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Prunus-infecting viruses

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Prunus-infecting viruses

Stone fruit are susceptible to a lot of pathogens and diseases.

- Many of these are fungal (i.e. *Eutypa lata* or *Calosphaeria pulchella*) or bacterial (*Pseudomonas syringae*.) in origin and cause significant harm to the tree and fruit production.
- Quarantine, eradication, and chemical applications can control or limit their effects.

Prunus-infecting viruses

Viruses tend to get overshadowed by fungal or bacterial disease because they are often less acute, and instead cause harm over the life of the tree.

- There are always exceptions and that is what we'll cover today!

Image: L. Reinhold, Oregon State University

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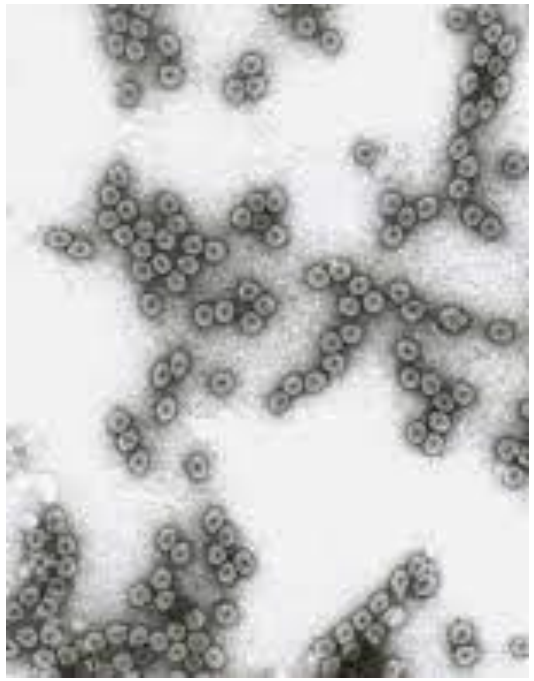
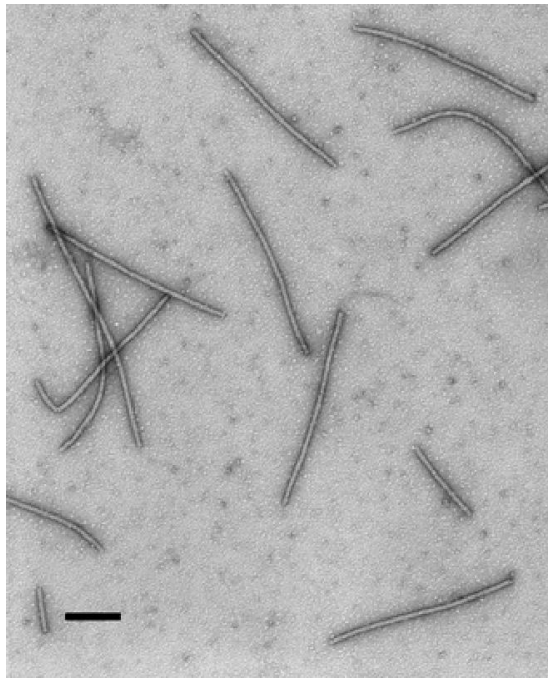
Viruses 101

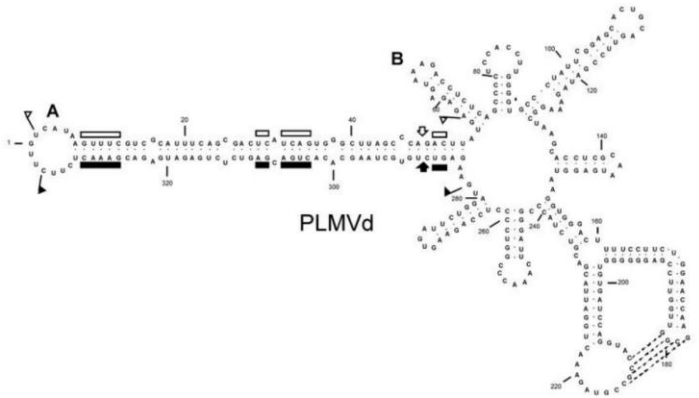
Before we get started, some basic virus biology!

Viruses





Viroids



Viruses 101

Characteristic features of all viruses and viroids:

- Obligate parasites: they require a host to replicate and survive.
- Vector or means of transmission required: they can’t move on their own.
- Disease is a byproduct of their replication, or interference with host systems to do so.

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Viruses 101

Some stone fruit viruses are spread by sap-feeding insects:

- Aphids (plum pox virus)
- Mites (peach mosaic virus)
- Mealybugs (little cherry virus-2)

These can be suppressed with contact or systemic insecticides.

Images: E. Burts, WSU

Viruses 101

Nepoviruses such as cherry rasp leaf virus or tomato ringspot virus are spread by nematodes.

- Fumigation between plantings can suppress nematode numbers temporarily. Planting in nematode free areas is more effective.

