




# Hop insects and diseases

“First the flea, then the fly; then the mould,  
then they die.” –

An old Kentish rhyme about hops



Diane Brown, Michigan State  
University Extension



# diseases to keep out of your hopyard

- Viruses and viroids
  - use planting material certified free of HSVd and other viruses is the best line of defense.
  - Purchase virus indexed stock.
  - The primary means of spread is by propagation from infected plants.
  - Unintentional propagation from infected root pieces can and does occur
  - may take 3 to 5 growing seasons before obvious symptoms of the disease appear.



**Apple mosaic virus**

David Gent, USDA Agricultural  
Research Service, Bugwood.org

# Virus testing results for hops in SWMREC test plots grown from rhizomes

<u>ACC. #</u>	<u>Sample I.D.</u>	<u>HMV</u>	<u>ApMV</u>	<u>HSVd</u>
9293-1	Sterling	Positive	Negative	Negative
9293-2	Chinook	Positive	Positive	Positive
9293-3	Galena	Positive	Positive	Positive
9293-4	Newport	Positive	Negative	Negative
9293-5	Mt. Hood	Negative	Negative	Negative
9293-6	Brewer's Gold	Negative	Positive	Negative

Virus testing lab for hop samples: ELISA lab, 24106 N. Bunn Rd. Prosser WA

<http://healthyplants.wsu.edu/contact-information/>

# Management of HpSVd

- Many plants are symptomless-
- Make sure planting material are free from HpSVd-know your source!
- Can be spread plant-to-plant mechanically- by mowing or pruning, leaf stripping-
- Viroid is present in plant sap; can survive in roots >1 yr, 3 mo. in plant debris



Foci of infected hop plants



# Management of HpSVd

- Test for presence of viroid-
- Remove and replant if possible
- Perform field operations in HpSVd free hopyards first
- Decontaminate equipment between yards-10% bleach for 10 min.



Symptoms on infected 'Glacier' hop

# Management of HpSVd

- Using contact herbicides to hold back vigorous new annual growth in spring until the proper training date for that variety and remove weak shoots in the spring is preferable to the use of mechanical mowers that may transmit the viroid.
- Removing basal vegetation later in the season by chemical rather than mechanical means also reduces the risk of transmission.

Delay in spring plant growth  
of HSVrd infected vines



Short internodes and poor  
leaf development



Cracking of bines infected  
with HSVrd



Stunted, poor growth,  
bines unwind due to  
disturbance of hooked  
climbing hairs



[http://www.fu.gov.si/en/services\\_and\\_measures/regulated\\_organisms/hop\\_stunt\\_viroid/graphical\\_material/](http://www.fu.gov.si/en/services_and_measures/regulated_organisms/hop_stunt_viroid/graphical_material/)



# Hop mosaic virus HpMV

- Transmitted by aphids- damson-hop, green peach
- Propagation, root grafts,
- Often symptomless
- most serious on varieties derived from Goldings



Photos: Compendium of Hop Diseases and Pests



# Apple mosaic virus

- Can reduce cone wt. by 50%
- Can reduce AA content by 10%
- May be symptomless
- Spreads by plant to plant contact, infected sap, and root grafts
- Use virus-indexed plants

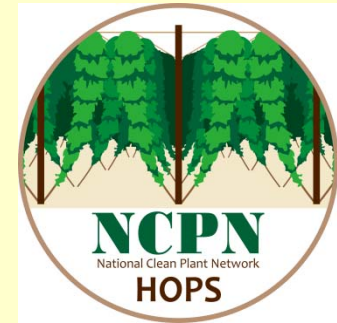


Symptoms on Columbus



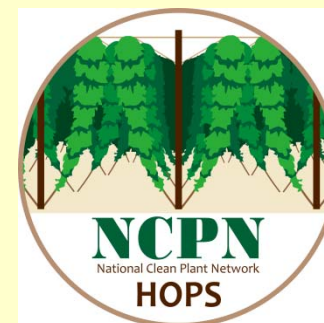
Symptoms on Nugget

# Hops Clean Plant Network



- Hop source material is tested initially for:
- **American hop latent virus\***
- Apple fruit crinkle viroid (not known to occur in North America)
- **Apple mosaic virus \*** (a.k.a. Prunus necrotic ringspot virus hop isolate)
- Arabis mosaic virus
- Hop latent viroid
- **Hop latent virus \***
- **Hop mosaic virus \***
- **Hop stunt viroid\***
- Strawberry latent ringspot virus
- Phytoplasma
- **Grown in meristem culture, tested 3x more times for \*viruses**

