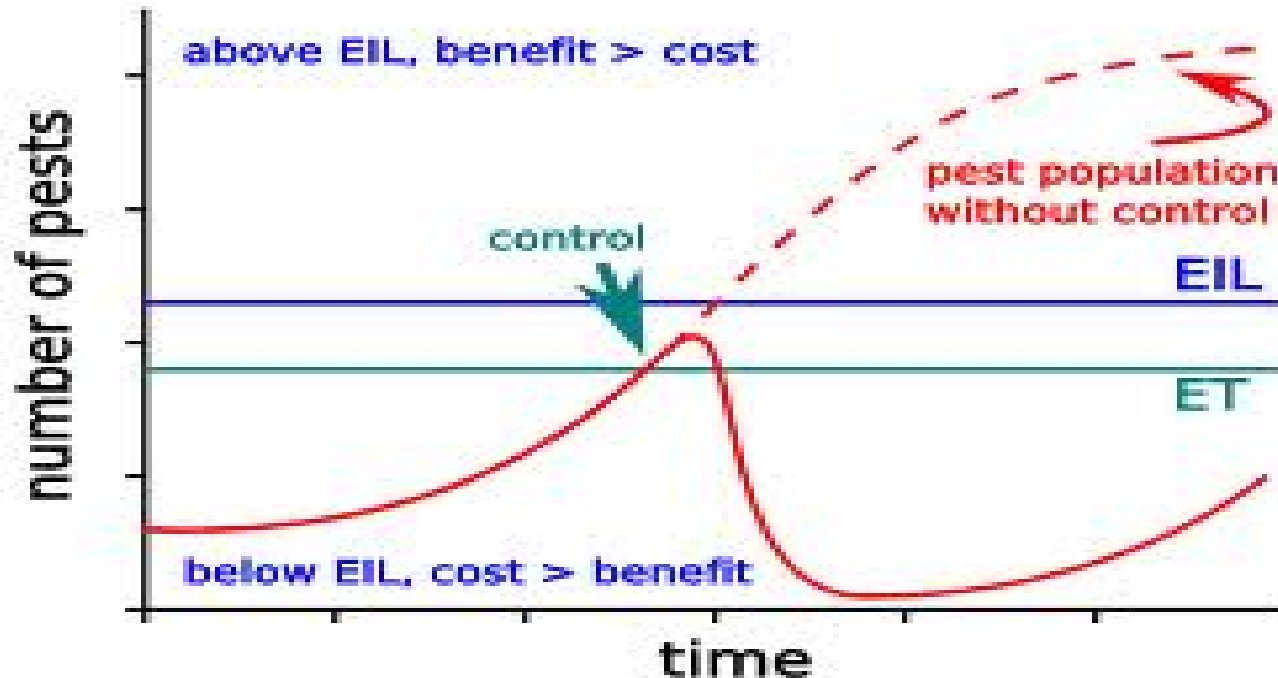
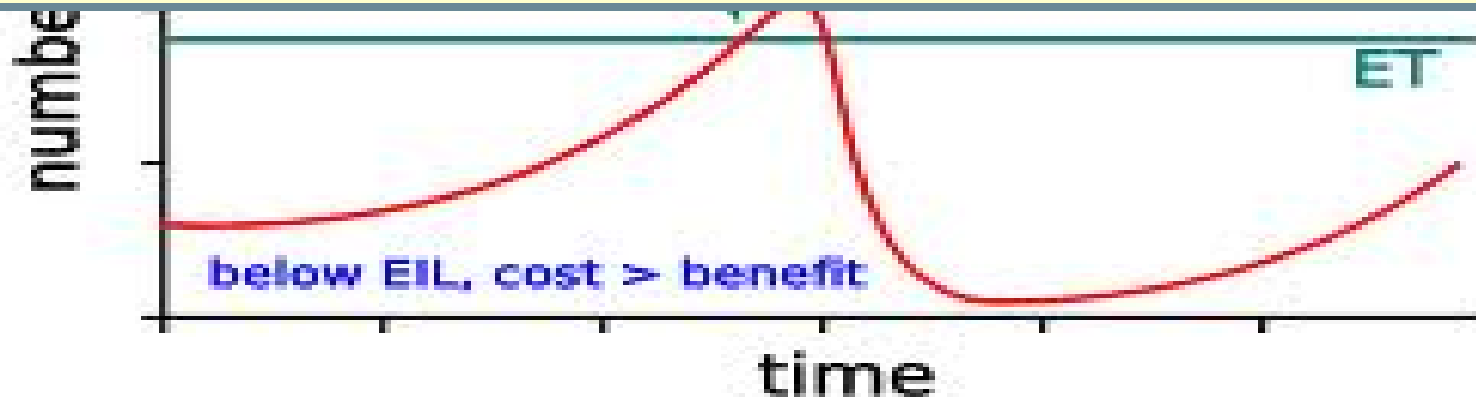


Figure Source: Geoff Zehnder, eOrganic (<http://articles.extension.org/pages/19198/overview-of-monitoring-and-identification-techniques-for-insect-pests>)

# Thresholds

above EIL, benefit > cost

True thresholds are based on scientific studies done over several years. This has not been done for most hops pests.



# Timing “Windows”

- Crops have “windows of vulnerability” to pests
- Pests also have “treatment windows” – times when they are at a life stage that is vulnerable to control measures, or when they have reached damaging levels

A pest is a “problem” when it is present in sufficient numbers at a time when the plant is vulnerable to attack