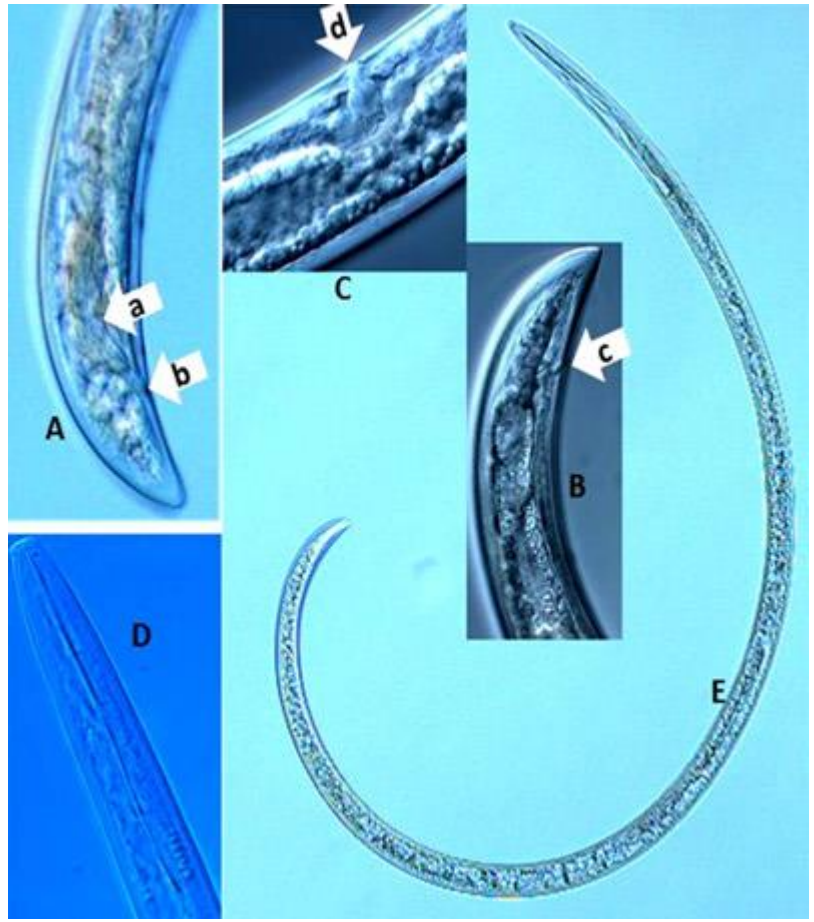

Image: T. Mengistu, UF

Viruses 101

Some viruses can be spread via pollen or seed transmission.

- Prune dwarf virus and Prunus necrotic ringspot virus is pollen transmitted, though not efficiently.
- Some viruses and viroids (peach latent mosaic viroid) are seed transmitted. This is primarily a problem with seedling rootstocks, or trade in heritage seeds.

Viruses 101

Mechanical transmission is the spread of virus through contact, wounding, and the transmission of virus-containing sap between plants.

- Wounds occur from pruning or hedging or snapping shoots by impact. It can also occur through plant-to plant contact and rubbing injury.
- Sap can be spread from wounds on tools and equipment.

Viruses 101

This isn't an efficient means of transmission for stone fruit viruses, but to reduce the risk of mechanical transmission:

- Clean tools and/or equipment between individual plants, plantings, or blocks with 10% bleach. Soak for ~5 minutes then clean tools with water.
- This is hard on your tools, but bleach is the most easily available and effective compound at removing virus contamination on tools.

Viruses 101

People are far more effective at spreading plant viruses than insects are:

- Introducing virus-infected material to a new planting, County, State, or even Country.

- Unrestricted trade in seeds and pollen.

Viruses 101

Characteristic features of all VLOs include:

- Obligate parasites: they require a host to replicate and survive.
- Vector or means of transmission required: they can’t move on their own.
- Disease is a byproduct of their replication, or interference with host systems to do so.

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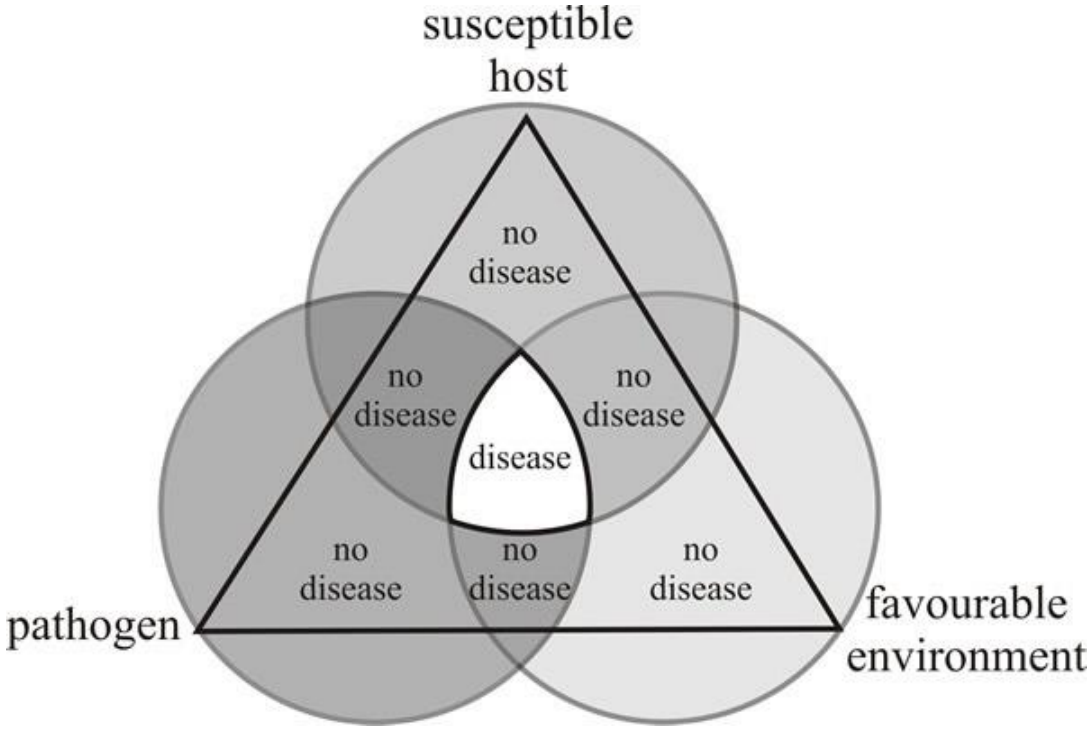
Viruses 101

