Grapevine Viruses: What They Are, Are Not, Their Damage

Regionalizing Grape Quarantine and Certification Program in the Pacific Northwest

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Major Virus Diseases of Grapevine

Virus Disease & Vectors	Distribution
1. Leafroll complex (GLRaV-1, 2, 3, 4) Mealybugs & scale insects	Worldwide
2. Rugose wood complex Mealybugs & scale insects Vitiviruses (GVA, GVB, GVE)	Worldwide
3. Rupestris stem pitting	Worldwide
4. Degeneration & Decline Nematodes, ToRSV, TRSV,	Worldwide
5. Grapevine red blotch virus TCAH, Leafhoppers?, Others?	Americas, Europe Korea, India

Other Virus Diseases of Grapevine

Grapevine vein clearing virus - midwest
Grapevine geminiviruses
5 new vitiviruses in past two years
Raspberry bushy dwarf virus
Wild vitis virus 1 (another Grablovirus)

Phytoplasmas
Xylella
Viroids

There are about 70 viruses and virus-like agents reported from grapevine worldwide

Virus Diseases of Grapevine

All viruses of grapevine are transmitted through vegetative cuttings

All are transmitted by grafting

Grafting infected vines can result in virus complexes with more severe symptoms

Suitcase importations allow for transmission anywhere in the world very quickly, and they could put existing vineyards at risk!

Grapevine Leafroll Disease: a broad range of impacts

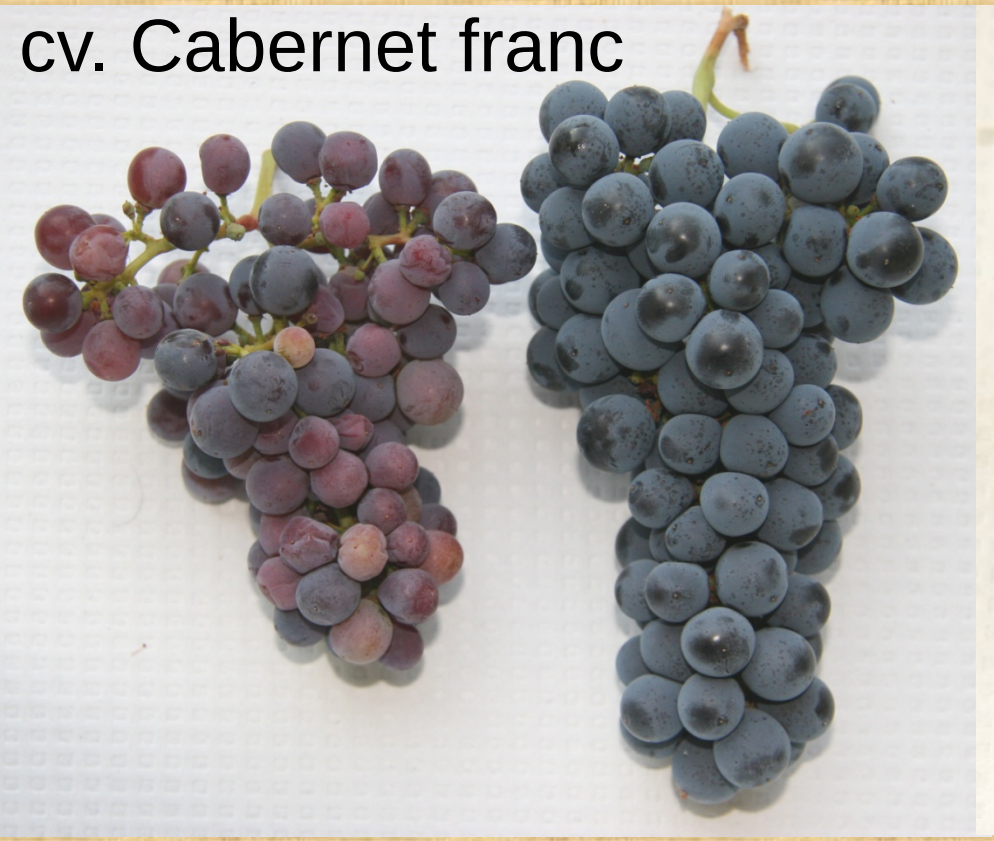
- Delayed maturity and ripening of grapes
- Lower sugar content
- Reduce anthocyanin content
- Increased acidity
- Reduced yields
- Poor quality wine
- Reduced economic returns
- Graft-union incompatibility/sometimes