# Hops Clean Plant Network



- website: <http://healthyplants.wsu.edu/hop-program-at-cpcnw/>
- <http://healthyplants.wsu.edu/hop-program-at-cpcnw/purchasing-hop-material/>
- Growing hops from healthy unrooted cuttings: <http://healthyplants.wsu.edu/hop-program-at-cpcnw/growing-hops-from-unrooted-cuttings/>

# Hop cyst nematode

*(Heterodera humuli)*

- Reported in Michigan
- most common plant parasitic nematode found on hops.
- U. S., Canada, Europe, New Zealand, Australia and other locations.
- found in the soil and in and on hop roots.
- There are 1-2 generations per year.
- The cysts are brown to black, lemon-shaped and smaller than the head of a pin.
- Males are transparent and less than 1/25th of an inch long.
- Females are cream colored and lemon shaped and about 1/50th of an inch long.



Cysts containing eggs



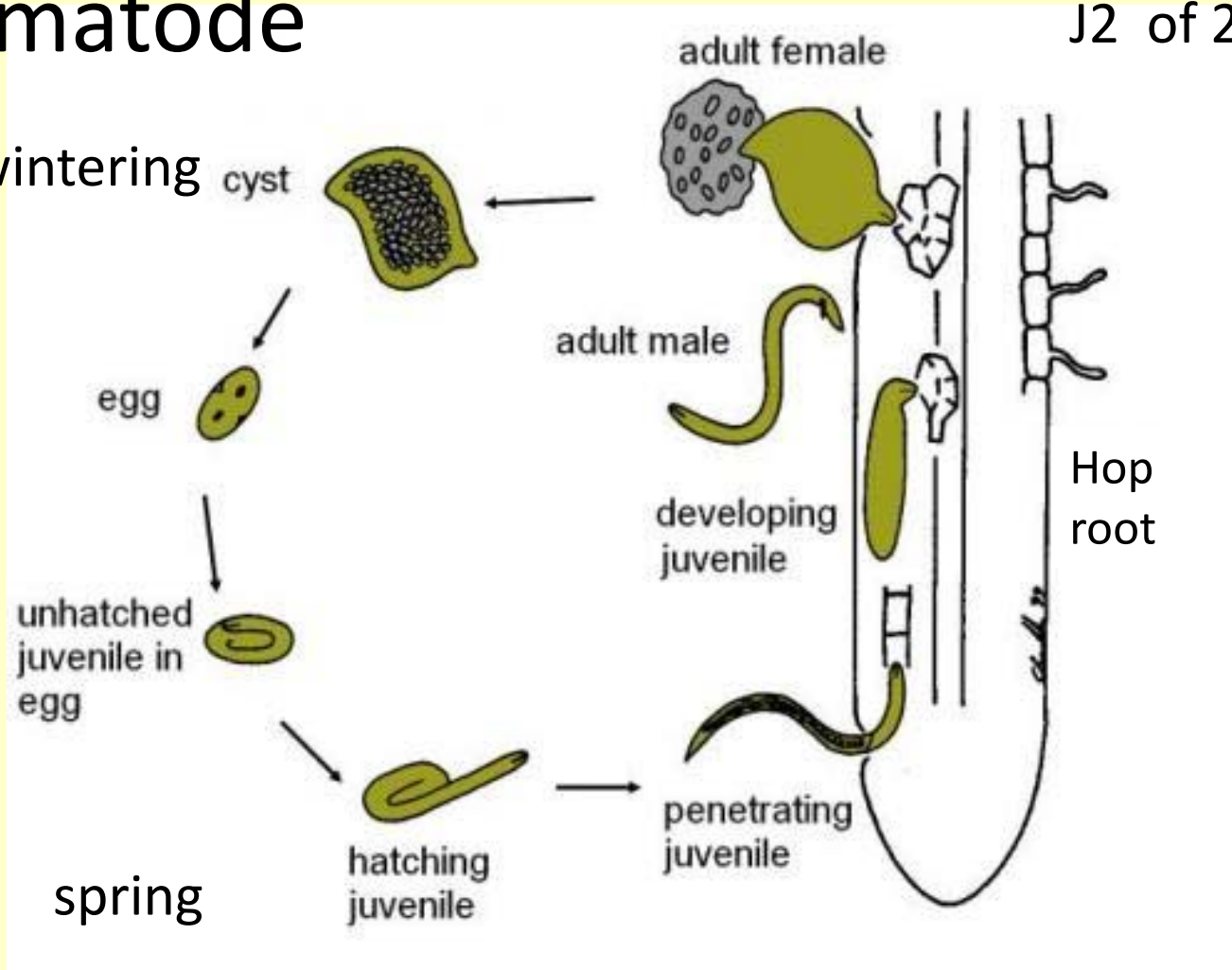


# Hop cyst nematode

1-2 generations/year

Early summer  
J2 of 2<sup>nd</sup> gen.