Disease is the exception, not the rule; you need three factors:

1. Correct host
2. Correct pathogen
3. Suitable environmental conditions



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Prunus-infecting viruses

There are a lot of viruses and viroids that infect stone fruits:

- American plum line pattern virus
- Apple chlorotic leafspot virus
- Apple mosaic virus
- Apricot latent virus
- Apricot pseudo-chlorotic leaf spot virus
- Arabis mosaic virus
- Asian Prunus virus 1
- Asian Prunus virus 2
- Asian Prunus virus 3
- Carnation italian ringspot virus
- Cherry green ring mottle virus
- Cherry leaf roll virus
- Cherry mottle leaf virus
- Cherry necrotic rusty mottle virus
- Cherry rasp leaf virus
- Cherry rusty mottle-associated virus
- Cherry twisted leaf-associated virus
- Cherry virus A
- Cherry virus F
- Cherry-associated luteovirus
- Cucumber green mottle mosaic virus
- Cucumber mosaic virus
- Epirus cherry virus
- Hop stunt viroid
- Little cherry virus 1
- Little cherry virus 2
- Nectarine stem pitting-associated virus
- Nectarine virus M
- Peach enation virus
- Peach latent mosaic viroid
- Peach mosaic virus
- Peach rosette mosaic virus
- Peach virus D
- Peach virus T
- Peach-associated luteovirus
- Petunia asteroid mosaic virus
- Plum bark necrosis stem pitting-associated virus
- Plum pox virus
- Prune dwarf virus
- Prunus necrotic ringspot virus
- Prunus virus F
- Prunus virus T
- Raspberry ringspot virus
- Sowbane mosaic virus
- Strawberry latent ringspot virus
- Tobacco mosaic virus
- Tobacco necrosis virus
- Tobacco ringspot virus
- Tomato black ring virus
- Tomato bushy stunt virus
- Tomato ringspot virus

Prune dwarf virus & Prunus necrotic ringspot virus

PDV and PNRSV are ubiquitous across the U.S. though the ratio varies: WA has predominantly PDV while SC & GA have more PNRSV.

- Transmitted by propagation or root-grafting between neighboring trees.
- Transmitted by pollen – inefficient but there is enough present to ensure it happens.

Prune dwarf virus

PDV causes decrease in growth, yield, and long-term productivity in cherry, peach and plum.

Cherry	Peach	Plum
• Stunting & short internodes, blind wood	• Stunting & short internodes	• Stunting & short internodes
• Narrow leaves	• Dark green leaves	• Narrow leaves
• Yellow spots or mottle on leaves		• Rough surface on leaves
• Distorted fruit, reduced yield		