Grapevine Red Blotch Disease: a broad range of impacts

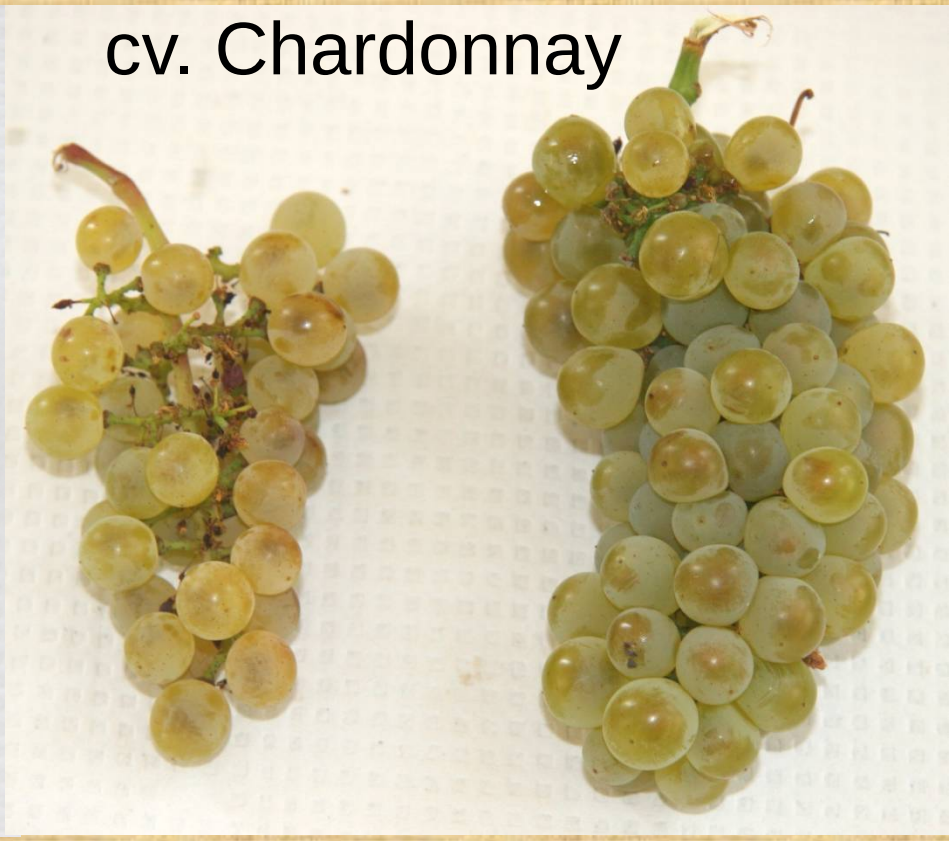
- Delayed maturity and ripening of grapes
- Lower sugar content (varies by cv. and site)
- Reduce anthocyanin content
- Increased acidity
- Reduced yields
- Poor quality wine
- Reduced economic returns