# Is there damage to the cone?



# Is there potential for damage to the cone?





# Potential for spread/systemic infection/plant death?



**Is damage to non-harvestable parts  
severe enough to significantly affect  
growth/cone production?**





# How widespread is the pest?



# Mitigating factors (e.g. weather/natural enemies)?

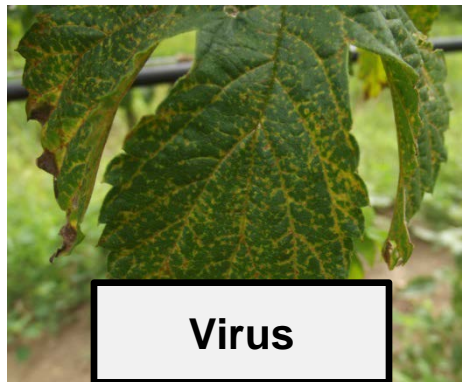




# Hop Pests in Ontario (so far...)



**Downy Mildew**



**Virus**



**Spider Mite**



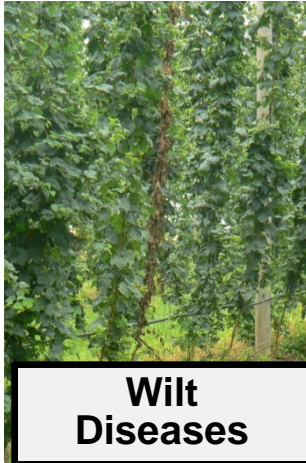
**Potato Leafhopper**



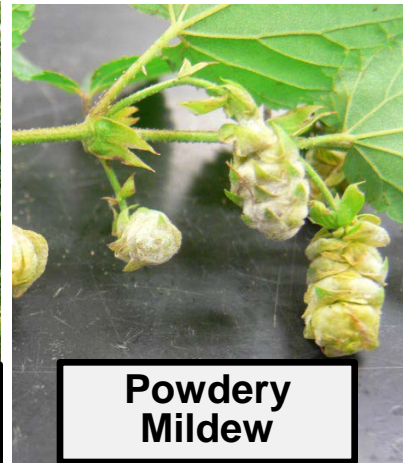
**Cone Diseases**



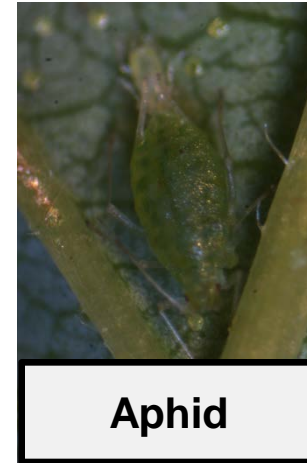
**Japanese Beetle**



**Wilt Diseases**



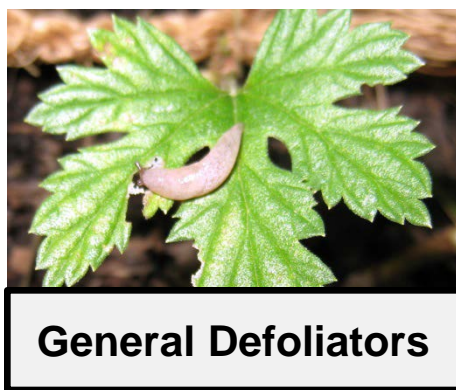
**Powdery Mildew**



**Aphid**



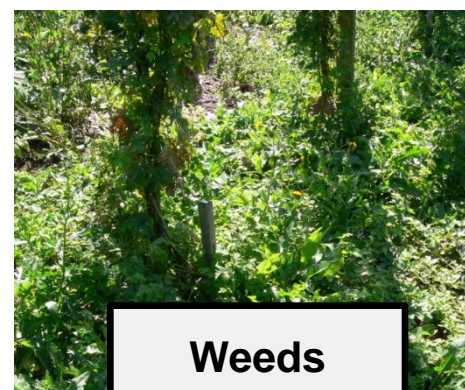
**Caterpillars**



**General Defoliators**



**Leaf Blights**



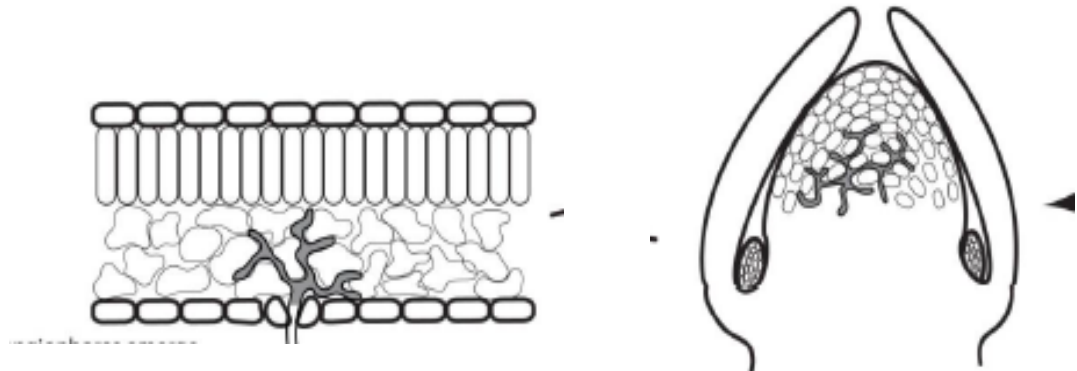
**Weeds**



# Downy mildew

*Pseudoperonospora humuli*

- Most important disease of hops In Ontario
- Fungus-like organism
- Specific to hops
- Affects all plant tissue (leaves, stem, cones, rhizomes)
- **Localized and systemic infections**
- Reduces yield and quality
- In severe cases, can cause plant death



Figures: V. Brewster, *Compendium of Hop Diseases and Pests*



- Infection favoured by wet conditions, mild to warm temperatures and prolonged leaf wetness
- Crop loss depends on variety susceptibility, timing of infection and environmental conditions but can be up to 100%
- Disease have strains which can behave differently
- Strains vary between locations and years



