

Grapevine Pests and Diseases

IPM Principles and Primary Pests of Grapevines

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Integrated Pest Management (IPM)

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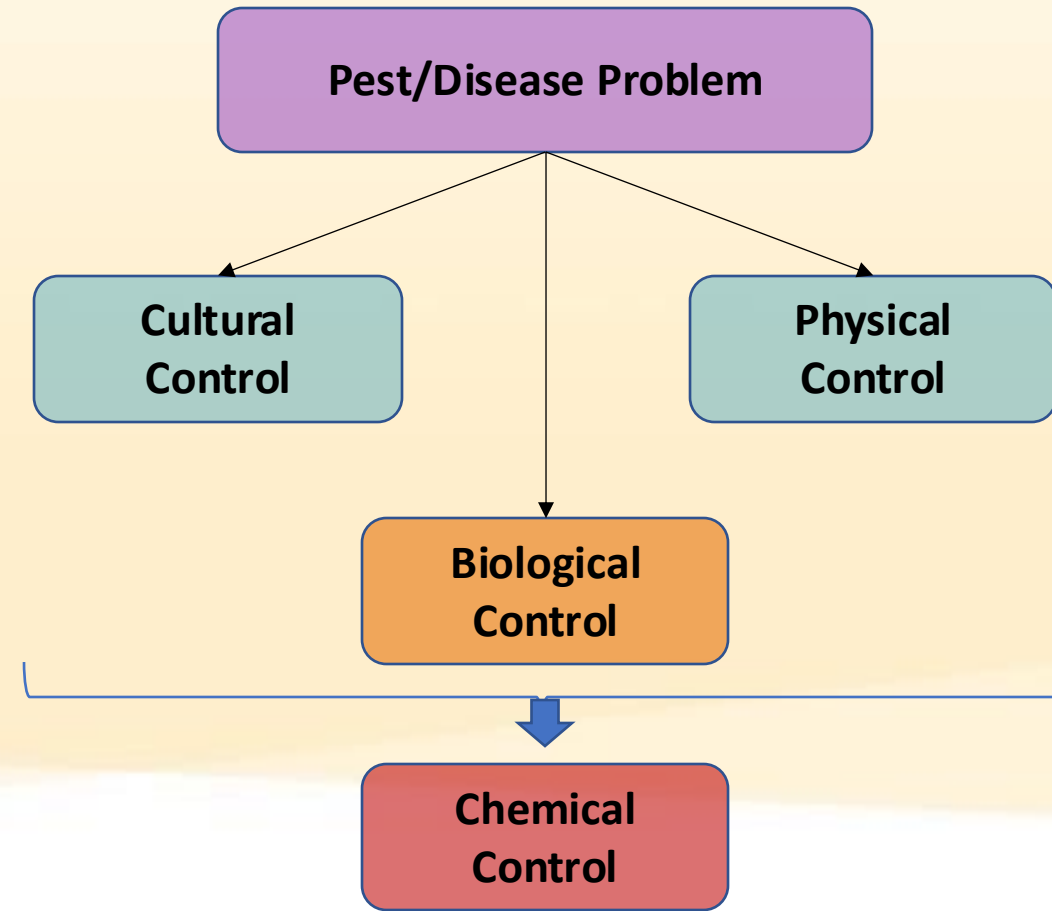
You'll hear this acronym a lot

Est. 1959 but really took off in the 60s

IPM is a foundational pillar of sustainable agriculture

Utilized practices:

1. Cultural (Modify the plant)
2. Physical (Modify environment)
3. Mechanical (Utilize devices)
4. Biological (Introduce species)
5. Chemical (Introduce chemicals)



Integrated Pest Management (IPM)

Definition:

a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks.

Key Tenants:

1. Identifying the pest
2. Monitoring and assessing the population size, damage, and favorable conditions
3. Using economic injury thresholds to determine when management is needed
4. Preventing pest problems
5. Combining management methods (biological, cultural, physical, chemical)

Monitoring strategies

Visual symptoms



Sticky traps



Pheromone traps



Beating tray



Sweep net



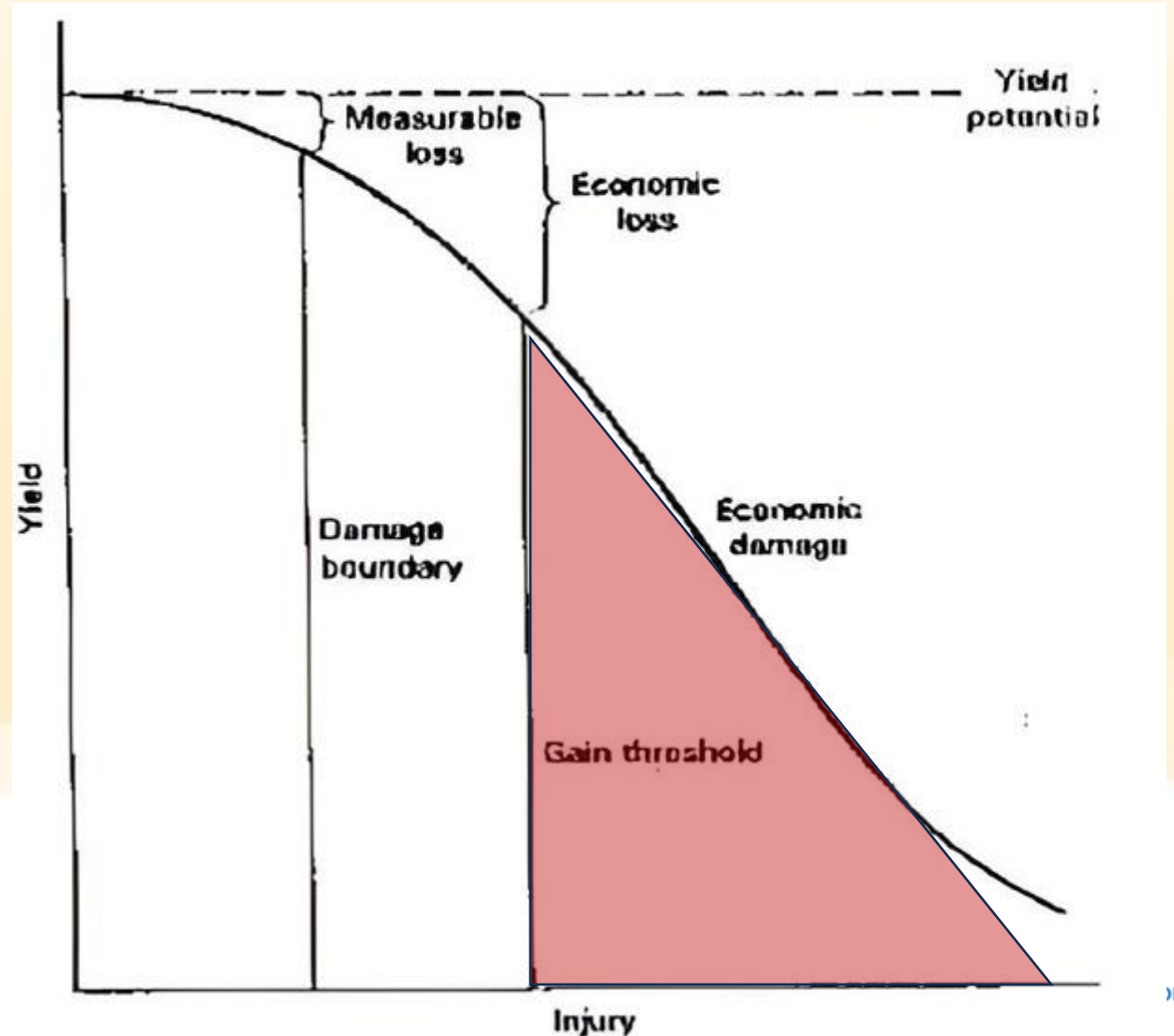
Viral testing

Economic Injury Thresholds

Complete elimination of pest is economically and physically impossible usually

Find the threshold at which your losses from that pest exceed the cost to manage them effectively