Impact of GLD on Fruit

cv. Cabernet franc



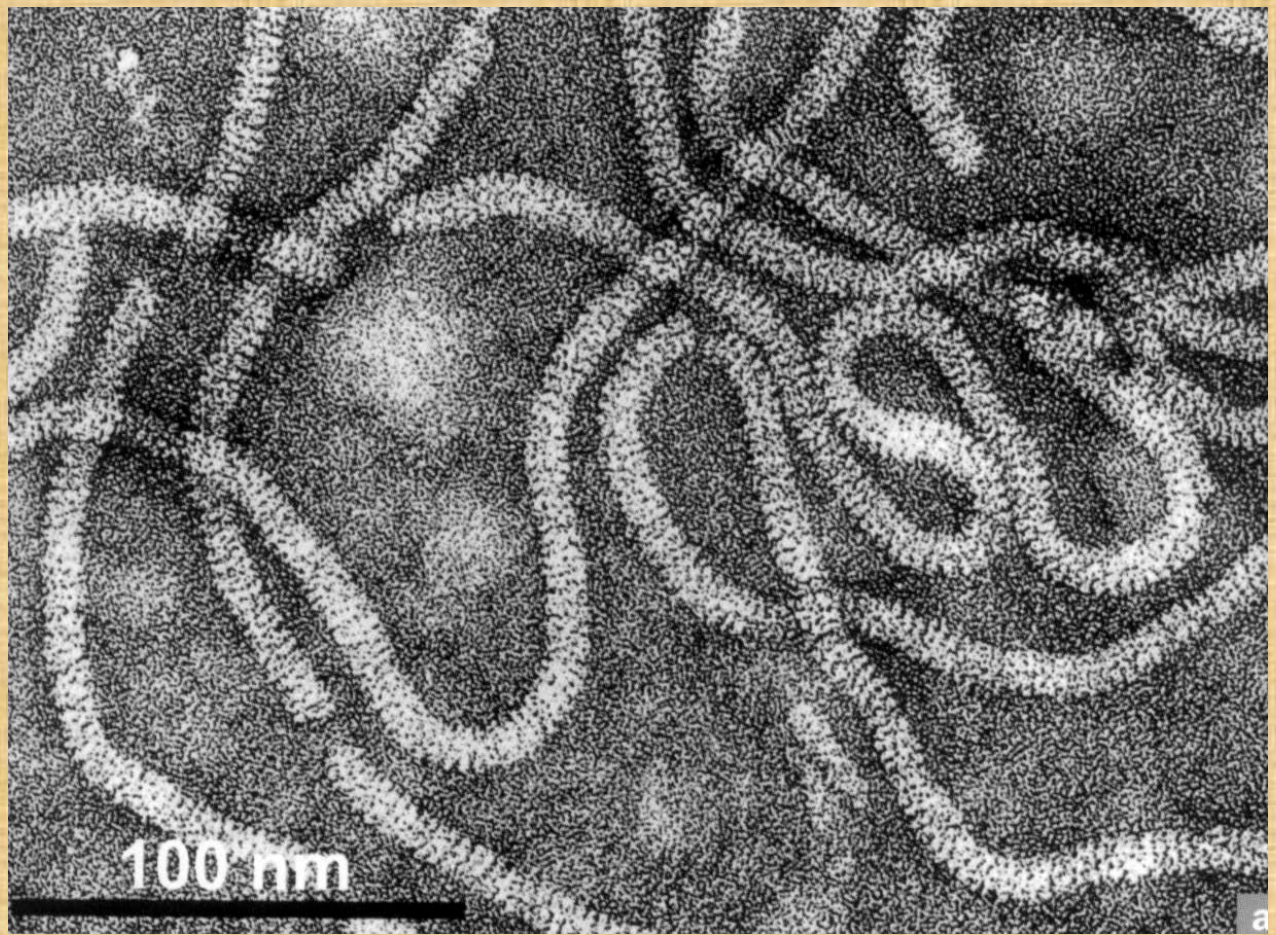
cv. Chardonnay



Uneven ripening
Unequal size and lower yields
Less compact
Poor quality (less sugar & more acid)

Grapevine Leafroll Viruses

Nine viruses capable of causing leafroll disease
all are members of the Closteroviridae family
GLRaV-1, -2, -3, -4, -5, -6, -7, -9, -10, Pr, De, Ca






GLRaV-2 – No Known Vector

Mild symptoms in self-rooted Pinot noir vines

Symptoms more pronounced in grafted vines

in the example shown GLRaV-2 in mixed infection with RSPaV

GLRaV-2 RG, symptomless in standard indicators and on grafted plants of some rootstocks

Lethal when grafted on sensitive rootstocks

Symptomless strains of leafroll (GLRaV-7), no known vector

GLRaV-2 plus RSPaV on grafted Pinot noir, Oregon

Current View of GLRaVs

Virus	Vector
GLRaV-1	Mealybugs, scale insects
GLRaV-2	Not known (rest of genus is by aphids)
GLRaV-3	Mealybugs, scale insects
GLRaV-4	Mealybugs, scale insects
GLRaV-7	Unknown