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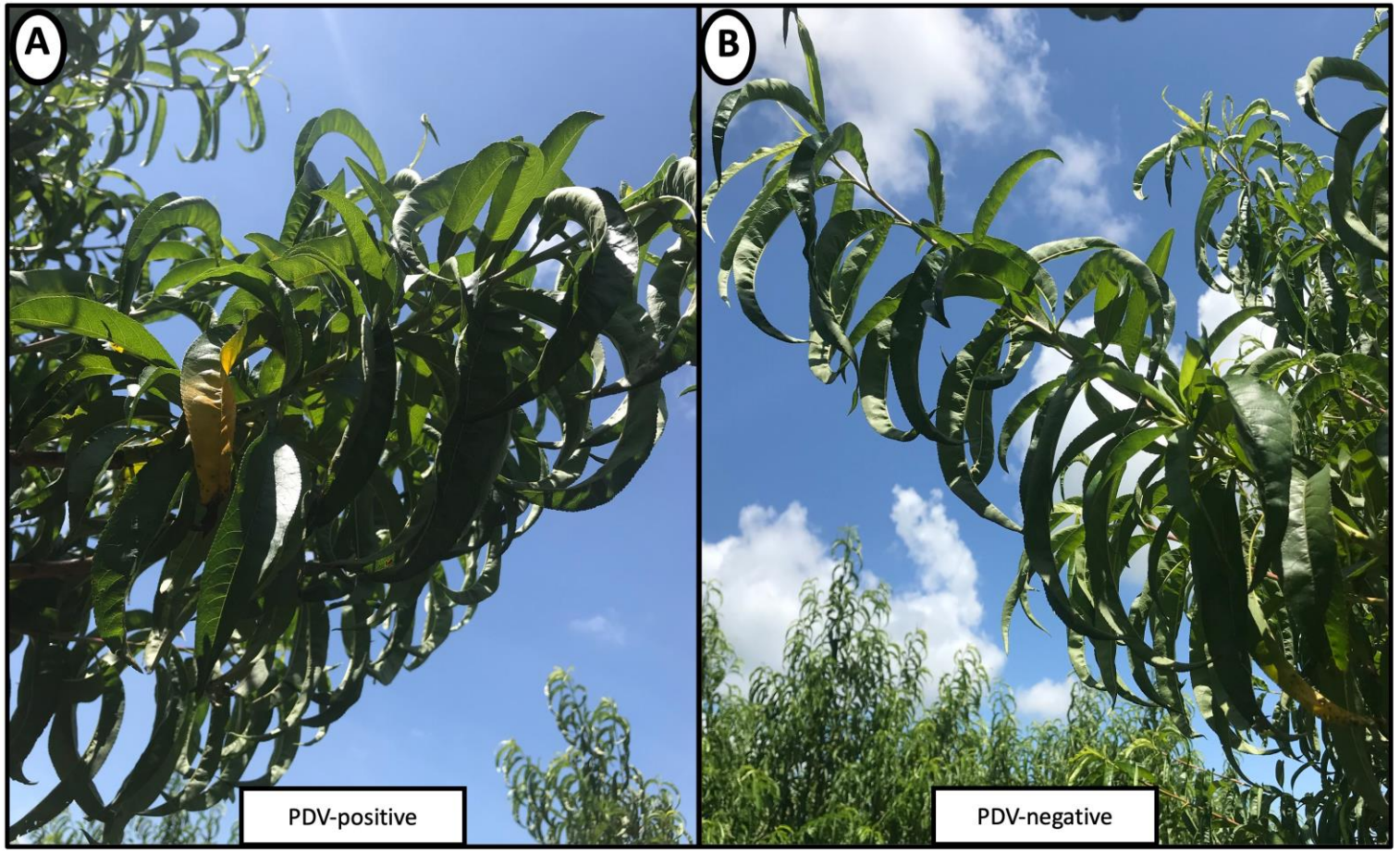
Prune dwarf virus

In peach you see proliferated leaf growth and stunted internodes caused by PDV.



Images: E. Cieniewicz, Clemson Univ.

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Prune dwarf virus

In cherry PDV foliar symptoms appear with cold springs and include mottling, chlorotic rings and distortion.

Images: B. Shane, Michigan State University, G. Bishop, G.S. Long Co., Calgayan et al. 2011

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Prune dwarf virus

PDV can also cause cherry fruit deformation (lumps or creases).

Images: G. Bishop, G.S. Long Co. & Calgayan et al. 2011

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Prunus necrotic ringspot virus

PNRSV, like PDV, causes decrease in growth, yield, and long-term productivity in cherry and peach.

Cherry	Peach
• Stunting & short internodes, blind wood	• Stunting & short internodes, blind wood
• Distorted or twisted leaves with yellow mottle or spots.	• Leaf yellowing, necrotic spots, and an open canopy with fewer buds.
• Smaller, pointed fruit fruit, reduced yield	• ‘Shock’ in young trees

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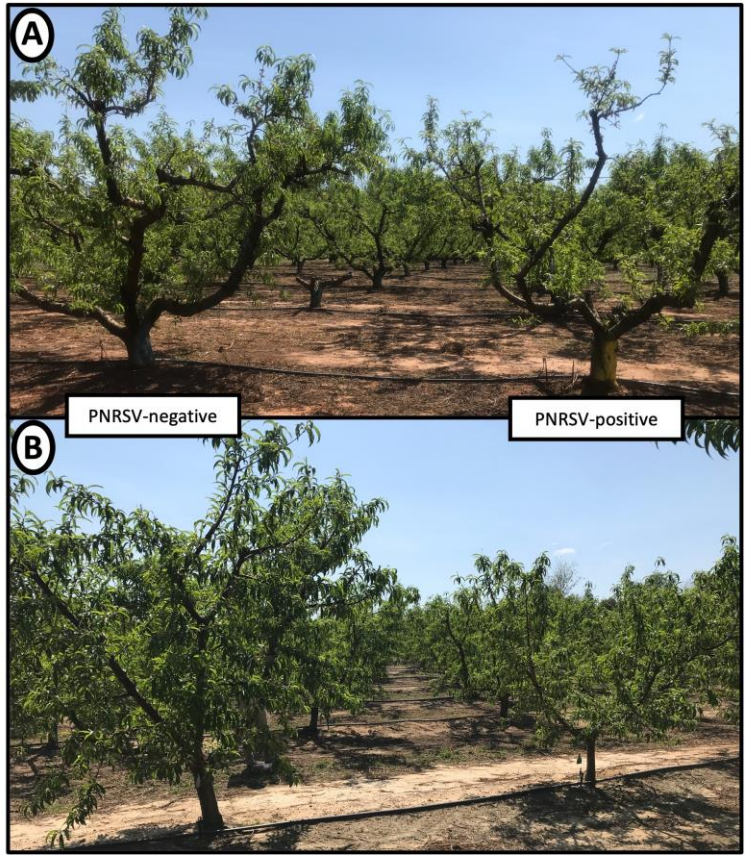
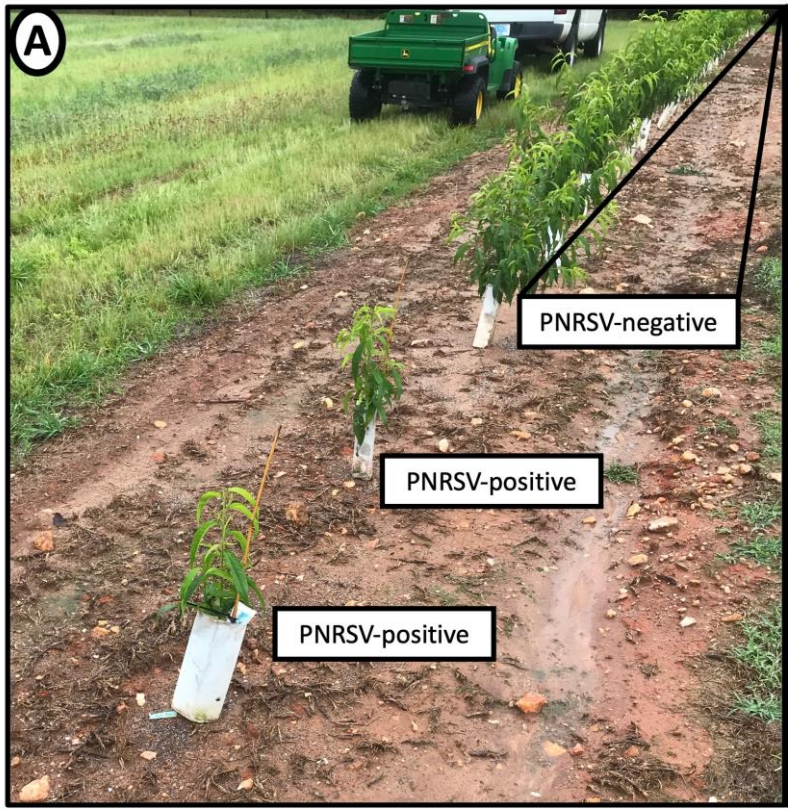
Prunus necrotic ringspot virus