Photo: B. Englehard, Field Guide for Integrated Pest Management in Hops



Photo: D. Ghent, Field Guide for Integrated Pest Management in Hops

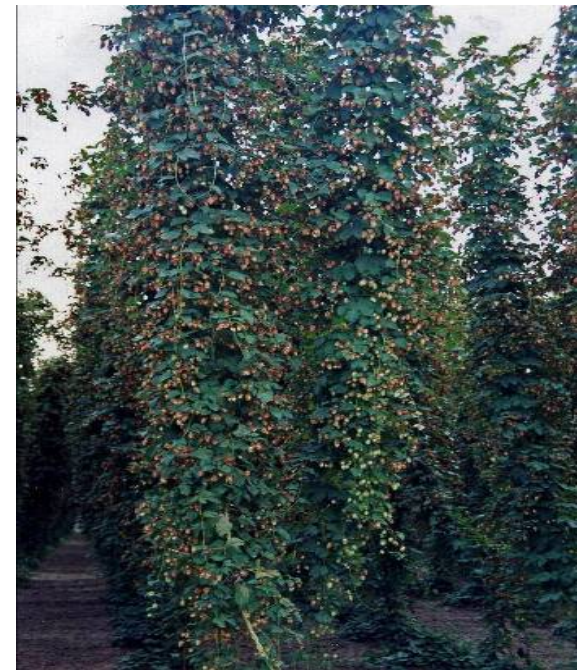
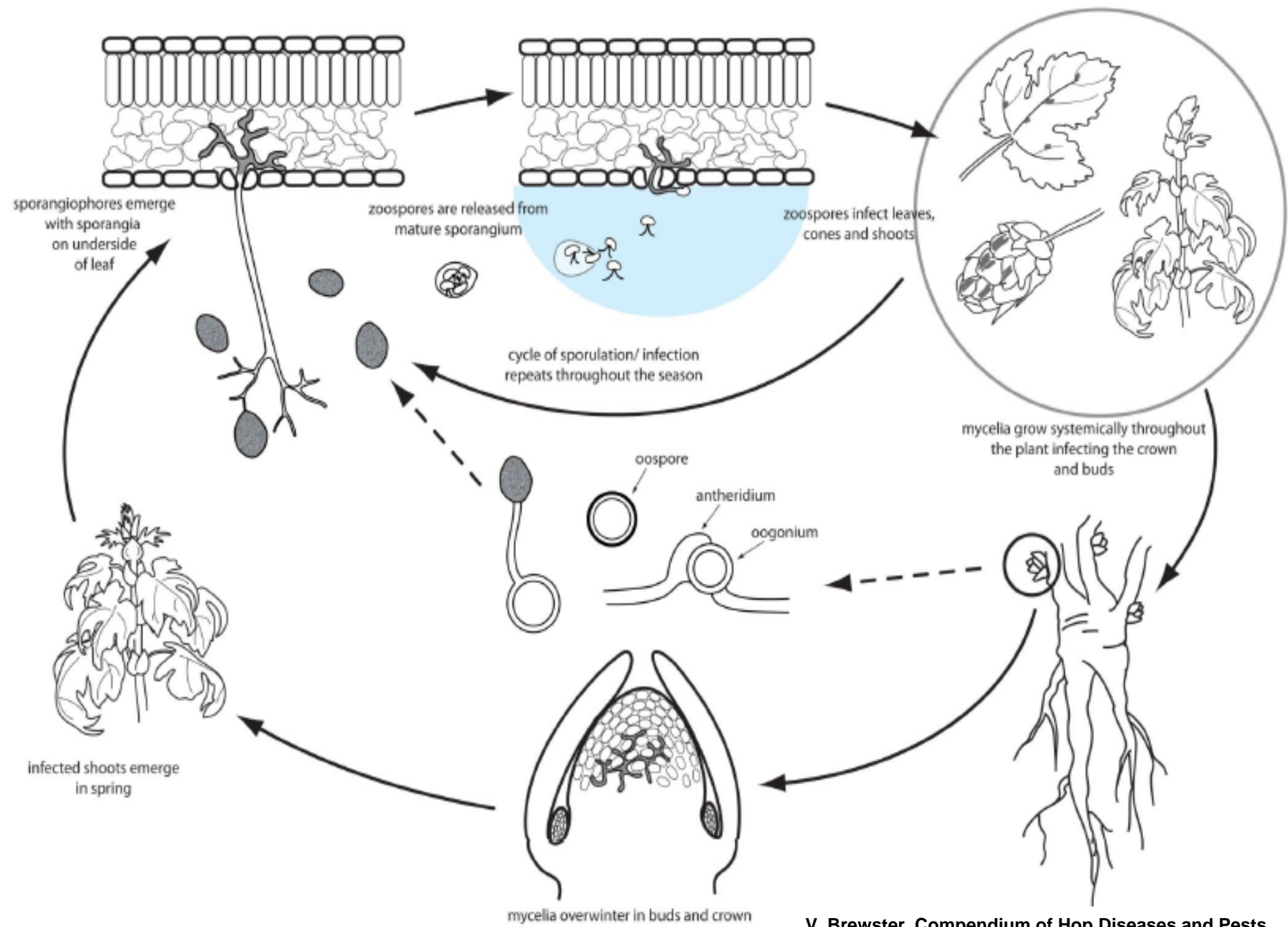


Photo: D. Gent, Compendium of Hop Diseases and Pests



# Winter



**Overwinters  
in dormant  
crowns/buds**

# Early Spring



*Diagram: V. Brewster*

**Moves into  
developing  
buds**



# Spring



*Diagrams: V. Brewster*



**Infected  
shoots/basal  
spikes  
emerge**

**SYSTEMIC**



# Spring

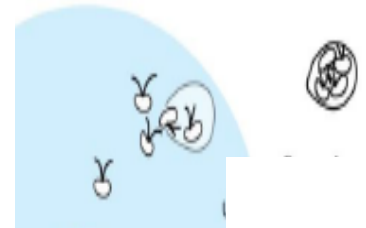
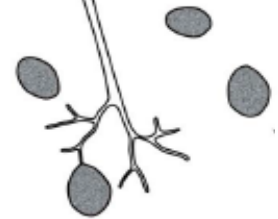
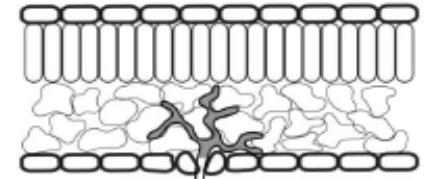
# SYSTEMIC



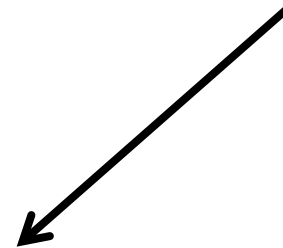
**Basal spikes**



**Sporulation  
under spikes**

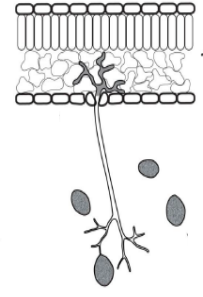


# LOCALIZED



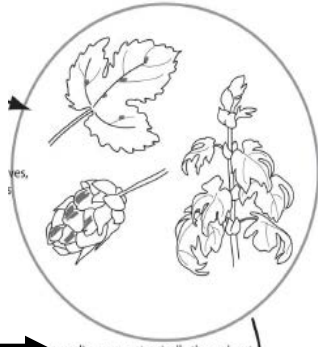
**Spores produced from  
spikes infect adjacent  
hop tissue**

# Spring/Summer



**Leaf spots then sporulate**

**Spores also blow in from outside yard!**



**Repeated cycles of infection on all parts of plant**

**LOCALIZED**

*Diagrams: V. Brewster, Compendium of Hop Disease and Pests*



# Summer



Repeated cycles of infection



Leaf infections eventually dry out



Infection of growing point can produce a new systemic infection



Systemic growth moves down the plant



And into the crown

**NEW SYSTEMIC**



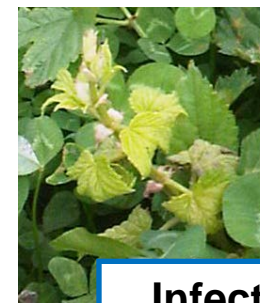
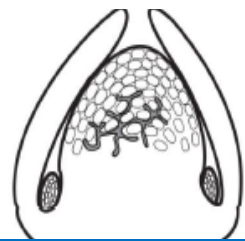
# Fall



# Fall/Winter

# Early Spring

# Spring



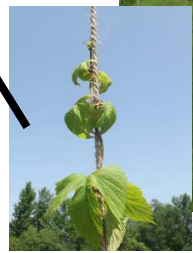
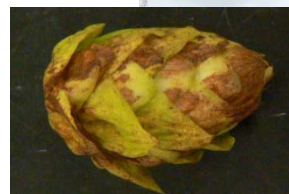
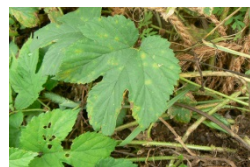
**Crown**