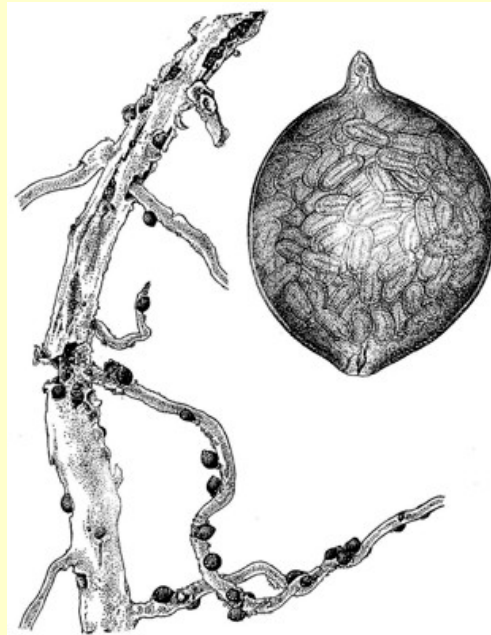
overwintering cyst



cyst nematode lifecycle, [www.plantpath.iastate.edu](http://www.plantpath.iastate.edu)

# Hop cyst nematode

- Can cause hop yield decrease of 50% and deterioration of quality.
- Losses depend on the nematode population density this in soil in spring and on plant growth stage.
- A decrease in the survivability of hop cuttings has been also recorded
- May interact with verticillium wilt fungus



# Verticillium wilt

- Caused by a fungus
- Soil borne
- Form microsclerotia in the soil
- Multiple hosts
- Can live for long periods in the soil



David Gent, USDA Agricultural Research Service, Bugwood.org

# Verticillium wilt

- No effective chemical controls
- Crop rotation- 4 years – grasses
- Rogue infected plants
- Limit nitrogen
- Reduced tillage
- Remove crop debris



David Gent, USDA Agricultural Research Service, Bugwood.org



# Crown gall- *Agrobacterium tumefaciens*

- Caused by a soil inhabiting bacterium
- Broad host range
- Of most concern in new plantings



Photos: Compendium of Hop Diseases and Pests



Gall symptoms on bines and crowns

# Crown gall- *Agrobacterium tumefaciens*

- Infection through wounds-Frost injury or mechanical
- Spread-planting stock, irrigation water, cutting tools
- Survives in infested soil, plant debris,



Photos: Compendium of Hop Diseases and Pests

Gall symptoms on bines and crowns

# Crown gall- *Agrobacterium tumefaciens*

- Use healthy planting stock
- Remove and destroy infected plants
- Galltrol- some reported effectiveness on aerial stems



Photos: Compendium of Hop Diseases and Pests

Gall symptoms on bines and crowns

# Management of some common hop insects, mites and diseases

- 2-spotted spider mites
- Hop aphids
- Japanese beetles
- Potato leafhopper
- Downy mildew
- Powdery mildew