Peach infected with PNSRV are stunted, with reduced growth





Images: E. Cieniewicz, Clemson Univ.

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Prunus necrotic ringspot virus

PNRSV foliar symptoms in cherry appear with cold springs: distortion, ring or line patterns, and shot-holes.

Images: B. Shane, Michigan State University, & Hammond 2011

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Prunus necrotic ringspot virus

PNRSV also causes reduced cherry yield (this tree had 7 fruit on it) and small, pointed and hard fruit.

- This tree had significant blind wood and bare limbs.
- You can also see the severe foliar symptoms on this individual tree.

Prune dwarf virus & Prunus necrotic ringspot virus

Control is difficult given their ubiquity in orchards, wild and ornamental *Prunus*, and pollen transmission.

- Trees should be removed if cherry leaf roll virus is also present (disease is worse).
- Declining trees should also be removed.

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Prune dwarf virus & Prunus necrotic ringspot virus

Coinfection of PDV and PNRSV in peach can cause an acute disease called ‘Peach Stunt’ – this results in:

- Stunting, shortened internodes
- Defoliation
- Delayed and reduced bud break
- Reduced fruit yield
- Bark splitting and gummosis

Images: S. Scott, Clemson Univ.

Cherry leaf roll virus

CLRV is rare – one of those diseases that you either have or you don’t – but is a problem for those that do.

- Transmitted by propagation or root-grafting between neighboring trees.
- Also transmitted by seed and (inefficiently) by pollen.
- Nematode transmission is suspected but not proven.

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Cherry leaf roll virus

The primary symptoms of CLRV are leaf rolling and leaf/bud rosetting – this reduced tree vigor and yield.



Images: Anonymous grower

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Cherry leaf roll virus

Foliar symptoms of CLRV in cherry are more severe when the plant is coinfected with PDV or PNRSV.

- Short internodes and leaf proliferation is common with co-infections.

Image: L. Reinhold, Oregon State University

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Cherry leaf roll virus

CLRV also causes long-term dieback of affected trees, reducing growth and vigor, bare limbs and eventual death.

Images: L. Reinhold, Oregon State University, and an anonymous grower

Cherry leaf roll virus

Control of CLRV relies on:

- Removal of affected trees and treating with roundup to identify root-grafted neighboring trees.
- Use clonal or certified seedling rootstocks.
- Fumigation between plantings to eliminate live root pieces in the soil.

Cherry rasp leaf virus

CRLV is present throughout the country, though its distribution is scattered – you either have it or you don't.

- Transmitted by propagation or root-grafting between neighboring trees.
- Transmitted by the Dagger nematode (*Xiphinema americanum*) and *X. rivesi*.