May be a yield-threshold or a fruit quality threshold



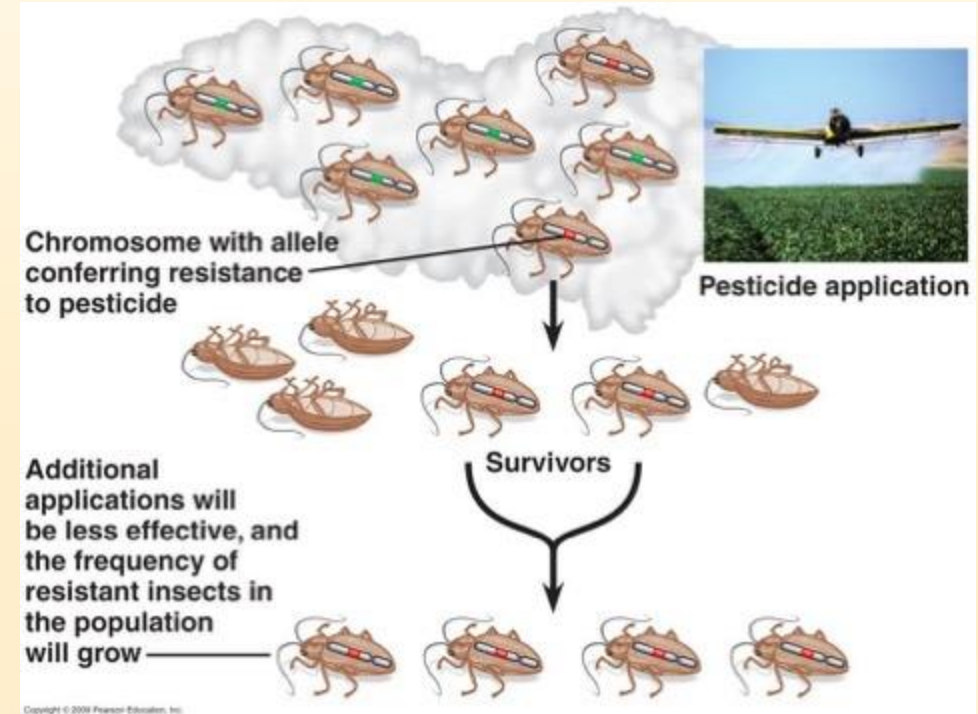
Well organic methods are fine right?

- Most organic pesticides are derived from **broad spectrum** sources of resistance
 - Chrysanthemum -> Pyrethrum -> Pyganictm
 - Affects many different kinds of invertebrates or non-target species
- Most synthetic pesticides are designed to affect a **narrow spectrum** of species
 - Designed by chemists to attack unique biological functions of a target organism
 - Less likely to negatively affect non-target species
 - Tend to be more “lethal” to organisms that are impacted



Responsible chemical control

- Pesticide resistance evolves from the **survivors** -> alternating between pesticides with **different** mechanisms (**modes of action**) reduces the likelihood of survivors
- Pesticides have been assigned group numbers for their mode of action -> IPM provides guidelines for alternating between groups

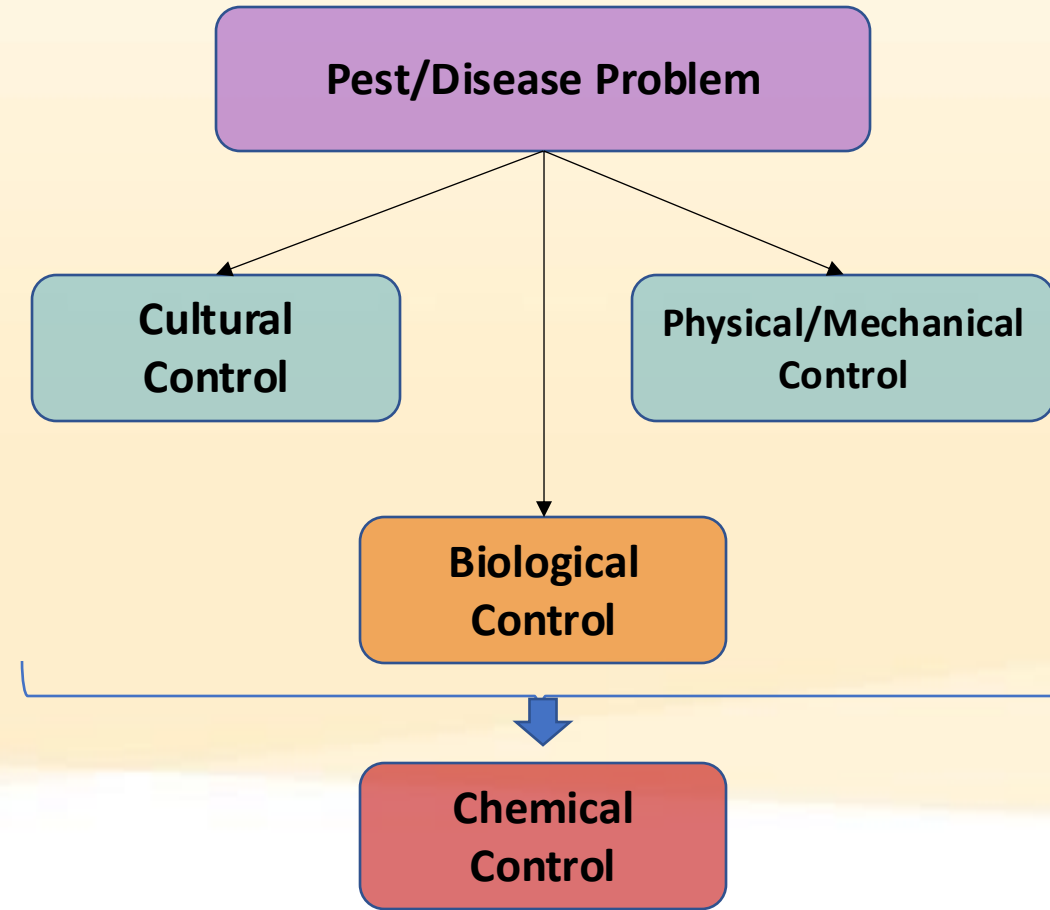


Integrated Pest Management (IPM)

This is why Chemical Control methods are always the last resort of a properly-managed IPM program

Utilized practices:

1. Cultural
2. Physical
3. Mechanical
4. Biological
5. Chemical



Ways to implement IPM

1. **Monitoring**

- Most important to find the pest/disease before it becomes a major issue
- May be done with traps, physical scouting, or through new technologies

2. **Assessing populations and preferred habitats**

- Some pests have preferred environments; identifying those will help monitor
- Limit those environments to limit population growth of the pest

3. **Estimate economic injury threshold**

- How much damage can be done before you must take action?

4. **Trying non-chemical control methods first**

- Physical, Mechanical, or Cultural methods should be tried first
- Biological methods may take multiple years to have an effect

5. **Understanding any chemical control product's mode of action and effects on non-target species and environments before applying**