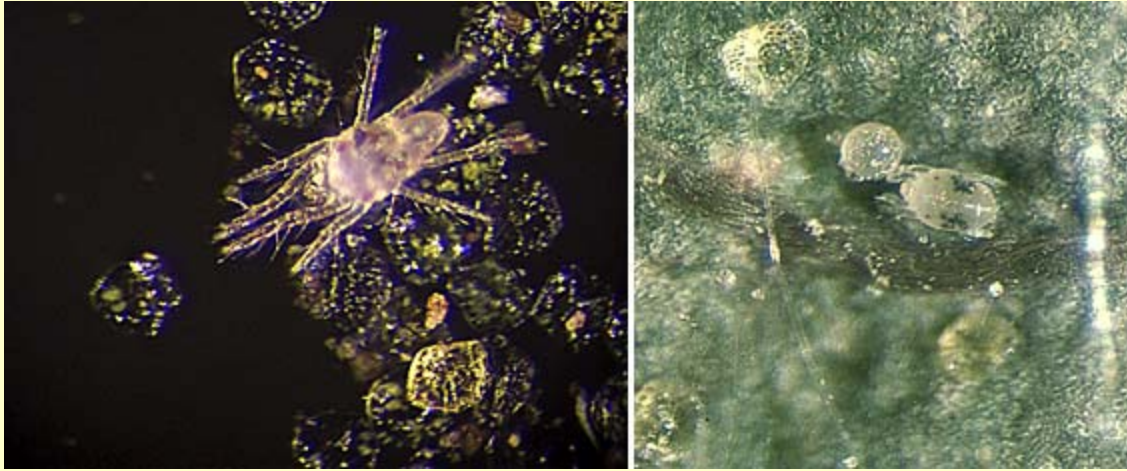


# **“The label is the law”**

- It is a violation of the law to disregard label directions.
- Always read the label before using any pesticide.
- You, the grower, are responsible for safe pesticide use. Trade (brand) names are provided for your reference only.
- No discrimination is intended, and other pesticides with the same active ingredient may be suitable.
- No endorsement is implied.

# Managing resistance

- Rotate modes of action
- FRAC codes
- IRAC codes
- Follow label directions for resistance management
- Tank mixes with multisite partners
- Recognize signs of pest resistance
- Sudden or gradual loss of control



Male spider mite , nymph with egg



Female spider mites

Photos: Compendium of hop diseases and pests

# Spider mites



- Females overwinter in crowns, cracks in hop poles
- lay eggs in spring both male and female
- Nymphs have two molts to become adults
- 1-3 weeks/ generation depending on temperatures



# Two-spotted spider mite

- Sample regularly, beginning in late May or earlier if weather is very dry. 2 leaves from 20 plants
- Miticides: Use high volume applications to ensure complete coverage.
- Thresholds from Pacific Northwest  
Provisional threshold is
- 2 adults/leaf-June
- 5 to 10 mites/leaf mid-July



# Two spotted spider mites

- Abamectin-RUP 6
  - Agri-Mek -must use with non-ionic surfactant
  - Epi-Mek
  - Temprano-
  - ABBA
- Brigade (bifenthrin) –RUP 3A
- Brigadier (bifenthrin/imidacloprid)-RUP 3A/4A
- MANA Dicofol 4E - **REI is 29 days UN**
- Acramite (bifenazate) UN
- Savey 50 DF-(hexythiazox) 10A

# Two spotted spider mites

- Fujimite (fenpyroximate) XLO 21A
- Envidor (spirodiclofen) 23
- Wettable sulfur - check label for OMRI approval
- Acoidal, Cosavet-DF, Kulumus, Microthiol Disperss are OMRI labeled
- PureSpray Green, Omni Supreme Spray, Suffoil-x (mineral oil) M OMRI
- Des-ex insecticidal soap, M-pede potassium salts of fatty acids M OMRI
- Trilogy (azadiractin) UN OMRI
- Ecotec (rosemary oil and peppermint oil) OMRI

# PLH

- PLH will be found on the underside of leaves so flip leaves and shoots over
- Growers may also chose to place two-sided yellow sticky traps in the field to catch PLH
- PLH move in all directions when
- Although hop plants are susceptible to PLH, they 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.



PLH



# PLH Management

- The most common efficacious insecticides recommended for the control of potato leafhoppers include the pyrethroids and neonicotinoids
- Pyrethroids are effective at controlling potato leafhoppers and remain relatively inexpensive, however, pyrethroids have been shown to cause increases in mite
- Neonicotinoids are longer lasting and narrow spectrum making them a solid choice for management
- Pyganic and Trilogy are OMRI approved insecticides organic growers might consider for PLH management



# Damson-hop aphid



Photos: compendium of  
hop diseases and pests



# Hop aphids

- overwinter as eggs on wild and cultivated *Prunus* species
- Multiple generations develop on *Prunus* host; can stay on *Prunus* spp. throughout the summer, particularly on the sucker growth of plums.
- Winged females produced in May; move to hop plants
- Give birth to many generations of wingless females on hops
- little movement within or between hops
- In September, females give birth to winged females and males that return to *Prunus*.
- On *Prunus*, the females give birth to egg-laying females
- Winged males mate with them on *Prunus*.
- Fertilized females lay eggs; cycle starts again.