**Developing buds**

**Infected shoots**

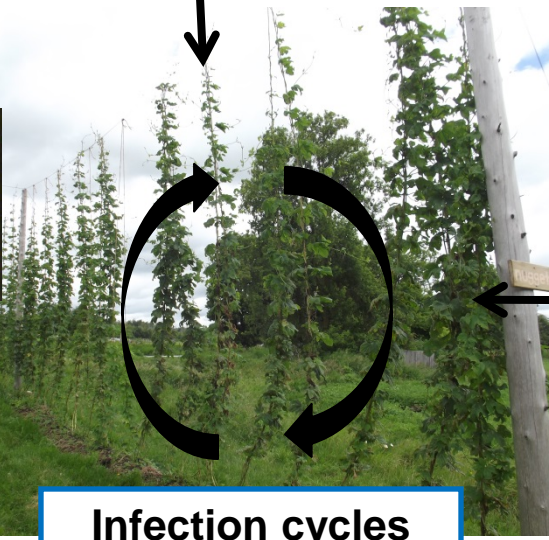


**Moves down plant**



**Growing point infections become systemic**

**Spores from outside yard**



**Infection cycles**

# Spring/Summer



**Spread up plant**



Diagrams: V. Brewster, Compendium of Hop Disease and Pests

# Management

## Fall/Winter



Crown

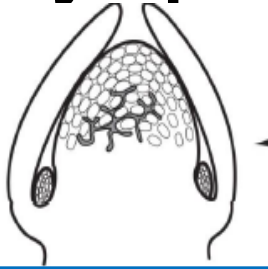


- Start with clean plants!
- Consider purchasing a small quantity of plants and having them tested if you haven't worked with nursery before
- Avoid planting susceptible varieties (Nugget, Centennial, Cluster, Galena)
- Do not locate new yards near heavily infested older ones



# Management

## Early Spring



Developing buds

Diagram: V. Brewster,

- Early season fungicide – Ridomil Gold (some systemic activity)
- Remove/destroy of infected buds/shoots in early spring by pruning/crowning:
  - Crowning – removal of top 2-5 cm of crown prior to budbreak
  - Scratching – Removing buds from crowns within 2-5 cm of soil surface
  - Pruning – Removal of shoots prior to training
- “Hilling up” soil on top of crowns after mechanical pruning – encourages root development and buries diseased shoots
- Begin scouting
- Continued removal of diseased shoots

## Spring

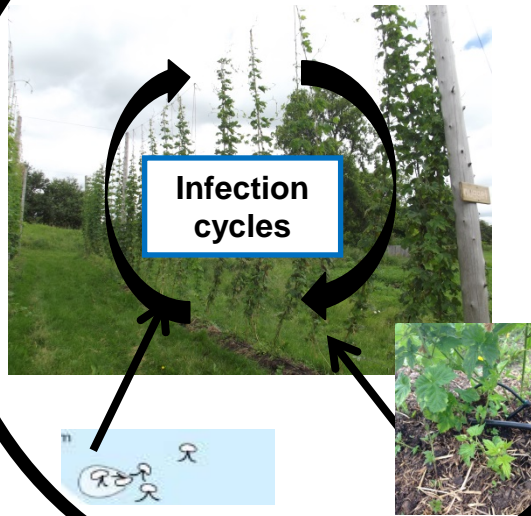


Infected shoots



# Management

Spring/Summer



- Remove extra basal foliage ASAP after training
- Minimize moisture in hop yard:
  - Mow cover crop
  - Stripping (removing lower 1.5 m of foliage)
  - Avoid overhead irrigation
- Continue removal of basal spikes
- Regular fungicide sprays



# Hop Viruses

- Numerous viruses known to infect hops worldwide
- May cause:
  - mottling, stunting, fewer laterals, smaller cones
  - no symptoms other than reduced yield
  - no symptoms for years until favourable environmental conditions occur
- Symptoms vary with virus and variety
- Sometimes confused with a nutrient deficiency
- Confirmation usually requires laboratory submission
- Widespread in Ontario hops



**Infected**

**Healthy**





**Apple Mosaic Virus:**

- Most significant - up to 50% yield and a-acid loss
- Spread mainly by propagation and mechanically
- Symptoms vary with weather



**Hop Stunt Viroid:**

- 50-65% yield loss, loss of a- and b- acids
- Spread only mechanically or plant-to-plant
- Symptoms and yield loss occur only 3-5 years after infection



**Carlavirus Complex:**

- Spread by aphids , mechanically or propagation
- Generally no visual symptoms except on certain cultivars
- HMV most likely to cause symptoms
- Reduced growth, generally yield losses around 15%



**Hop Latent Virus:**

- Up to 70% yield loss in susceptible varieties but in most only mild yield and a-acid loss

**Hop Mosaic Virus:**

- >60% yield loss in susceptible varieties

**American Hop Latent:**

- Mild yield and a-acid loss



# Virus Management



- No treatment after infection – focus is on prevention!
- Start a yard with **clean plants**
- **Clean Plants** = propagation material that is virus-free

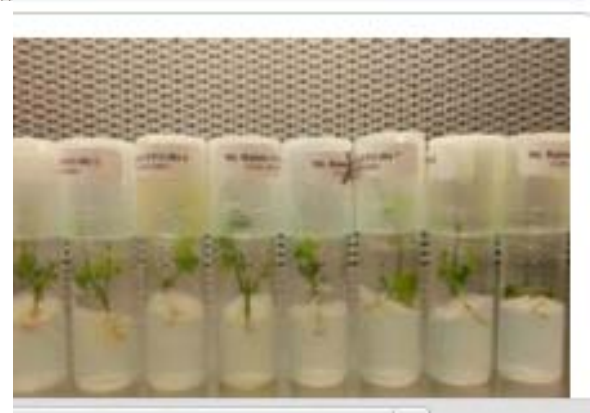


# Clean plants

- Micropropagation – use of plant tissue culture methods to grow plant cells in an sterile manner
- “Clean-up” viruses
- For hops – done by the Clean Plant Center Northwest

## Clean Plant Center Northwest-Hops

The National Clean Plant Network-Hops (NCPN-Hops) was added to the NCPN in 2010. The clean plant center for hops is located within the Clean Plant Center of the Northwest at Washington State University (IAREC) in Prosser, Washington. The NCPN Hops Tier 2 directory and charter are accessible.



*Photo: [nationalcleanplantnetwork.org/National\\_Clean\\_Plant\\_Centers/Clean\\_Plant\\_Center\\_Northwest\\_Prosser\\_WA/HOPS/](http://nationalcleanplantnetwork.org/National_Clean_Plant_Centers/Clean_Plant_Center_Northwest_Prosser_WA/HOPS/)*

- Typically, CPN hops go to propagators/nurseries. Growers buy from propagators
- To stay clean, nurseries must ensure plants are not re-infected with viruses as they propagate the plants
- Just because plants originally came from the CPN does not mean they are still clean!!!