Continual reassessment & refining



Types of pests and diseases

1. Microbial

- Fungal
- Viral
- Bacterial

2. Animal

- Invertebrate pests
- Vertebrate pests

3. Plants

- Weeds



Causal Agents of Disease in Grapevines

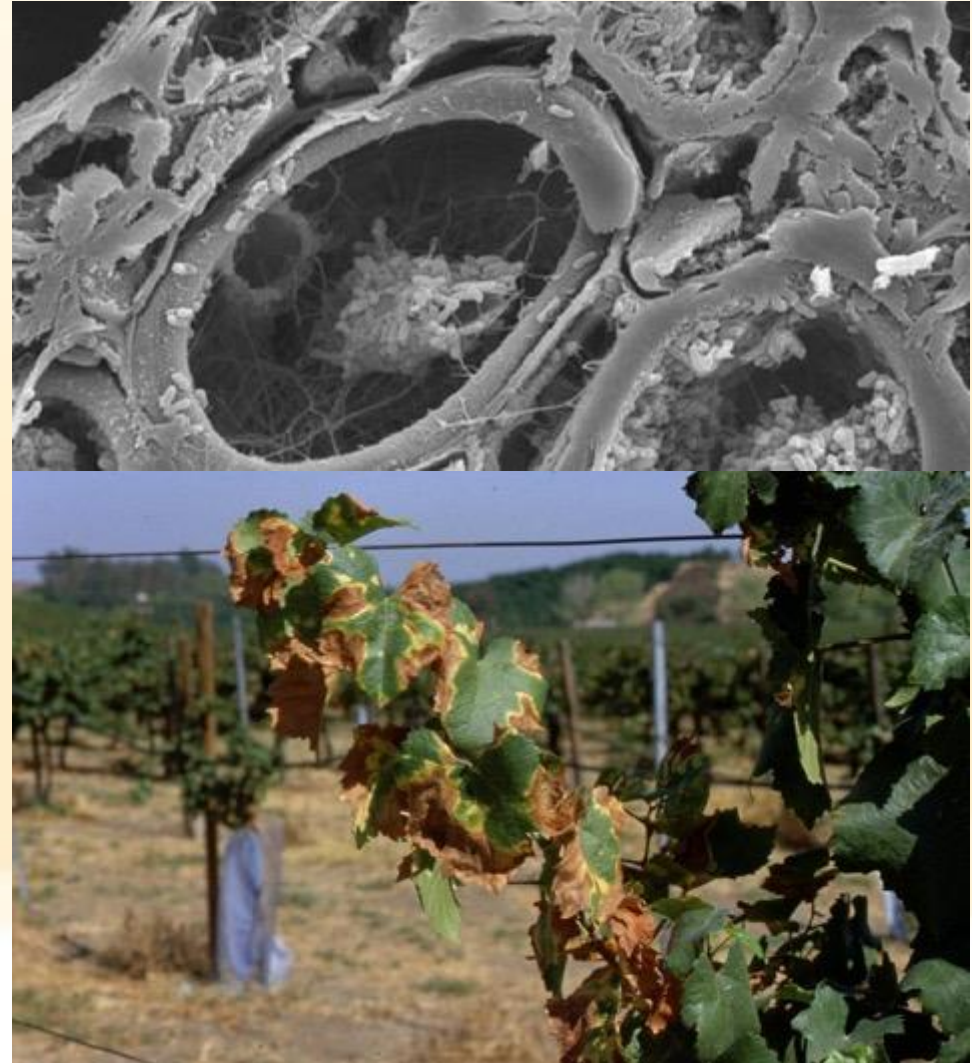
Viruses

1. Many kinds of viruses
2. The most common problems are the “associated Virus” groups
3. No cure & No immune system
4. Often impact fruit sugar accumulation



Bacteria

1. Only a handful that really matter
2. Ice-Nucleating Bacteria
3. Pierce's Disease (*Xylella fastidiosa*)
4. Crown Gall (*Agrobacterium spp.*)

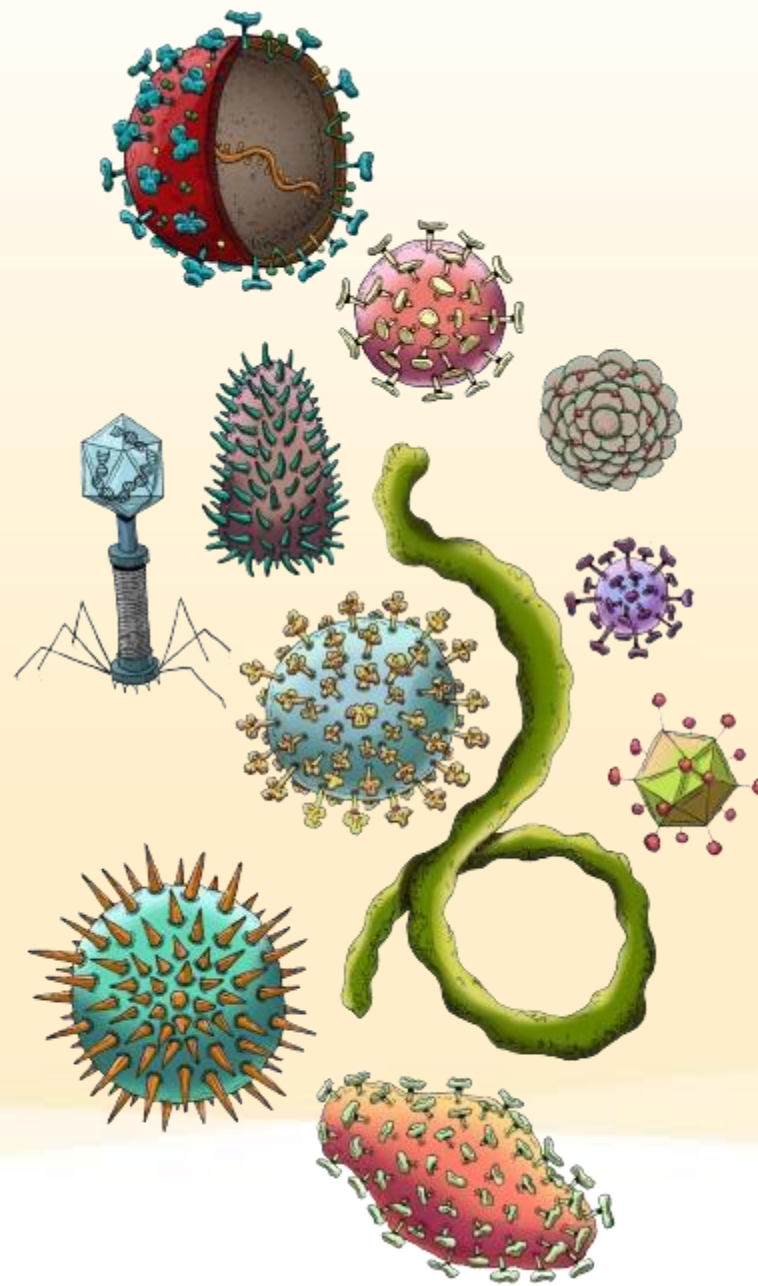


Fungi and Oomycetes

1. Biggest problem microbe in vineyards
2. Attack all tissue types, but most have a preferred tissue
3. Mildews, Trunk Diseases, and Bunch Rots are most common



Viral and Bacterial Diseases



Categories

Viruses are often grouped into categories based on what they do

These are referred to as “**associated viruses**”

1. Red-leaf viruses

- Leafroll (Grapevine Leafroll Associated Virus; GLRaV)
- Red Blotch (Grapevine Red Blotch Associated Virus; GRBaV)
- Syrah Decline (Grapevine virus A = suspected virus)

2. Rugose Wood Complexes

- Rupestris Stem Pitting (Rupestris stem pitting associated viruses; RSPaV)
- Corky Bark (Grapevine virus B)

3. Fanleaf Virus (Grapevine fanleaf virus; GFLV)

Red Leaf Viruses of Grapevines

Leafroll (GLRaV-2 and GLRaV-3)

Symptoms change based on the grape cultivar:

- Red-skinned grapes = red leaf tissue
- White-skinned grapes = yellow leaf tissue

Veins of leaves remain green

Margins of leaf will curl downward

Two main strains:

- GLRaV-2 = Spreads horizontally on basal leaves
- GLRaV-3 = Spreads vertically up individual shoots



Leafroll (GLRaV-2 and GLRaV-3)

Yields can decline by 30-50%

Ripening can be delayed or uneven

Reduction in °Brix and berry color

Increase in Titratable acidity in berries

May look similar to:

- Phosphorous deficiency
- Potassium deficiency

Vectored by mealybugs or soft-scales



Red Blotch (GRBaV)

Looks very similar to Leafroll

Difference:

- Veins turn red along with the leaf blade
- Or veins turn yellow if white-skinned grape

Was thought to be a form of Leafroll virus for a long time

Identified in 2008 in Napa Valley



Red Blotch (GRBaV)

Yields do not decline noticeably

Ripening can be delayed or uneven

Reduction in °Brix by 4-5°Brix near harvest

Increase in Titratable acidity in berries

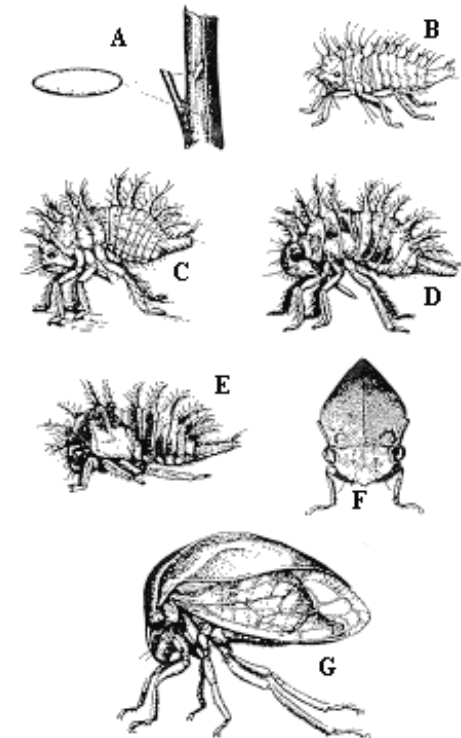
May look similar to:

- Leafroll virus symptoms

Vectored by Three-cornered Alfalfa Hoppers



I. Threecornered alfalfa hopper and damage to stem.



Threecornered alfalfa hopper. A, Egg. B-F, Nymphs. G-H, Adults.