# Hop aphids

- ! Transmit several hop viruses- hop mosaic virus, American hop latent virus
- Infestations develop more rapidly during cool weather.
- limit excessive nitrogen application- favors aphid outbreaks. Scouting is recommended 20-40 leaves- Provisional threshold numbers are 8 to 10 aphids per leaf

- Aphids should be controlled before or during flowering to prevent them from entering young cones.
- aphids secrete honeydew and cause can sooty mold to grow in hop cones
- Threshold numbers often decline to zero when cones are present.
- Enhancing habitat to encourage beneficial predatory insects can reduce populations of aphids.



Photo: Steve Miller, Cornell **Hops** Specialist



# Insecticides for hop aphids

- Malathion 1B
- Baythroid (beta-cyfluthrin) 3A
- Brigade -(bifenthrin) 3A
- Brigadier(bifenthrin/imidacloprid 3A/4A)
- Platinum (thiamethoxam) 4A
- Provado (imidacloprid) 4A
- Fulfill (pymetrozine) 9B
- Movento (spirotetramat) 23



# Insecticides for hop aphids

- OMRI listed
- Azadirect, (azadiractin) UN
- Azera (azadiractin, pyrethroids) UN/3A
- Pyganic 3A
- Des-x insecticidal soap M
- Suff-oil mineral oil m
- Grandevo (bacterium) 11
- Mycotrol O (biological)
- Sil-matrix potassium silicate

# Japanese beetle

- Foliage feeders



# Japanese beetle management

- little labeled specifically for Japanese beetle on hops
- Pyganic 3A

## 2 types of Fungicides

- Protectants
  - On surface of plant and kill fungal spores as they germinate
  - Kill by poisoning several sites in fungus
  - Less likely for resistance to develop
- Systemics
  - Absorbed into plant and kill fungus as it penetrates the plant.
  - Usually a single-site poison- resistance may be more likely