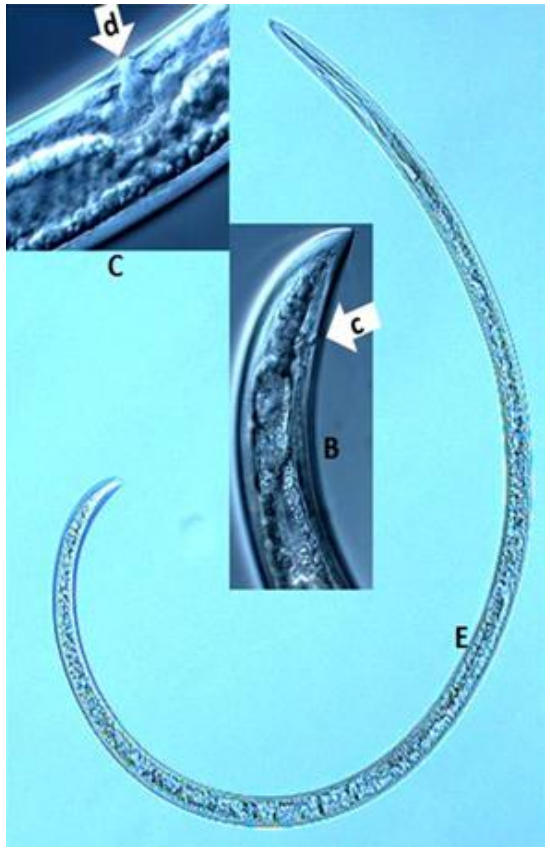

Image: T. Mengistu, University of Florida

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Cherry rasp leaf virus

The diagnostic symptoms of CRLV are:

1. ‘Rasp’ - tattered edge and twisting of leaves,
2. Enations (small lumps) on the lower surface of affected leaves.

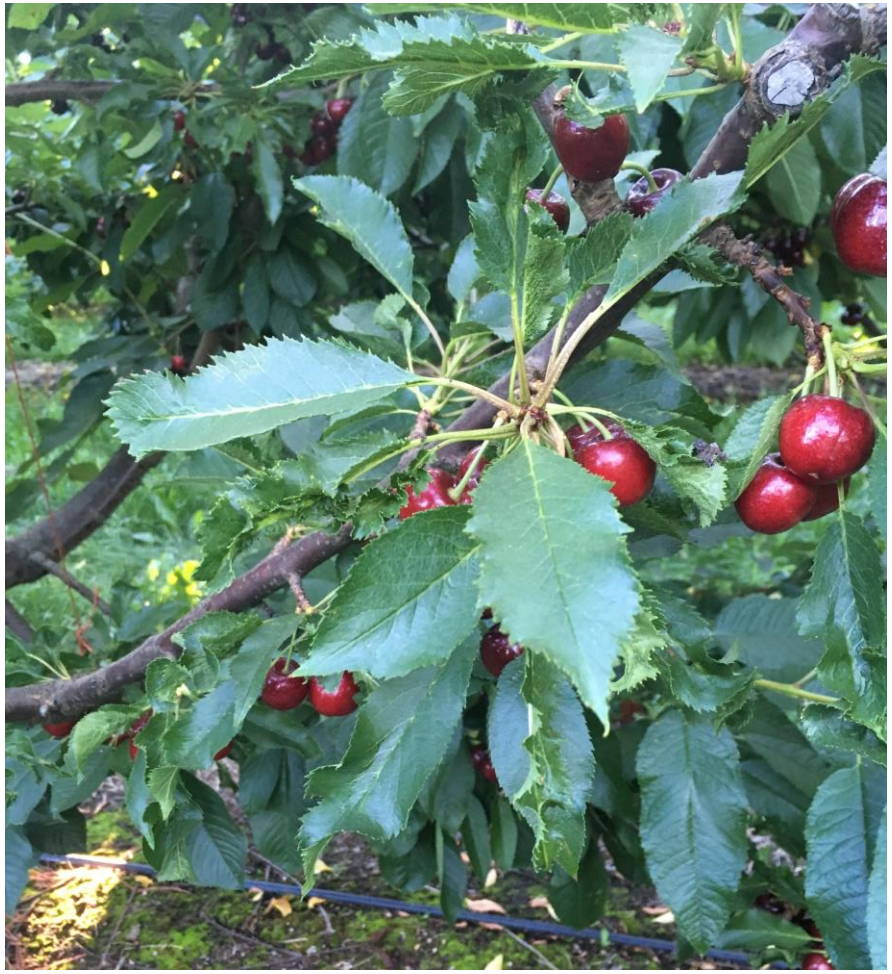

Image: G. Bishop, G.S. Long Co.

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Cherry rasp leaf virus

CLRV symptoms on the upper and lower surfaces of an affected leaf.

Images: G. Bishop, G.S. Long Co.

Cherry rasp leaf virus

Long-term, CRLV can cause decline and dieback of individual limbs – particularly on lower parts of the tree.

- If infected in the 1st or 2nd leaf stages, trees will become stunted.
- Control relies on tree or orchard removal, fumigation and leaving the site fallow.

Cherry rasp leaf virus

CRLV also causes flat apple, where fruit of affected trees are smaller and compressed vertically.

- This presents a problem when changing an orchard from cherry to apple or vice versa.

Image: L. Parrish, USDA-ARS

Tomato ringspot virus

ToRSV has a scattered distribution in the western U.S. and it is more common in the northeast.

- Transmitted by propagation or root-grafting between neighboring trees. Also (inefficiently) seed transmitted.
- Transmitted by *Xiphinema Americanum* (Dagger nematode) as well as X. *bricolensis, X. californicum X. intermedium, X. rivesi,* and *X. tarjanese.*

Tomato ringspot virus

ToRSV has several diagnostic symptoms in stone fruits although may be confused with other viral diseases.