Syrah/Shiraz Decline

Mostly affects Syrah/Shiraz and Petite Syrah

Graft union can swell and crack

Stem pitting and grooving

Premature leaf reddening

Shows up first in 4-10 year old vines

Unsure if this is a Rugose wood complex or red-leaf virus disease



Rugose Wood Complexes of Grapevines

Rupestris stem pitting associated viruses (RSPaV)

Spread by propagation of infected plant material

Vines are dwarfed in growth

Vines may decline and die after a few years in the field

Swelling of the scion above graft union

Pits or grooves in the rootstock, scion, or both



Corky Bark (Grapevine Virus B; GVB)

Often enters the vine via graft unions

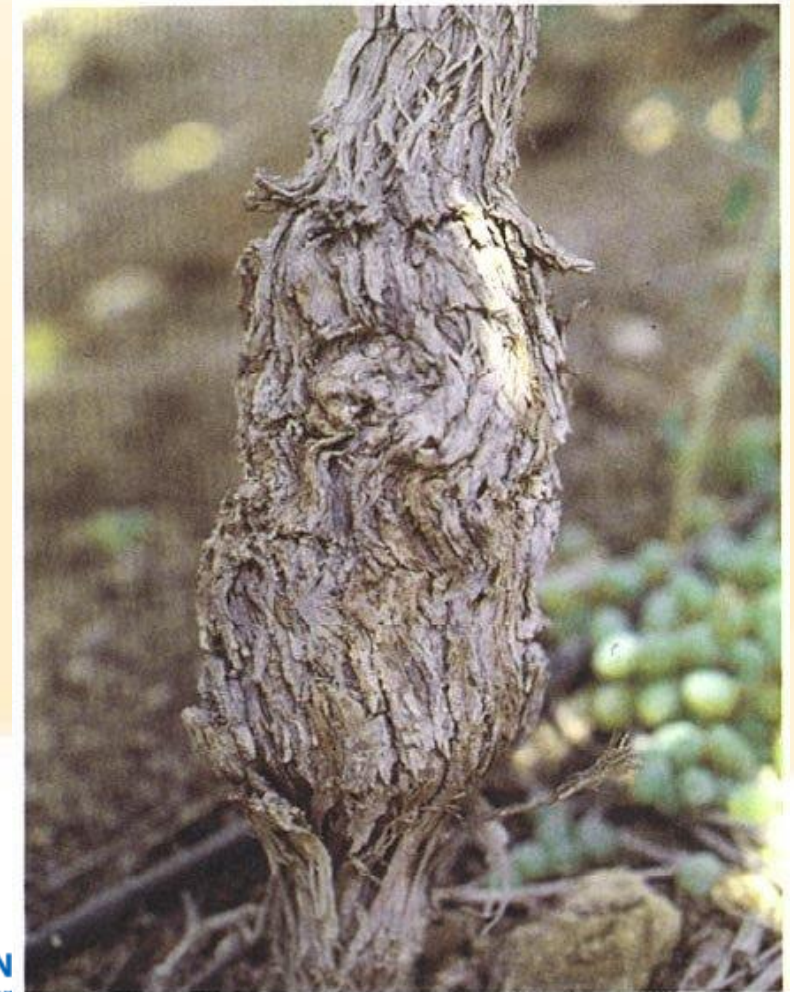
Symptoms do not show until *V. vinifera* is grafted onto an American rootstock

Does not move (or moves very slowly) in a vineyard setting

Swelling of the scion above graft union

Bark of the scion may be thick and corky with spongy texture

Dark purple leaves



Bacteria of Grapevines

Three main bacteria of concern

1. Crown Gall (*Agrobacterium vitis/tumefaciens*)



Crown Gall (*Agrobacterium vitis*)

Bacteria is found EVERYWHERE in soils

Most plants infected by the closely related,
Agrobacterium tumefaciens/vitis

Grapes have their own species!

Usually not a problem

Can result in damaged tissue or cracked
trunks/cordons if vine is coming out of dormancy
and a freeze event hits



Crown Gall (*Agrobacterium vitis*)

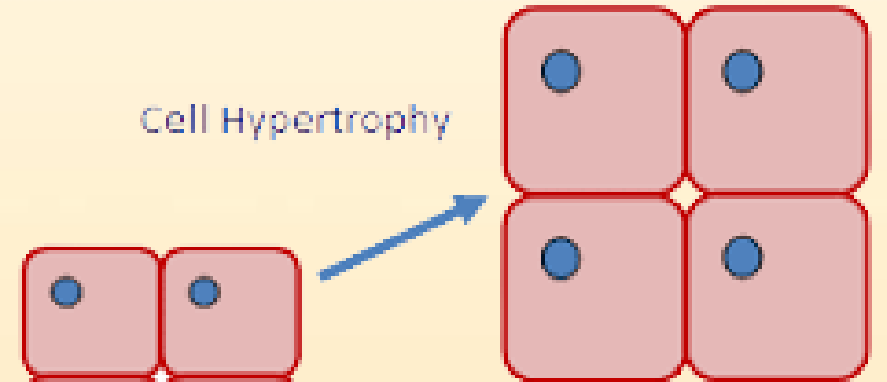
Two main effects on plant cells

1. Hypertrophy = Cells get larger than normal

- Hypertrophied corn
- Think of a 'large trophy'

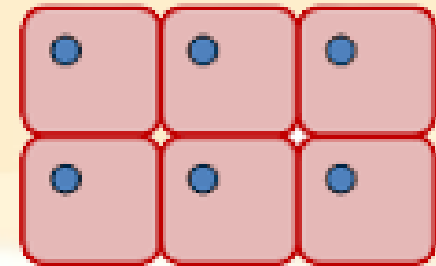


Cell Hypertrophy



2. Hyperplasia = Cells divide more than normal

Cell Hyperplasia



3. Can be desirable:

- Corn smut/ huitlacoche

Three main bacteria of concern

2. Pierce's Disease (*Xylella fastidiosa*)

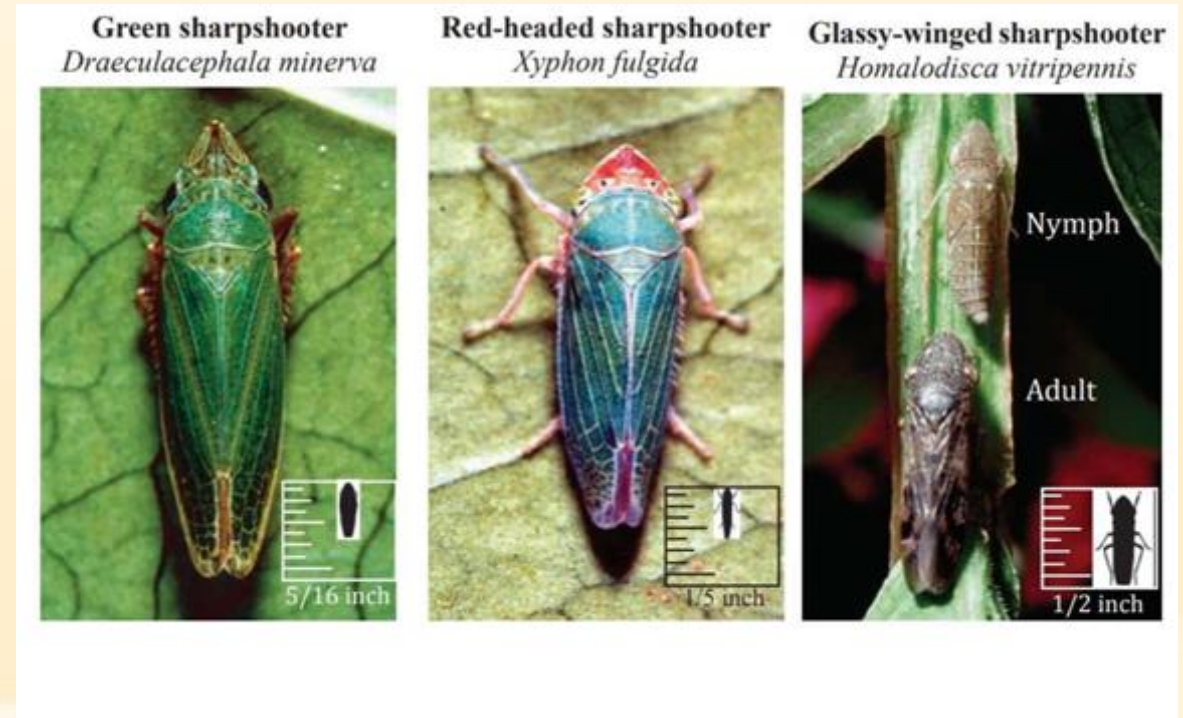


Pierce's Disease (*Xylella fastidiosa*)

Bacteria vectored by:

1. **Sharpshooters** (*Cicadellidae*)
 1. **Blue-green sharpshooters**
 2. **Green sharpshooters**
 3. **Glassy-winged sharpshooters**
 4. **Red-headed sharpshooters**
 5. **Smoketree/Willow sharpshooters**
2. **Spittlebugs** (*Cercopidae*)

Infects and multiplies **INSIDE** the xylem vessels



Pierce's Disease (*Xylella fastidiosa*)

Leaves yellow/brown in 'splotches' around the margins

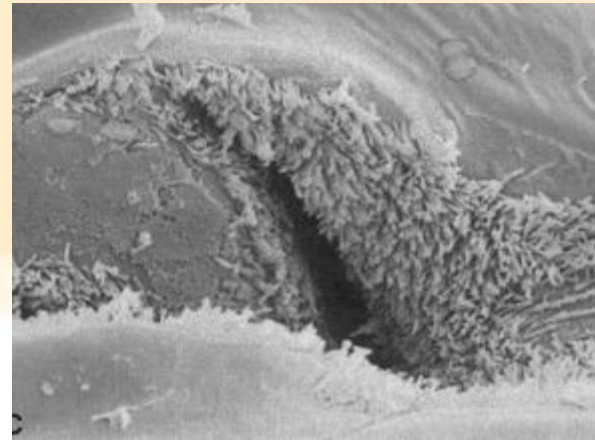
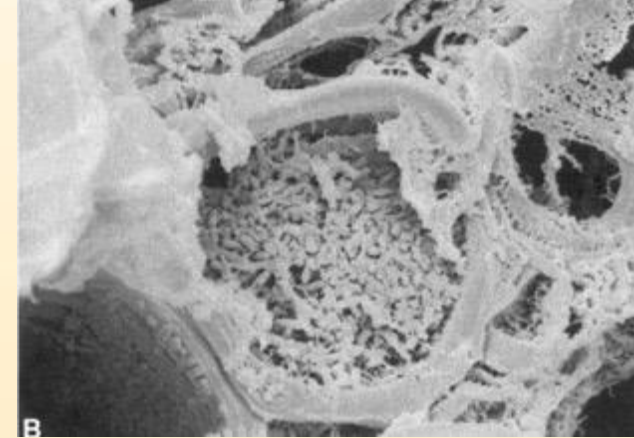
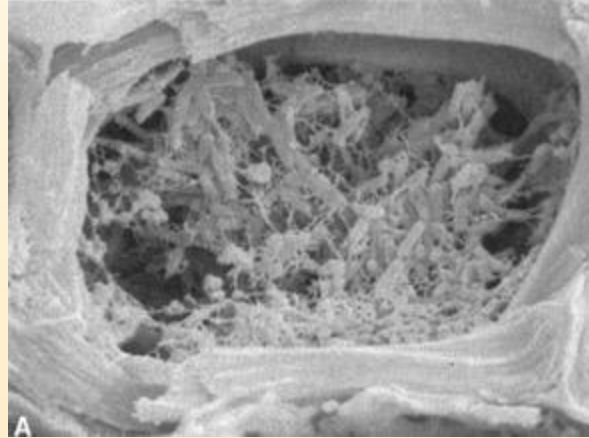
Fruit shrivels/raisins

Matchstick petioles

New canes mature irregularly

Cane tips and roots die back

Eventually vine dies



Overwinter Recovery – *Xylella fastidiosa*

Overwinter recovery from Pierce's Disease relies on cold Winter temperatures < 53 °F for prolonged periods

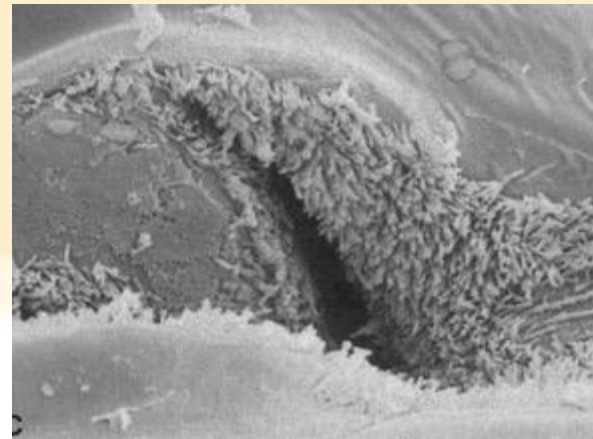
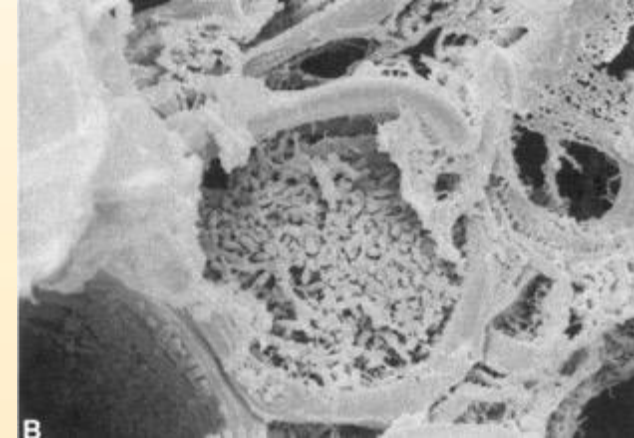
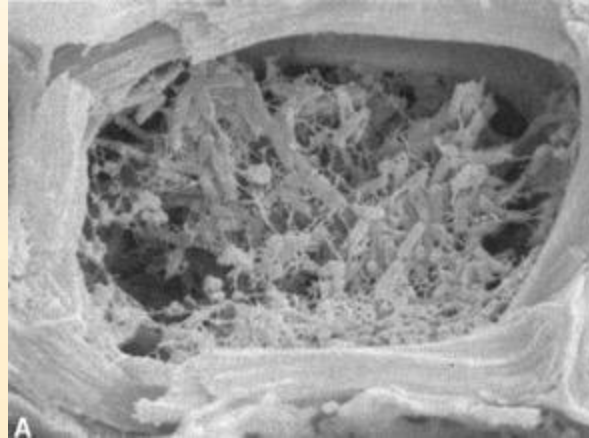
Warmer winter temperatures could impede the phenomenon of overwinter recovery

Winter temperatures in California have risen around 2 °F since the 1970s and made overwinter recovery of *X. fastidiosa* less likely to occur in regions where winter-kill used to be more common

Finding a PD-resistant Scion

Xylella fastidiosa clogs the xylem vessels in grapevines by colonizing the vessels

To find a ‘resistant cultivar’ would be to find one where vascular hydraulic conductivity does not fail under *X. fastidiosa* infections



Ice-Nucleating Bacteria

Impacts on Frost Risk



How Ice-Nucleating Bacteria Increase Frost Risk

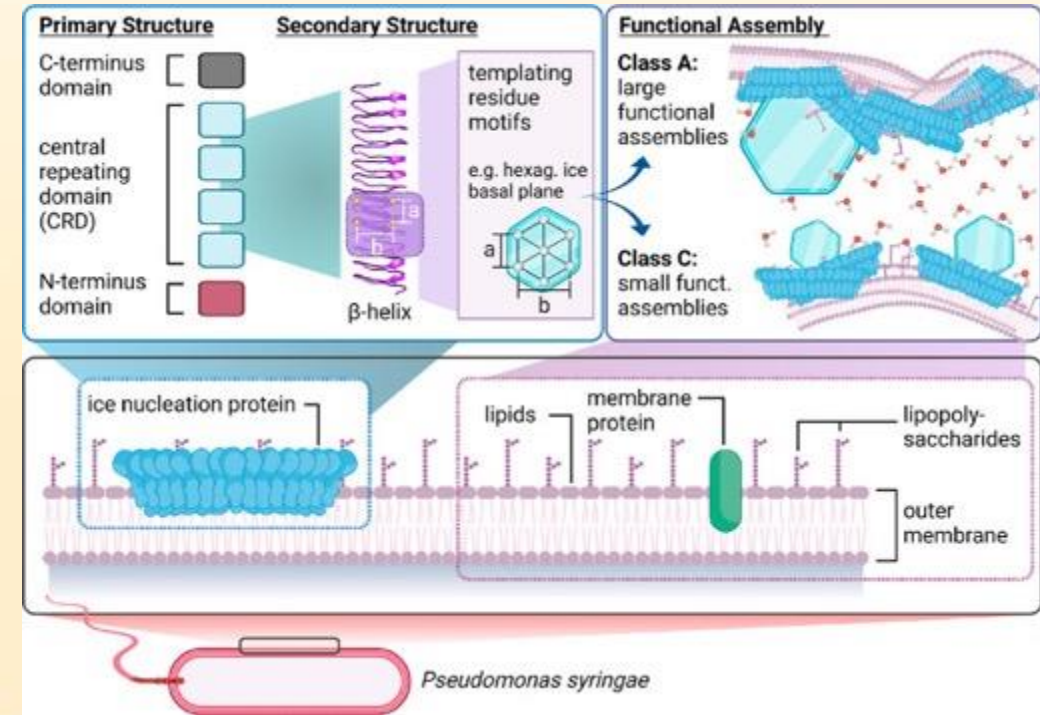
Ice-Nucleating bacteria have the ability to facilitate ice formation