# When purchasing propagation material....

- Where did the mother plants originate?
- How many generations away from these mother plants?
- How are the plants stored (e.g. a greenhouse; outdoors, but far from other yards)?
- What is the propagation protocol (sanitizing cutting tools, do they always enter the nursery first, etc.)?
- If purchasing rhizomes, can you look at plants in year prior to purchase to look for disease symptoms (BUT sometimes virus symptoms not visible)?
- Do they test their plants and will they provide documentation showing that (note - ON propagators haven't been able to do this prior to this year). If tested, is it based on visual symptoms (common in some states) or genetic tests?
- Any guarantee or warranty for plants exhibiting symptoms within first months/year?
- **Talk to other growers**
- **Purchase a few plants and have them tested**



# Virus Management



- No treatment after infection – focus is on prevention!
  - Starting with **clean plants** is the main line of defense
  - **Clean Plants** = propagation material that is virus-free
- 
- If it is present in your yard:
    - Always work in virus-infested or older yards LAST
    - Sanitize knives and cutting tools with disinfectant
    - Thoroughly wash farm equipment to remove plant residue and sap
    - Consider chemical rather than mechanical means for stripping
    - With localized infection, rogue out infected and adjacent plants, making sure to remove as much of the roots as possible
    - With significant infection, removal of entire yard may be necessary
  - **You still may get virus despite all of this. Your goal is to delay it as long as possible**

# Powdery mildew

*Podosphaera macularis*

- Fungus – specific to hops
- Powdery fungal colonies on leaves, buds, stems and cones
- Infection favoured by rapid plant growth, mild temperatures, high humidity and cloudy weather
- 20-80% crop loss, more of a quality problem (aroma hops)
- To date, more of a problem in the Pacific northwest



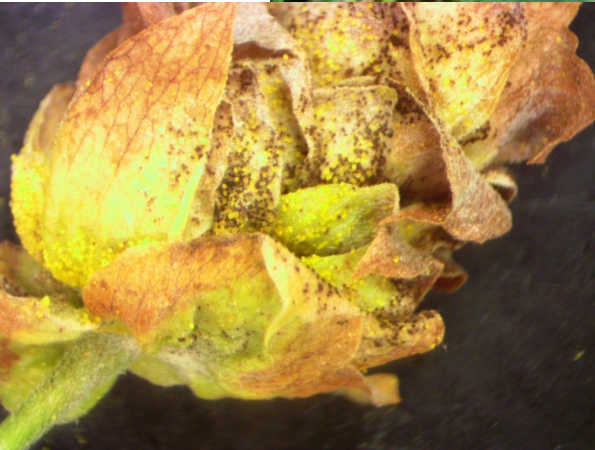
Photo: David Gent



Photo: David Gent

5393902

# Simcoe Research Station



- 2014 – minor infection observed
- No preventative sprays in 2015 but regular scouting
- 1<sup>st</sup> observed in large quantities Aug 4
- Likely began mid to late July
- Some varieties more severely affected than others
- Reports from 2 other hop yards in ON, some in Quebec
- Lesson learned: Can spread extremely rapidly. Easy to miss. Preventative sprays or **extremely** close monitoring may be needed.



# Cone Diseases



**Downy Mildew**



**Powdery Mildew**



**Alternaria**



**Grey Mould**



- Several pathogens cause browning of cones
- Alternaria and Grey Mold caused by secondary pathogens that invade weakened tissue
- Often occurs when plants damaged by wind, mechanical injury or damage from other pests are exposed to wet or humid conditions
- Control other pests, keep plants healthy, locate yards in less exposed areas, avoid wind or other damage



# Wilt Diseases

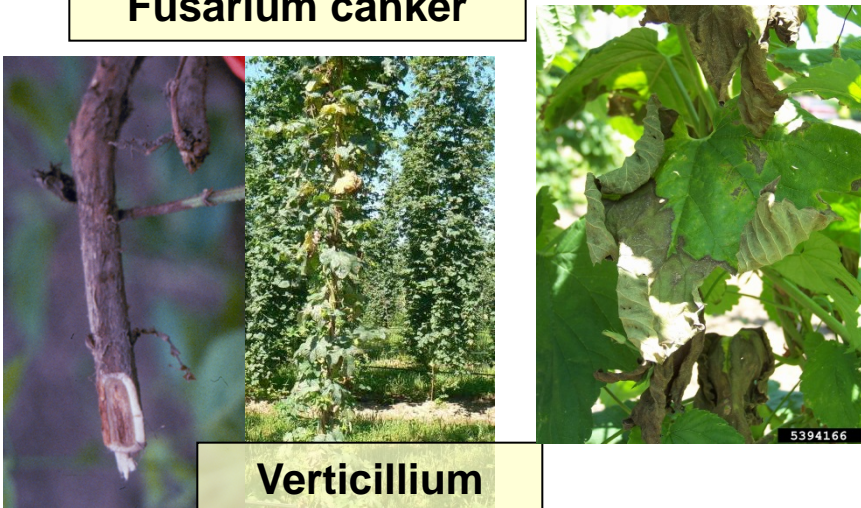


- Fusarium canker:
  - Rots plant at base of bine
  - often enters plant when bine is injured
  - Minimize injury to bines, reduce moisture around crown, hill soil



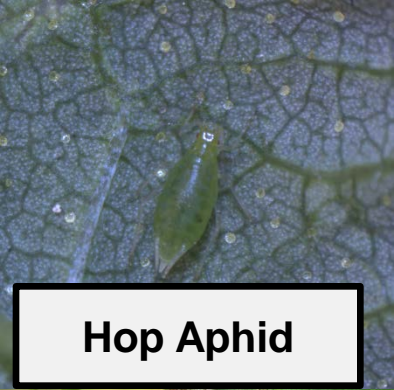
**Fusarium canker**

- Verticillium wilt:
  - Soil fungus invades root and clogs up vascular system
  - Avoid fields with a history of verticillium wilt
  - Use clean plants



**Verticillium**





**Hop Aphid**



**Cutworm**



**Slug**



**Japanese Beetle**



**Flea beetles/  
fleahoppers**



**Earwigs**

# Hop Insects



**Rose Chafer**



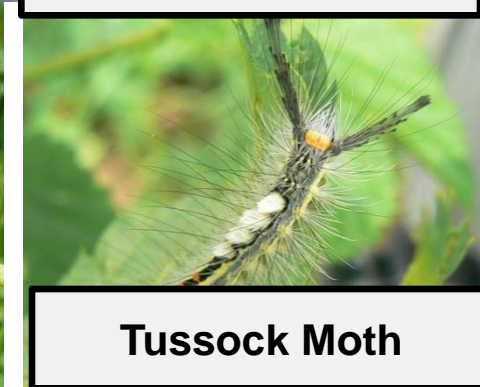
**Potato Leafhopper**



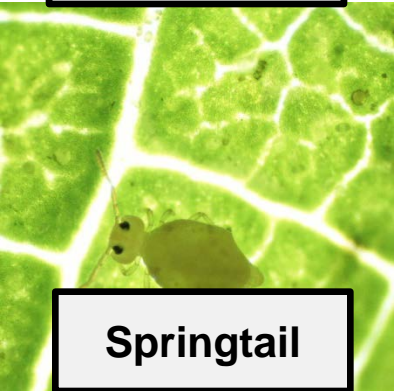
**Spider Mites**



**Grasshopper**



**Tussock Moth**



**Springtail**



**Hop Looper**



**Hop Merchant**



**Various social caterpillars**



# Two-spotted Spider Mite

*Tetranychus urticae*

- Very small animals related to spiders/ticks
- Use mouthparts to scrape individual plant cells, causing stippling and bronzing
- Feeding on leaves and cones reduces cone quantity and quality
- Thrive in hot, dusty conditions, favoured by disruption of predators, high fertility, certain cultural practices
- Populations can develop quickly
- Several registered miticides
- Often controlled by natural enemies