- Eola rasp leaf
- Stem pitting (depressions in the wood) and necrosis near the graft union.
- Small, immature fruit (can be confused with LCD).
- Gradual decline and dieback

Tomato ringspot virus

Eola rasp leaf is similar to, but milder than CRLV, enations present near the midrib.

Image: J. Pscheidt, Oregon State University

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Tomato ringspot virus

ToRSV-induced stem pitting in cherry:

Images: L. Reinhold, Oregon State University

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Tomato ringspot virus

Decline and dieback caused by ToRSV may be uneven, as you can see here.

Dieback can take several years to appear.

Images: J. Pscheidt, Oregon State University

Tomato ringspot virus

ToRSV infects a wide range of plants, from weeds and row crops, to grapes and cherries.

- Herbicide treatment followed by fumigation is critical when replanting.
- Fields should be left fallow (with additional herbicide treatments) to allow for the nematode population to clear the virus.

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Little cherry virus-2

Little cherry virus-2 has been a major problem for cherry production in the U.S. and other countries.

- Fruit are smaller, pale, and taste terrible due to decreased sugars and higher citric acid content.
- LChV2 is transmitted by the apple (*Phenacoccus aceris*) and grape (*Pseudococcus maritimus*) mealybugs.

Images: E. Burts, WSU

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Little cherry virus-2

Little cherry virus-2 interferes with the fruit maturation process, producing small, bitter, pale fruit.

- There are no other significant symptoms on infected trees, only late season leaf bronzing with some virus strain and (older) cherry cultivar combinations.
- It asymptomatically infects peach.

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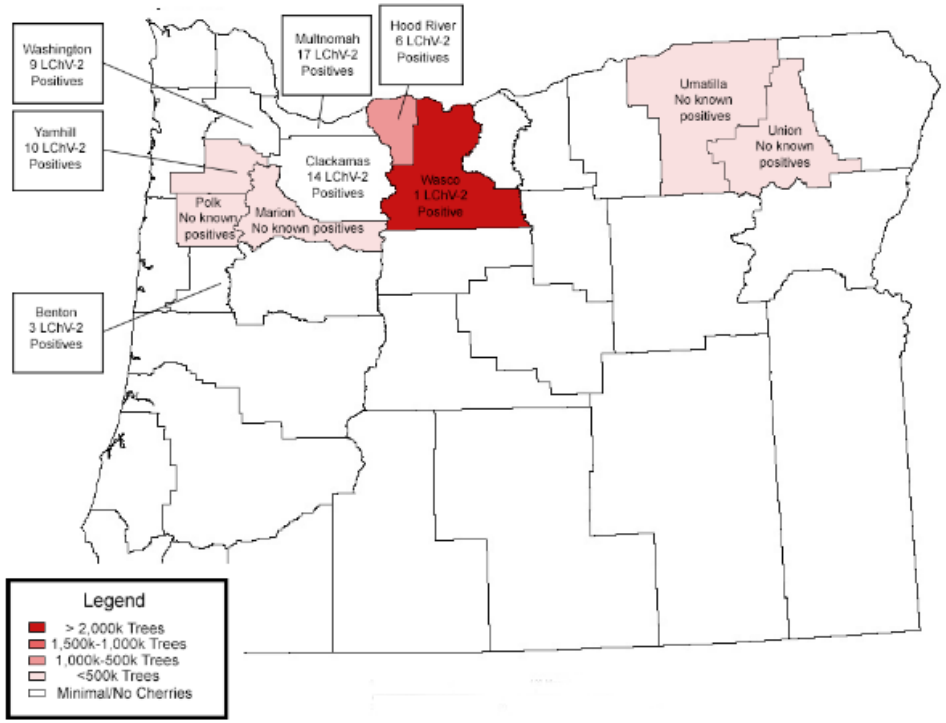
Little cherry virus-2

Where's it coming from?

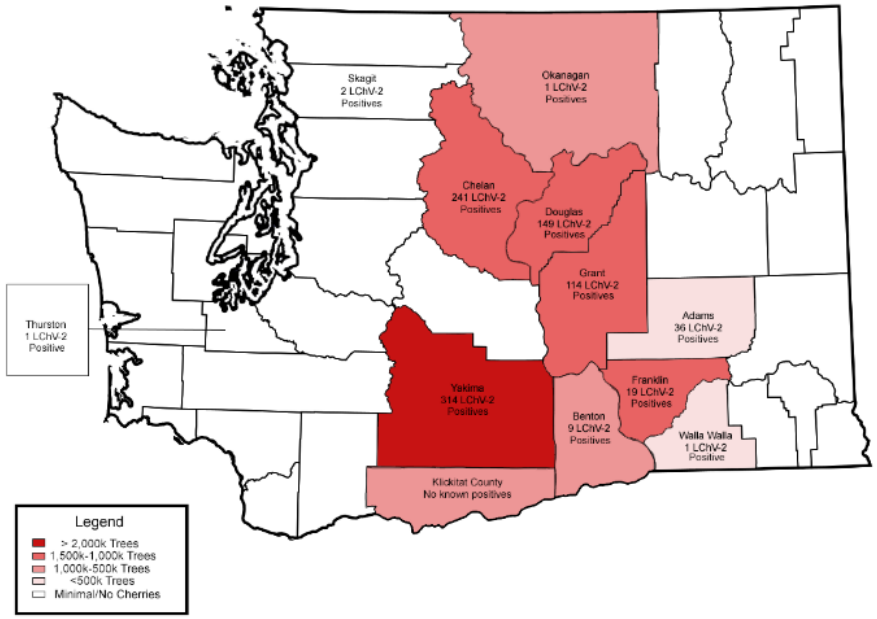
- An ODA survey in 2022 found it in Oregon counties where there is no commercial cherry production.
- It was in ornamental cherries, in which LChV2 infection is hard to distinguish.