This is due to specialized ice-nucleating proteins (INPs) anchored to the outer bacterial cell membrane

- These INPs lead to ice crystallization at higher temperatures in plant tissues

In absence of ice-nucleating bacteria, plants can **'supercool'** down to 23 °F without damage to tissues

- Removing populations of INBs can decrease the upper limit of frost risk by **3-4 °F** in vineyards



Ice-Nucleating Bacterial Species

There are a handful of ice-nucleating bacterial species that can impact frost risk in vineyards:

- *Pseudomonas syringae*
- *Erwinia herbicola*
- *Pseudomonas viridiflava*
- *Pseudomonas fluorescens*
- *Xanthomonas campestris* pv. *translucens*



Proximity to Other Vegetation

Vegetation nearby	Distance from edge of orchard (trees)	Bacteria deposited per petri plate/hr	Leaf Bacteria (Log cells/g)
NO	0	33 a	4.8 a 4.7 a 4.7 a 4.9 a 4.7 a
	7	29 a	
	14	37 a	
	21	38 a	
	28	37 a	
	YES	0	
7		97 a	
14		51 b	
21		46 b	
28		34 b	

Bacterial populations on citrus and numbers of airborne bacteria related to proximity to vegetation with high epiphytic bacterial populations

From Lindow & Andersen, AEM 62:2978-2987 (1996)

Use of Copper Sprays for Reducing Frost Risk



How Copper limits Frost Risk

Copper has been used as a disinfectant for centuries

- Hospital railings used to be made entirely of copper for this reason

Copper ions can damage cell membranes or DNA and disrupt enzymatic activity in bacteria

- This leads to cell death and control over bacterial populations

This is true for ice-nucleating bacterial species as well



Enters

Copper ions on the surface are recognized as an essential nutrient and enter the bacteria cell.



Disrupts

Copper ions interfere with normal cell functions and membrane integrity.



Kills

When excess copper binds to the enzymes, the bacteria can no longer breathe, eat, digest or create energy.

Fungal Trunk Diseases



Eutypa and Esca

- Symptoms first become apparent in vineyards 5 to 7 or more years old
- Wedge-shaped wood cankers form in infected wood
- Dead spurs and shoot dieback
 - Symptoms shared among multiple trunk diseases
- Spores enter through pruning wounds
- Difficult to identify until too late



Managing/Controlling Trunk Diseases

Late Pruning or Double-Pruning

Clean your equipment before and after each use

Remove infected wood and retrain trunk

Paint large pruning wounds with protectant

- *Trichoderma* Based biological fungicides (Vintec, Bio-Tam, Crab-Life)
- Can help control Eutypa (*E. lata*) and Botryosphaeria Dieback (*N. parvum*)



Mildews & Bunch Rot



Downy Mildew

Not a huge problem in California

- Limited rainfall in spring and summer generally limits the spread of the disease in California

Requires warm and wet periods during the growing season

- Spring – Summer

In California the greatest potential for disease development exists when a wet winter is followed by late spring rains



Powdery Mildew

First appears on leaves as chlorotic spots on the upper leaf surface

Visible signs = White, webby mycelium on the lower leaf surface

Infected areas have a white-powdery or dusty appearance

- On leaves and fruit

Black/Brown scarring = signs of a former colony



Bunch Rot

Bunch rot is also very common

Can be worsened when the canopy or cluster is too dense

Results in loss of whole clusters



Managing Mildews

Keep things dry!

- Effective soil drainage and reduction of sources of overwintering inoculum

Leaf removal by itself can result in 50% disease control

Preventive fungicides must be applied before an infection period begins

- Early season copper sprays

Micronized sprayable sulfur application or oil should be applied prior to other fungicides

PM Risk Assessment Index and Spray Index (UC ANR)



Vectors

What is a vector?

A vector is a living organism that transmits and infection agent from one host organism to another

Vectors are often arthropods (member of phylum Arthropoda) and are classified as having

1. Exoskeletons
2. Segmented bodies
3. Paired-jointed appendages

Other vectors (such as nematodes) also exist

Main types of vectors

Mechanical

- Microbes do not multiply within mechanical vectors
- Mechanical vectors only *physically transport* the vectors from one host to another
- Transported on **outside of their bodies**
- Think of Zebra Mussels on the bottom of a boat moving from one lake to a river



Biological

- Biological vectors are alive, and microbes often multiply within them
- However, they sometimes act as ‘living-mechanical’ vectors



Phytophagous Pests

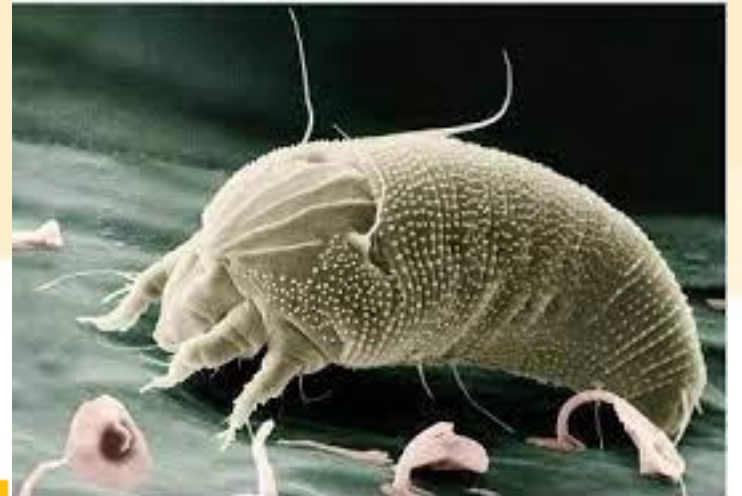
Phytophagous Pests

These are pests that **feed on** the grapevine directly

They may also be a biological vector

Examples

1. Nematodes (Dagger & Root-knot)
2. Ground rodents (Squirrels and Gophers)
3. Mites (Blister, Bbud, and Spider)
4. Moths and larvae