Photo: [www.freshops.com](http://www.freshops.com)



Photo: Washington State University



Photo: Washington State University

# Potato leafhopper

*Empoasca fabae*



- Winged sucking insect carried to ON alfalfa by storm systems in late spring
- Move to other crops after the first cut of hay in June
- Injects toxin, blocking movement of water and nutrients
- Significant damage - leaf necrosis, stunted growth and reduced cones
- More severe on young hops
- No registered products! Some effect of aphid products?
- Difficult to control with predators
- Avoid planting near hay or grapes
- Trap crops? Unmowed red clover in drive row?
- In ON, less damage on Galena, Centennial, Zeus, Chinook

# Hop aphid

*Phorodon humuli*

- Small sucking insect
- Suck water and nutrients from plant tissues causing curling, wilting, defoliation
- Secrete honeydew which encourages development of “sooty mould”
- Yield loss but most commonly cone quality loss due to sooty mould
- Transmit viruses
- Several registered products
- Often controlled by predators in Ontario



Photo: David Gent, USDA



Photo: David Gent,

5393919



# Japanese Beetle



- Invasive pest with very wide host range
- Feeding often near top of wire
- Migrate into hops in late June-early July
- Very significant defoliation in some yards
- No registered products, no thresholds
- Mostly a problem in southwestern Ontario

# Don't discount natural enemies!



- Very active in Ontario hop yards
- Presence can help delay or prevent need for control of some pests (e.g. aphids)
- Count beneficials when monitoring for pests
- Consider impact on beneficials when selecting pest control products



# Weed Management

- Very important, especially in young hop yards
- Impact growth and yield by competing for nutrients and water
- Impede airflow through canopy and can harbour pests
- Interfere with spraying, training, harvest







Lambsquarters



Pigweed



Canada  
Thistle



Bindweed

- Summer annual weeds – germinate in spring/summer, make seed in late summer then die. Interfere with summer activities
- Winter annual weeds – germinate late summer/fall, overwinter, flower and make seed in spring, die in early summer. Little direct impact on hop growth but interfere with spring activities and can harbour other pests
- Perennial weeds – live for > 2years and spread from vegetative parts. More difficult to control.

# Weed Management

- Know the weed species present
- Keep weeds from entering field (clean equipment, control weeds around field borders, etc.)
- Cultivation or mowing for weeds between row – typically from early spring through July (when fibrous root system begins to grow). Shallow to avoid bringing new weed seeds to surface.
- Organic mulches – grow cover crop, mow and blow residue onto crown. Can also affect other pests.
- Within row: hand weeding, mulches, chemicals
- Only 2 herbicides registered in ON hops – Poast (180 day PHI) and Aim EC



- Sheep – used in some yards in Michigan and Ontario to control weeds and bottom growth
- Exercise caution when using sheep with other pesticides (especially copper)
- Copper is toxic to sheep!



# Pest control products for hops

- Current list of registered products posted on blog:

<https://onspecialtycrops.wordpress.com>

Look for post dated 2016/03/18

**ONspecialtycrops**



Home **Hops** Ginseng Sweet Potato Specialty Vegetables Specialty Grains Specialty Fruit and Nuts

Industrial and Misc. Crops

← OMAFRA IPM Scout Training Workshops for 2016

## Pest Control Products for Ontario Hops 2016

Posted on March 18, 2016 by Melanie Filotas

As the growing season approaches, we are starting to get questions about what's currently registered on hops in Ontario. A current list for 2016 can be found at the link below. Note that pesticide registrations are always changing, so be sure to check this blog periodically for updates to this list.

[Hops Pesticides 2016](#)

As always, this list does not replace the need for growers to thoroughly read product labels

### Pest Control Products Registered for Use on Hops in Ontario - 2016

This table lists pest control products registered on hops in Ontario as of March 17, 2016. This list is intended as a guide and does not replace current product labels. Labels and product registrations status can change. Always read the label thoroughly before applying a pest control product and follow all label instructions. Various federal and provincial regulations govern the use of pesticides on all crops in Ontario. It is the grower's responsibility to be aware of these regulations. More information on the use of pesticides in Ontario can be found on the OMAFRA website at [www.ontario.ca/usingpesticides](http://www.ontario.ca/usingpesticides)

TABLE 1 - INSECT CONTROL FOR HOPS IN ONTARIO

#### LEGEND

**Group:** Chemical group number for a pest control product established by the Insecticide Resistance Action Committee (Insecticides), Fungicide Resistance Action Committee (fungicides) or Weed Science Society of America (herbicides) based on mode of action for resistance management planning.

**REI:** Restricted Entry Interval. Do not enter treated fields unprotected until after the REI has passed. For some hop products, the REI varies with the activity. If the REI is not specified, assume a 12-hr REI.

**NS:** Not specified on label.

**PHI:** Pre-Harvest Interval. The required time period between the last spray and the first harvest.

Group	Active Ingredient	Trade Name	Rate	REI	PHI	Notes
<b>HOP APHID</b>						
4	imidacloprid	Admirer 240 DF	230 mL/ha	24 hrs	28 days	Allow at least 21 days between applications. No more than 2 foliar applications per season.
9C	flonicamid	Beleaf 50 SG	0.12 – 0.16 kg/ha	31 days (stripping and training) 12-hrs (all other activities)	31 days	Apply as populations begin to increase and before damaging levels become established. Apply in sufficient water to ensure good coverage (minimum 94 L/ha); increase spray volume when foliage is dense. Allow at least 7 days between applications. No more than 3 applications per year.
23	spirotetramat	Moverto 240 SC	365-435 mL	12 hrs	7 days	Apply early in infestation as populations begin to develop. Use a minimum application volume of 500 L water/ha. Apply with an adjuvant as specified on product label. Allow at least 14 days between applications. No more than 820 mL/ha Moverto 240 SC permitted per season.

# Pest control products

- Limited selection of products compared to US
- Why?
  - Lack of residue data
  - Lack of efficacy data
  - Under re-evaluation
  - Company will not register here
- Be cautious with pesticide advice from US industry – the onus is on you to ensure the product you are applying is legal!