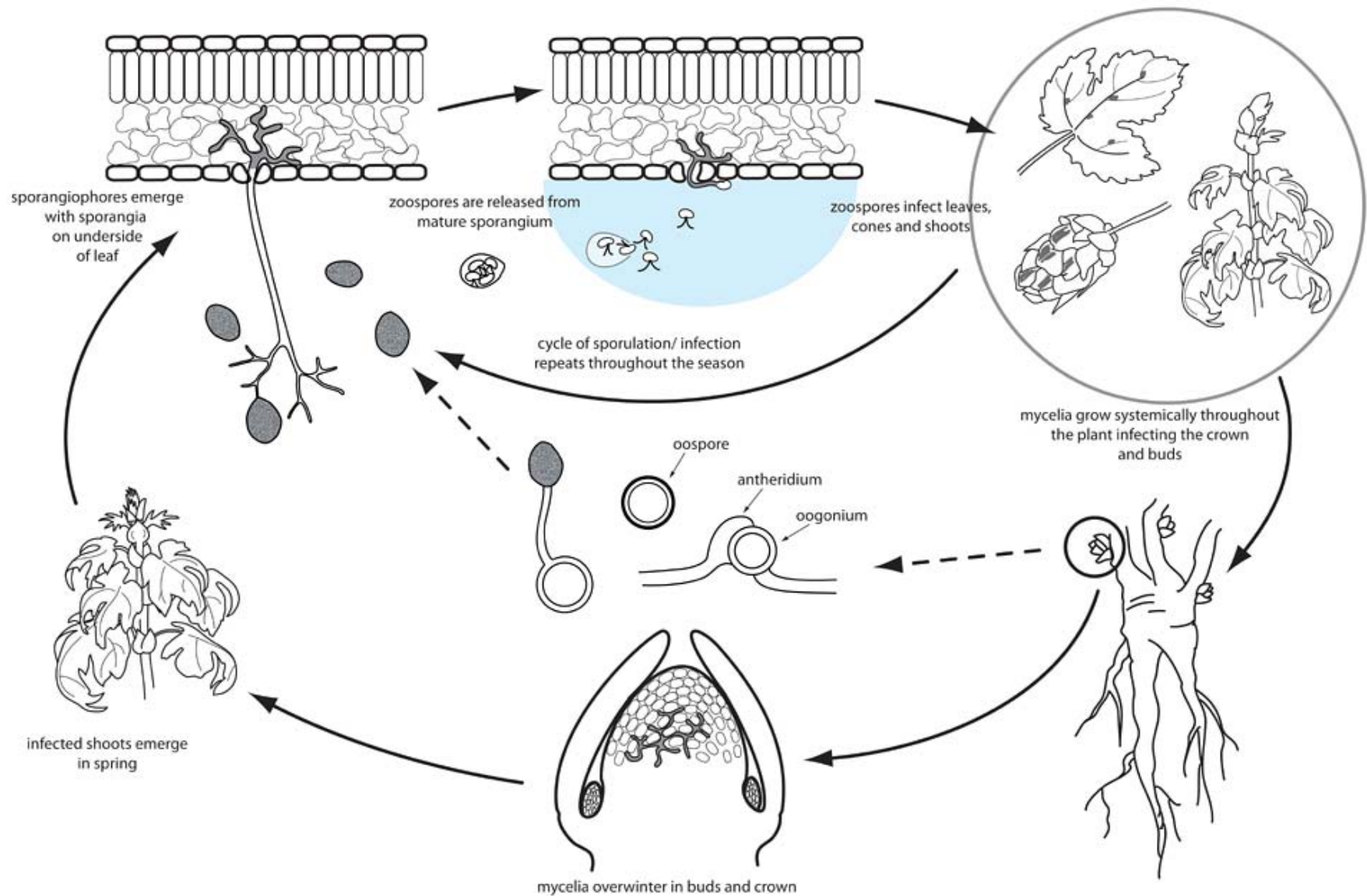


# Downy mildew

## *Pseudoperonospora humuli*

- Downy mildew overwinters in the crowns
- First appears as a primary “spike”
- The spike has pale green or light yellow, slightly downward-cupped leaves, and shortened internodes.





Life cycle of *Pseudoperonospora humuli* on hop. (Prepared by V. Brewster)

# Downy mildew

secondary basal “spike”-  
chlorotic leaves



(Courtesy D. H. Gent)



Stunted lateral branch  
caused by systemic  
infection with downy  
mildew producing an aerial  
“spike.”



# Downy mildew

- Favored by rainy weather and morning dew , ground fog
- Under favorable environmental conditions, the under surface of the leaves becomes blackened with spores, which spread the disease to other shoots, causing lesions to develop on the leaves.
- Secondary spikes are formed from these shoots.



# Downy mildew

## *Pseudoperonospora humuli*

- Can spread to leaves, cones and flowers
- Cultural practices that increase air movement,
- decrease relative humidity, and increases summer temperatures will also help control downy mildew
- Spring pruning of spikes
- Regular fungicide applications





# Downy mildew management

- Utilize a protectant fungicide management strategy to mitigate the risks of early and severe infections
- Varietal susceptibility is important
- Clean planting materials should be selected
- All plant materials removed in prunings should be removed from the hopyard and covered up or burned.

# Downy mildew management

- Well timed fungicide applications just after the first spikes emerge and before pruning have been shown to significantly improve infection levels season long
- Subsequent applications should be made in response to conducive environmental conditions (temps above 41F and wetting events)
- Copper, boscalid, pyraclostrobin, phosphorous acids and a number of biopesticides have varying activity against downy mildew

# Cultural management of powdery and downy mildew

- On plantings 2 yrs old or more
- Remove first shoots
- From 2<sup>nd</sup> flush of growth train 2-6 vines per string
- Strip lower 3-4 feet of leaves
- Remove and compost plant debris



# Powdery mildew

## *Podosphaera macularis*

A-Healthy hop cones, B-cones infected with powdery mildew, C-leaves infected with powdery mildew



Image from Plant Health Progress article:  
A Decade of Hop Powdery Mildew in the Pacific Northwest

# Powdery mildew

## *Podosphaera macularis*

- Overwinters as mycelium in aerial buds or as chasmothecia in hop yard debris.
- In early spring, infections resulting from mycelium overwintering in aerial buds produces mildew covered flag shoots.
- secondary infections "move up the plant" eventually infecting hop flowers and cones.
- High humidity and temperatures between
- In susceptible varieties, cones can become infected, resulting in stunting, cone-shatter, and reduced yields
- Optimal temperature for growth and infection is 64 °to 70 ° F



# Powdery mildew

## *Podosphaera macularis*

- Hop powdery mildew
- Not confirmed in Michigan
- See fungicide list

# Resources for pesticide labels

- Crop data management systems
  - [www.cdms.net](http://www.cdms.net)
- GREENBOOK
  - [www.greenbook.net](http://www.greenbook.net)
- Agrian
  - <http://www.agrian.com/home/label-lookup/overview#>