Nematodes

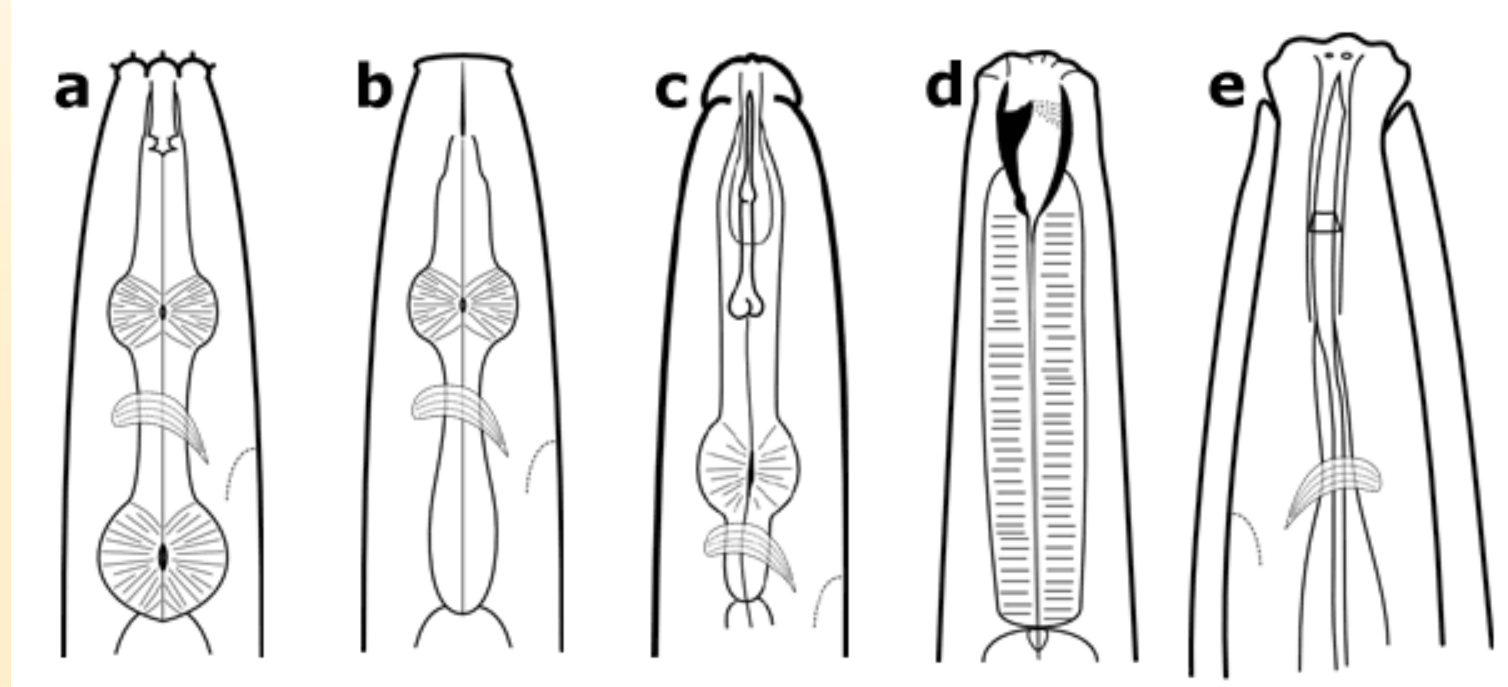
Vector and Phytophagous Pest

Nematodes

Exist everywhere

Many types of them

- a. Bacterial feeders
- b. Fungal feeders
- c. **Plant feeders**
- d. Predatory
- e. **Omnivorous**



Plant feeders and Omnivores are what worry us in vineyards

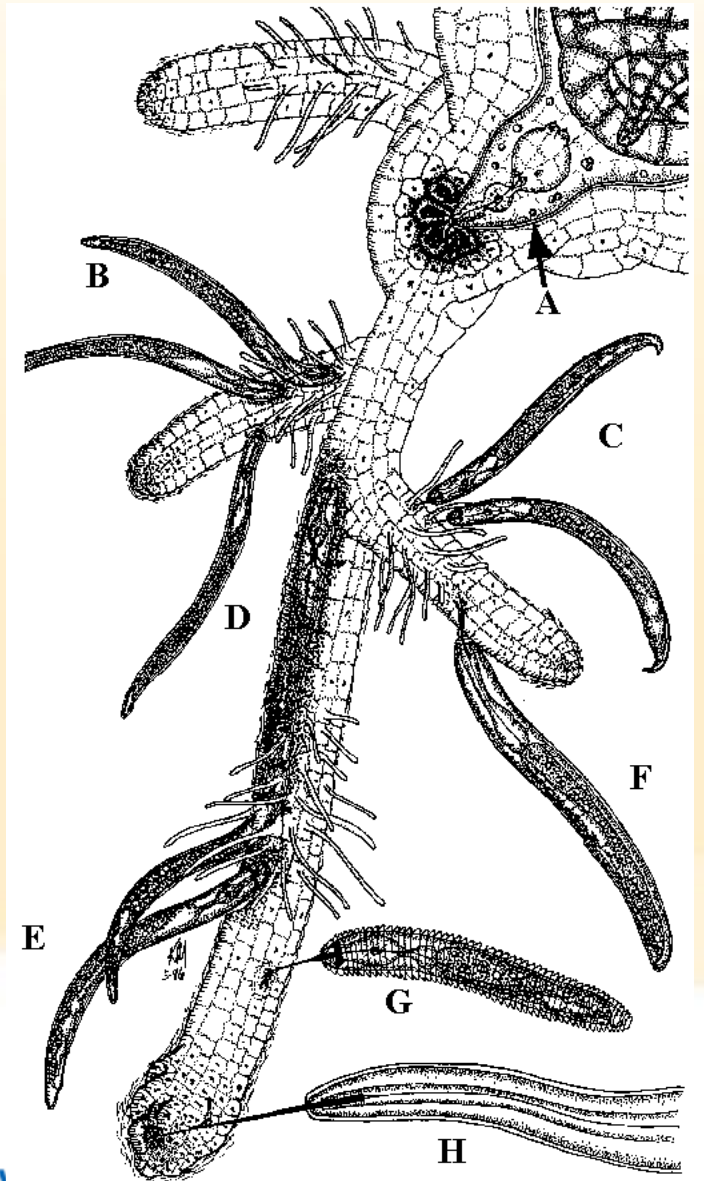
Nematodes

Unsegmented roundworms

Feed on plant roots by puncturing cell walls and sucking out the cell contents

Feed with a hypodermic structure = stylet

Will often kill off the root through high populations and excessive feeding



Types of problematic nematodes

1. Dagger Nematode (*Xiphinema index/ americanum*)
2. Root-knot Nematode (*Meloidogyne spp.*)
3. Citrus Nematode (*Tylenchulus semiipenetrans*)
4. Ring Nematode (*Mesocriconema xenoplax*)
5. Root lesion nematode (*Pratylenchus vulnus*)

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Dagger Nematodes (*Xiphinema index/ americanum*)

Nematodes vector a group of viruses called Nepoviruses

Seven nematode-transmitted viruses (Nepoviruses) are known to infect grapevines in North America including:

1. *Arabis mosaic virus*
2. *Blueberry leaf mottle virus*
3. ***Grapevine fanleaf virus (GFLV)***
4. *Peach rosette mosaic virus*
5. *Tobacco ringspot virus*
6. *Tomato black ring virus*
7. *Tomato ringspot virus*



Root-Knot Nematode (*Meloidogyne spp*)

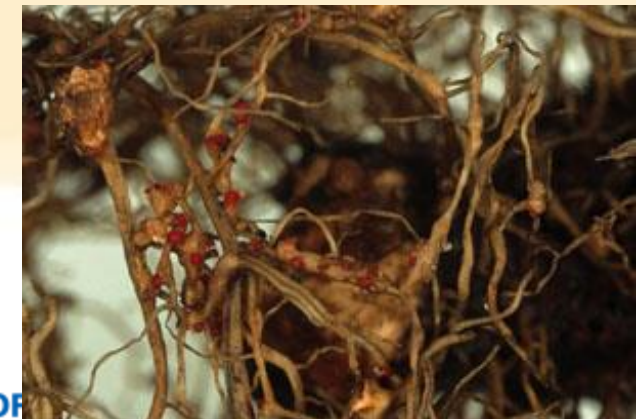
Create 'galls' on the roots

These structures are the females

Once they reproduce, they stick themselves to a part of the root and never move again

Galls result in:

1. Decreased water and nutrient uptake
2. Decreased vine vegetative vigor
3. Lower yields



Sharpshooters

Vector

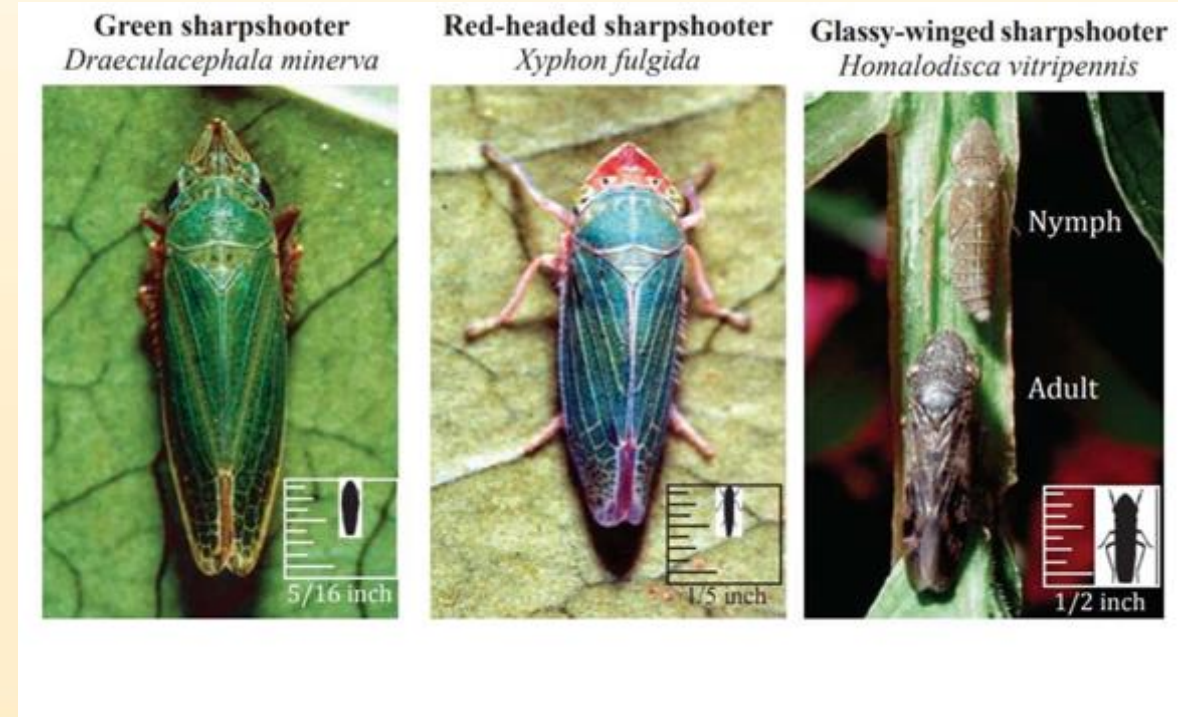
Sharpshooters

Five main species in California

1. **Blue-Green sharpshooters**
2. **Green sharpshooters**
3. **Red-Headed sharpshooters**
4. **Glassy-Winged sharpshooters**
5. **Smoketree/Look-alike sharpshooters**