Herbicides registered for use on hops in Michigan 2015							
Trade name	Common name	WSSA code <sup>1</sup>	Pre- or post emergence	Weeds controlled: broad-leaf or grasses	Notes	PHI <sup>2</sup>	REI <sup>3</sup>
2,4 D— many formulations available	2,4 D	4	post emergence	broadleaf	See labels for rates and timing. Use as a directed spray to row middles. Ester* formulations restricted in certain townships in Berrien, Van Buren and Cass County: May 1-October 1.	28 d	48 hr
Aim EC	carfentrazone	14	post emergence	both— burn-down and sucker control	Use shielded or hooded sprayers. 0.5-2.0 fl oz/A. No more than 7.6 fl oz/A/season. Allow 19 d between treatments.	7 d	12 hr
Chateau Herbicide SW	flumioxazin	14	preemergence	both	No more than 6 oz/A. Apply Jan -Mar as a 1-1.5 ft. band to dormant hops. See label for sucker control directions.	30 d	12 hr
Finalsan Total Vegetation Killer	ammoniated soap of fatty acids	***	postemergence	both	26 oz/1 gallon water; 2.0-5.0 gallons/1000 sq ft or as spot treatment. Avoid spraying desirable plants. OMRI listed.	***	24 hr
Gramoxone and other formulations	paraquat	22	post emergence	both— burn-down and sucker control	Not registered for use on hops in Michigan- WA, OR, ID only. RUP	14 d	24 hr
Roundup and other formulations	glyphosate	9	post emergence	both	Apply only when green shoots, foliage or canes are not in the spray zone.	14 d	4 hr
Scythe	pelargonic acid	27	post emergence	both— burn-down	Uses in hops-vegetative burn-down, directed spray, prior to crop emergence, dormant or post harvest spray.	24 hr	12 hr
Select Max	clethodim	1	preemergence	grasses- annual and perennial	Annual grasses-9-16 fl oz; perennial grasses-12-16 fl oz. Use NIS at 0.25% v/v.	21 d	24 hr
Solicam DF	norflurazon	12	preemergence	both	Rate determined by soil type- wait 6 months after planting for first application.	60 d	12 hr
Treflan 4EC, Treflan HFP, Treflan TR-10	trifluralin	3	preemergence	annual grasses and broadleaf weeds	Rate determined by soil type- see label. Apply during dormancy.	***	12 hr

# Organic products

TABLE 4 - POTENTIAL ORGANIC PRODUCTS FOR HOPS IN ONTARIO

Products listed in this table may be acceptable for organic production. However, by all certification bodies. Always check with your organic certification body before rates and other application instructions, refer to the entry for each product in Table

Product	Active Ingredient	Label
<b>INSECTICIDES</b>		
<i>Bacillus thuringiensis</i>	Dipel 2X DF	Hop looper, European corn
	Bliprotec CAF	
mineral oil	Purespray Green Spray Oil 13 E	Aphids, spider mites
potassium salts of fatty acids	Kopa Insecticidal Soap	Aphids, spider mites
	Opal Insecticidal Soap	
	Neusodan Commercial	
<b>FUNGICIDES</b>		
copper sulphate	Copper 53 W	Downy mildew
mineral oil	Purespray Green Spray Oil 13 E	Powdery mildew
potassium bicarbonate	MiStop	Powdery mildew
	Sirocco	
<i>Reynoutria sachalinensis</i> extract	Regalia Maxx	Downy mildew
Not permitted for use after July 12, 2018	Not permitted for use after July 12, 2018	
<b>HERBICIDES</b>		
None currently registered on hops.		

OMRI listed Insecticides labeled for use on hops in Michigan 2015 <sup>1</sup>							
trade name	common name	IRAC <sup>2</sup> group	pests	Japanese beetle listed elsewhere on label <sup>3</sup>	rates/notes	PHI <sup>4</sup>	REI <sup>5</sup>
Kumulus	sulfur		spider mites	no	2-4 lb/A. Do not use within 2 weeks of an oil treatment.	0 d	24 hr
Mycotrol O	<i>Beauveria bassiana</i>	biological	aphids, thrips	no	0.25-1.0 qt/A. Read label for adjuvant and tank mix restrictions.	0 d	4 hr
Omni Supreme spray	mineral oil	M	spider mites, powdery mildew	no	1-2 gal/100 gal water/A. Discontinue use at burr development. Do not mix with sulfur or apply within 30 d of a sulfur application.	0 d	12 hr
Purespray green	mineral oil	M	aphids, mites, powdery mildew, whiteflies	no	1-2 gal/A in a minimum of 50 gal water/A. Discontinue at burr development. See label for sulfur and other pesticide application restrictions.	0 d	4 hr
PyGanic EC 1.4	pyrethrins	3A	aphids, Japanese beetle, loopers, thrips	yes	1 pt-2 qt/A	0 d	12 hr
PyGanic EC 5.0					4.5-17 fl oz/A		
Sil-matrix	Potassium silicate		aphid, mite suppression	no	2-4 qts/100 gal	0 d	4 hr
SuffOil-X	mineral oil	M	aphids, mites, powdery mildew	no	1-2 gal/100 gal water- 70-100 gal/A	0 d	4 hr
Surround WP	kaolin clay		suppression of thrips	yes	25-50 lb/A	0 d	4 hr
Trilogy	azadirachtin (neem oil)	UN	PM, anthracnose, spider mites	no	0.5-1.0% in 25-100 g/A	0 d	4 hr
XenTari DF	<i>Bacillus thuringiensis</i> (B.t.)		armyworms				hr

Registered, company not selling in Canada



# It's getting better....

## NOT YET REGISTERED ON HOPS IN CANADA, BUT AT VARIOUS STAGES OF DATA GATHERING/REVIEW

- Kanemite (acequinocyl) for mites
- Success/**Entrust** (spinosad) for loopers
- Fulfill (pymetrozine) for aphids
- **Pyganic** (pyrethroids) for aphids and leafhoppers
- Presidio (fluopicolide) for downy mildew
- **Regalia Maxx** (*Reynoutria sachalinensis*) for downy mildew and powdery mildew
- **Rootshield** (*Trichoderma harzianum*) for root diseases
- Orondis (oxathiapiprolin) – downy mildew
- Alion (indaziflam) for weeds
- Select/Centurion (clethodim) for grassy weeds

# Resistance Management!

Group	Active Ingredient	Trade Name	Rate
<b>DOWNY MILDEW (continued)</b>			
40	dimethomorph	Acrobat 50 WP	450 g/ha
		Forum	450 mL/ha
	mandipropamid	Revus	800 mL/ha
40/45	ametoctradin + dimethomorph	Zampro	0.8-1.0 L/ha
M	copper sulphate	Copper 53W	4-5 kg/1000 L
P5	Extract of <i>Reynoutria sachalinensis</i>	Regalia Maxx Emergency Use Only. Not permitted for use after July 12, 2016.	0.25-0.50% v/v (2.50-5.0 mL/L or 1.875-3.75 L product/750 L water)

<b>DOWNY MILDEW</b>			
4	metalaxy-m and s-isomer	Ridomil Gold 480 SL	570 mL/ha
21	cyazofamid	Torrent 400 SC	0.15-0.2 L/ha

- Some hops pests, like downy mildew and spider mites, can develop resistance very quickly
- Rotate between products from different fungicide/insecticide groups