Little cherry virus-2

It is also present in ornamental cherries in Washington state.

- This suggests it is coming through propagation and sale of ornamentals.
- This is a risk for your orchards – don't plant ornamentals in or near your fields.



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Virus Management

Viruses are uncurable – once a trees is infected, it is infected for life - therefore virus control efforts focus on:

1. Preventing infection in the first place.
2. Reducing inoculum load and slowing the rate of in-field spread.

Virus Prevention

Viruses enter your fields through vector transmission or through trade and propagation of infected material.

- Vectors are difficult to exclude because they don’t respect fences or boundary lines.
- Working with your neighbors to ensure you all have effective spray and infected plant removal programs is critical.

Virus Prevention

Trade and propagation are more complex:

- Don’t propagated from infected orchards.
- Why buying material, ask if it has been propagated from clean stock, or has been tested for viruses – and ask which ones!
- Check your state quarantines, with your department of agriculture or local extension advisors.

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Virus Management

Key to reducing virus impacts and slowing spread is the identification and removal of infected trees.

- Scout for symptoms and flag suspect trees.
- Extension or your local plant pathologists can help ID the cause and laboratory tests can confirm which pathogen(s) are present.
- REMOVE INFECTED TREES!

Virus Management

The best way to remove an infected stone fruit tree is to either

- Make frill cuts around the trunk during the growing season and apply herbicide or, cut the tree down and apply herbicide directly to the stump.
- You want to kill the root system before removal because the infection can survive in broken roots which can sucker and be a source for spread.

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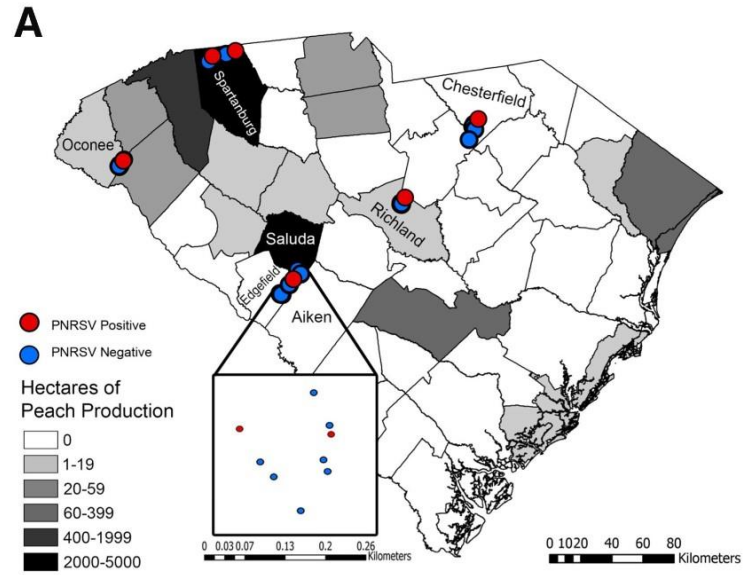
Virus Management

What about alternative hosts?

- Most common stone fruit viruses in the U.S. only infect *Prunus*.
- Therefore, awareness of wild or ornamental *Prunus* near your orchards is important.
- Also be aware of what was planted in the orchard before stone fruit (ToRSV, CRLV)

Summary of wild *Prunus* survey results in South Carolina and Georgia, United States[a]

Collection area	Species collected	Virus or viroid positive/total samples		
		PNRSV	PDV	PLMVd
South Carolina	*Prunus serotina*	11/73	0/73	0/73
	Prunus angustifolia	0/13	0/13	0/13
	Prunus caroliniana	1/12	0/12	0/12
Georgia	*Prunus serotina*	2/19	0/19	0/19
	Total	**14/117**	**0/117**	**0/117**



Source: Rodriguez Bonilla et al (2022). *PhytoFrontiers*, *2:* 363-370.

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Virus Management

Tree removal reduces inoculum, but what about the vectors?

- Have a spray program that controls the vector species in your area.
- If you remove a large number of trees, or an orchard, spray before cutting the trees down to kill the vectors – otherwise they'll just move when you take the trees out.

Images: E. Burts, WSU

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Virus Management

Making your orchard unappealing to vectors is also effective.

- Remove preferred hosts like weeds, and plant grasses as a cover crop.
- Use groundcover fabrics to cover weeds between rows.
- Kaolin makes trees (and other plants it might fall on) unappealing for insect feeding.

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Summary

Be aware of these viruses – they can cause long term growth problems, yield loss, and reduction in fruit quality.

- Testing – most diagnostic labs can test for these common viruses. March-June is the best time to test for most stone fruit viruses.
- Tree removal is the best option, with combined with vector control or fumigation if you have nepoviruses (CLRV, CRLV, & ToRSV).

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Acknowledgements

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