2-3 generations/year

Vectors *Xylella fastidiosa* (Pierce's Disease)



Blue-Green Sharpshooters (*Graphocephala atropunctata*)

Two generations/year

≈ 0.4 inches long (relatively small)

Alternative hosts:

- Wild grapevines
- Blackberry
- Elderberry

Most common in riparian areas in dense vegetation

Overwinter in riparian areas

Eggs hatch (May-July); Move to riparian (August)



Green Sharpshooters (*Draeculacephala minerva*)

Three generations/year

≈ 0.4 inches long (relatively small)

Alternative hosts:

- Bermuda grass
- Italian and perennial rye
- Fescue

Most common in irrigated rangeland

Overwinter in pasture as adults

Eggs hatch (April-May)



Red-Headed Sharpshooters (*Xyphon fuldiga*)

Three generations/year

Will only breed near grasses

Main host:

- Bermuda Grass

Grapes are an 'incidental' host

Overwinter in pasture as adults

Eggs hatch (April-May)



Glassy-Winged Sharpshooters (*Homalodisca vitripennis*)

Two generations/year

≈ 0.5 inches long (largest one)

Alternative hosts:

- Citrus
- Avocados
- CA native perennials

Spots on head help identify it from Smoke-tree sharpshooter

Overwinter in riparian areas and woodlands

Predominant in S. California and San Joaquin Valley

Most effective spreader of *Xylella fastidiosa*



Smoke-Tree Sharpshooters (*Homalodisca lacerata*)

Two generations/year

≈ 0.45 inches long

Alternative hosts:

- Desert shrubs
- CA native perennials



Wavy-lines on head help identify it from Glassy-winged sharpshooter

Overwinter in riparian areas and woodlands

Predominant in deserts of S. California (Mojave)

Reproduces slower than Glassy-winged sharpshooter



Smoke Tree Sharpshooter

6 mm



Glassy Winged Sharpshooter

Mealybugs and Scales

(and ants)

Vector and Phytophagous Pest

Mealybugs (*Pseudococcus spp.* & *Planococcus ficus*)

Mealybugs are a type of scale insect

There are four problematic species:

1. Grape mealybug (*Pseudococcus maritimus*)
2. Vine mealybug (***Planococcus ficus***)
3. Obscure mealybug (*Pseudococcus viburni*)
4. Longtailed mealybug (*Pesudococcus longispinus*)



Mealybugs (*Pseudococcus spp.* & *Planococcus ficus*)

Natural enemies exist for the *Pseudococcus* species, but not many for Vine Mealybug

Natural enemies:

1. Parasitoid wasps (*Coccophagus*, *Leptomastix*, *Allotropa*, *Pseudaphycus*, and *Acerophagus*)
2. Lady beetles (cultivar = Mealybug Destroyer)
3. Brown and green lacewings
4. Spiders
5. Minute Pirate Bugs



Ants love 'em



Ants love 'em



Mealybugs

The 'honeydew' they produce is why ants will protect them

It also causes black-sooty mold and fungal growth

Mealybugs also vector Grapevine Leafroll associated Viruses



Three-Cornered Alfalfa Hoppers (TCAH)

Vector of Red Blotch viruses

≈ 0.25 inches long

Piercing-sucking mouthparts

Alternative hosts

- Grapes
- Alfalfa

Two generations/year

S. CA deserts and SJV



Larger Pests

YOU

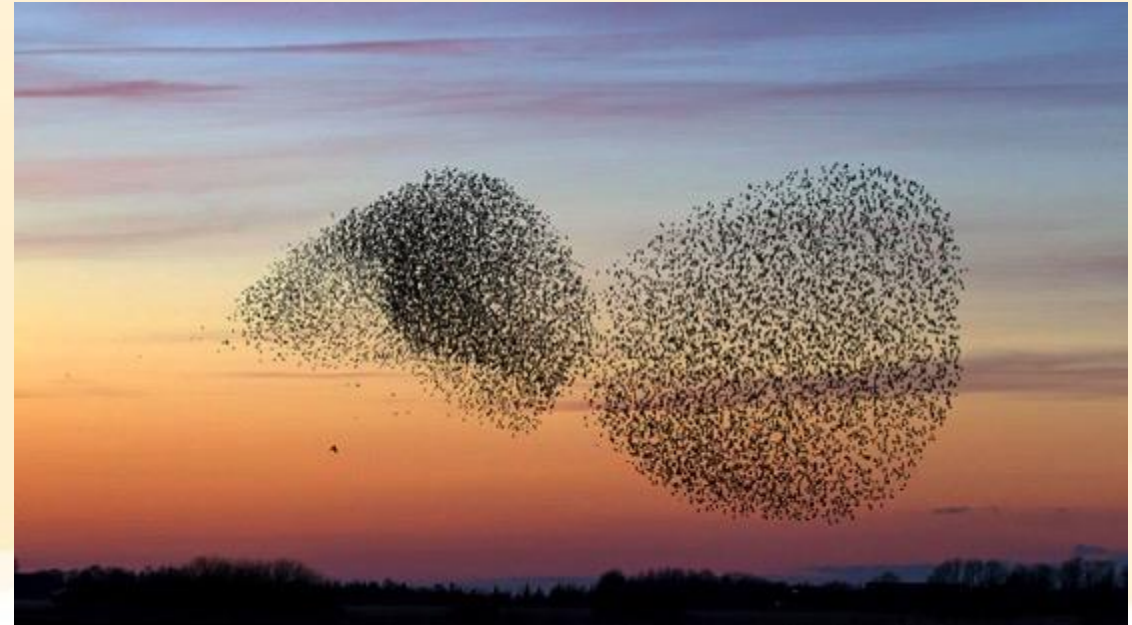


Birds

Starlings can pick a vineyard clean and are migratory; they migrate just in time for ripe grapes

Turkeys will also pick a vineyard clean if allowed to

Other birds will eat and damage fruit leading to loss and fungal pathogen growth



Rodents

Ground squirrels and **Gophers** are notorious for eating every part of a grapevine

- Nibble roots (kills the vine)
- Eat new shoots (reduces yield)
- Eat fruit (reduces yield; mold growth)

Rats will use the trellising wire as a highway to free fruit



yourfriendchrischen

RMI vineyard

- Cultural:
 - Destroying old pruning wood & late pruning to prevent trunk disease
 - Shoot thinning & hedging to prevent powdery mildew and Botrytis
 - Cover cropping to reduce weeds and provide suitable habitats for natural predators
- Physical/Mechanical:
 - Removing weeds with a weed whacker
- Biological:
 - Monitoring ladybug populations
 - Bird and Owl boxes
- Chemical:
 - Vitiseal on pruning wounds to prevent trunk disease
 - Spraying mostly for powdery mildew and Botrytis (OLD)
 - Spray #1: 4/24 – Microthiol Disperss Micronized Wettable Sulfur (MOA: M2)
 - Spray #2: 5/5 – Sulfur (M2) & Flint (11)

Summary

- Integrated Pest Management (IPM) is the main philosophy behind pest control in agricultural systems like vineyards
 - Must account for pest identification, population and reproduction
 - Chemical controls seen as a last resort
- The *causal agent* of a disease might be different than the disease itself which is presented as symptoms
- Primary pests and diseases of grapevines can be broken down to:
 - Vector of disease, phytophagous pest, competitor, or parasitic organism
- Most living things can be considered a pest
 - Bacteria, Viruses, Fungi, Birds, Rodents, People, etc.

Downloadable Presentation

You can find this presentation at:

1. <https://ucanr.edu/sites/chenlab>
2. Speaker Presentations

Some original images created by OpenAI Labs Dall-E 3 Program



Thank You