# Other notes

Active Ingredient	Trade Name	Rate	REI	PHI	
RY MILDEW					
Quinoxifen	Quintec	300-500 mL/ha	12 hrs	21 days	S w d t v p
boscalid + pyraclostrobin	Pristine WG	0.105 kg/ 100 L dilute spray	8 days (hand set irrigation) 46 days (harvesting) 12 hrs (all other activities)	46 days	A n e d 4 P s P N s

Registration No. <sup>1</sup>	Trade Name	Active Ingredient	Guaranteed Active	Ontario Class <sup>2</sup>
27925	Acramite 50 WS	bifenazate	50%	4
27700	Acrobat 50 WP	dimethomorph	50%	3
24094	Admire 240	imidacloprid	240 g/L	4
24551	Agri-mek 1.9% EC	abamectin	19 g/L	3
28573	Aim EC	carfentrazone-ethyl	240 g/L	3
29796	Beleaf 50SG	flonicamid	50%	4
26854	Bioprotec CAF	<i>Bacillus thuringiensis</i> var <i>kurstaki</i> strain EVG113-19	8.12%	3
9934	Copper 53W	copper sulphate	53.4%	3

- Long re-entry, pre-harvest intervals for some products can affect your activities in the yard
- You must be considered a commercial grower to use commercial pesticides
- You must be certified to purchase and use Class 2 and 3 pesticides
- Ontario Pesticide Safety Program:

Trade Name	Rate	REI	
Admire 240 DF	230 mL/ha	24 hrs	28
Beleaf 50 SG	0.12 – 0.16 kg/ha	31 days (stripping and training) 12-hrs (all other activities)	31
Movero 240 SC	365-435 mL	12 hrs	24



# Coverage is critical!



- Airblast sprayer
- Must reach top and bottom of plant,
- Leaf upper and underside
- Use adjuvant when specified on the label

# Tying it all together – Before you plant

- **Plant the cleanest hops you can acquire!**
  - Consider testing plants before purchase
- Consider resistant/tolerant varieties:
  - Downy Mildew – Tolerant: Magnum, Perle, Orion, Wye Challenger; Susceptible: Cascade, Centennial, Chinook, Columbus, Nugget
  - Powdery Mildew – choose early maturing varieties
  - Leafhopper – Tolerant: Galena, Centennial, Zeus, Chinook; Susceptible: Sterling, N. Brewer, Hallertauer, Crystal, Liberty, Fuggle, Mt. Hood, Tettnager, Santium, Newport
- Location:
  - Away from hay, grapes, turf (?)
  - Avoid past history of Verticillium
  - Away from older, infested hop yards
  - Avoid very exposed areas with high potential for wind damage (but not too sheltered)
- Drip irrigation rather than overhead

# Tying it all together – in season

- Early season removal of infected shoots (crowning/pruning)
- Remove extra foliage after training
- Stripping lower leaves once plants are tall enough
- Rogue out isolated plants with virus, wilts (veriticillium, etc.)
- Timely application of fungicides for downy mildew
- Close attention to powdery mildew
- Release of natural enemies for mites if problematic
- Un-mowed red clover for leafhopper?
- Minimize injury to vines by spraying, wind, mowing, pests
- Fertility, irrigation adequate but not too high
- Irrigation timed to minimize leaf wetness
- Frequent scouting



Crowning/pruning  
Ridomil spray

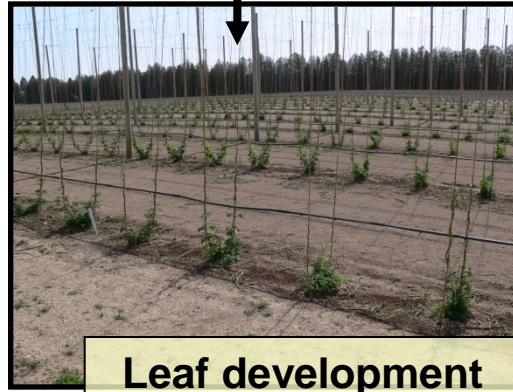


**Sprouting**

DM spray



Remove excess  
basal foliage



**Leaf development**

DM spray



Start watching  
for PLH,  
TSSM



**Bine elongation**

Stripping



DM spray  
PM (if needed)



DM spray  
Miticide, PM (if  
needed)



Closely watch  
for PM



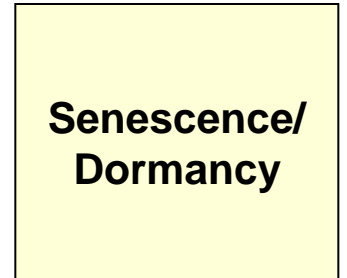
DM spray



**Flower development**



**Cone development**



**Senescence/  
Dormancy**

\*Summer  
solstice\*

# Further information...

## ON specialty crops



The screenshot shows the Ontario CropIPM website interface. At the top left is the Ontario logo. At the top right is the text "MINISTRY OF AGRICULTURE FOOD & RURAL AFFAIRS". Below the logo is the "Ontario CropIPM" title. A navigation bar contains links for "Ontario CropIPM Home", "OMAFRA Website", "Discovery", "Contact Us", and "Help", along with a "Jump to a section" dropdown. The main content area is divided into two columns. The left column, titled "Quick Choices", features three buttons: "INTRO TO IPM INTEGRATED PEST MANAGEMENT BASICS" (with a clipboard icon), "SOIL DIAGNOSTICS SOIL QUALITY, NUTRITION AND SOIL CROP INTERACTIONS" (with a shovel icon), and "WEEDS & HERBICIDES WEED BIOLOGY, IDENTIFICATION AND HERBICIDE INJURY" (with a plant icon). The right column, titled "Choose Your Crop", features a grid of six crop images with labels: "Brussels" (purple sprouts), "Cucurbits" (pumpkin), "Peppers" (green peppers), "Strawberries" (red strawberries), "Sweet Corn" (yellow corn), and "Tomatoes" (red tomatoes). At the bottom, there is a footer with "Ontario CropIPM Home | OMAFRA Website | Acknowledgements" and a small line of text: "©2014 Ontario Ministry of Agriculture, Food and Rural Affairs".

# Hops Workshops 2016

## 1) Hops Scouting and Integrated Pest Management Training

**Woodstock OMAFRA Resource Centre**

**Friday, April 8, 2016, 1:00 - 3:30 pm**

**Melanie Filotas, Specialty Crops IPM Specialist, OMAFRA**

## 2) Hops Informal Field Workshop

**Pleasant Valley Hops**

**Prince Edward County, ON**

**Wednesday, June 2016, 4:00 pm—6:30 pm**

**Melanie Filotas, Specialty Crops IPM Specialist, OMAFRA**

**Evan Elford, New Crop Development Specialist, OMAFRA**

## 3) Hops Sprayer Optimization Workshop

**Heritage Hill Hop Yard and Nursery**

**1933 Line 2 N, Shanty Bay ON**

**Wednesday, July 20, 2016 (Rain date: July 21), 9:00 am - Noon**

**Jason Deveau, Application Technology Specialist, OMAFRA**

**Melanie Filotas, Specialty Crops IPM Specialist, OMAFRA**



# Questions?