Lemberger – Finger Lakes Region, New York – Marc Fuchs

GLRaV-3, Pinot noir/3309 rootstock

GLD - a complex virus disease

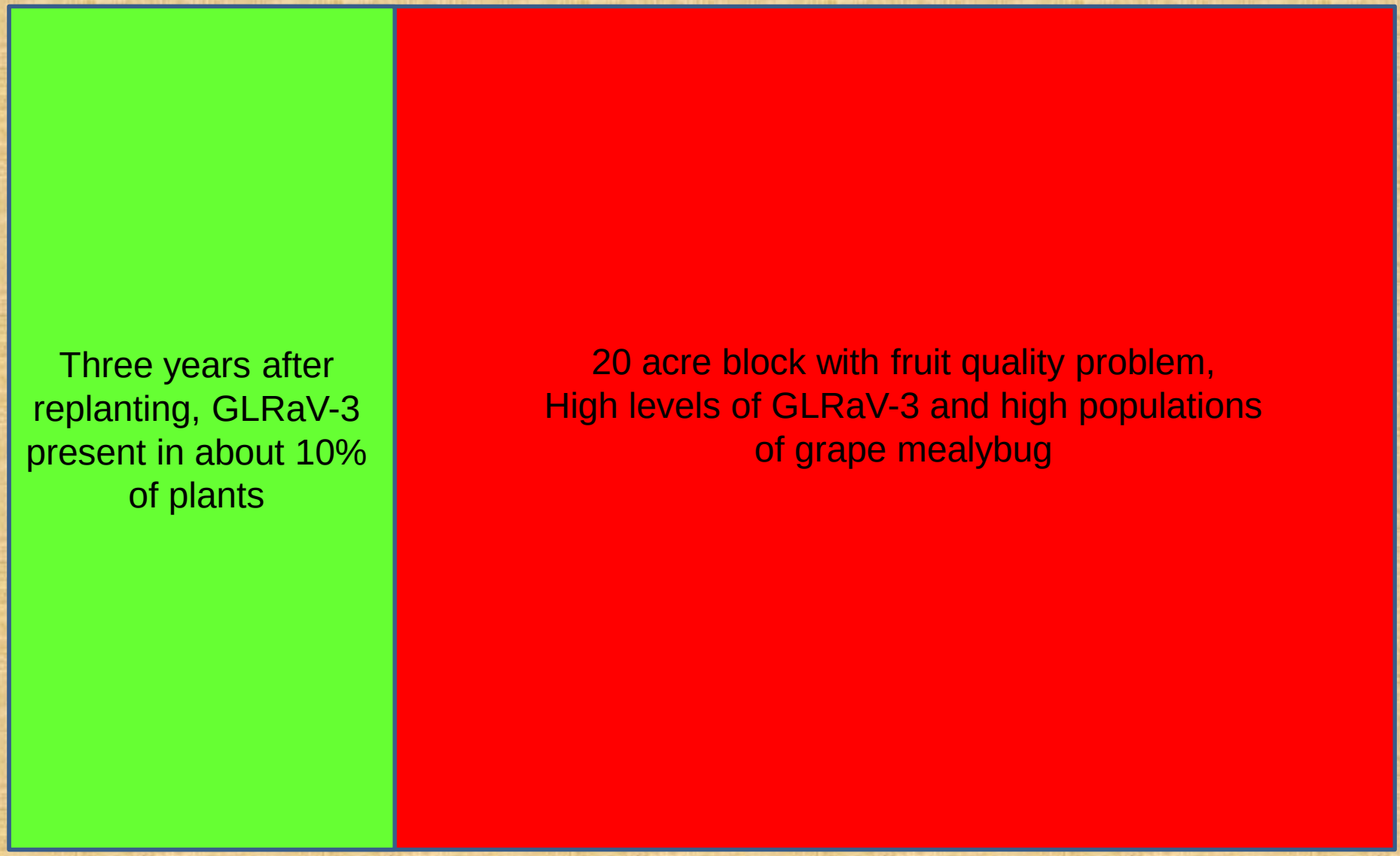
White grape cultivar
e.g. Chardonnay

Red grape cultivar
e.g. Cabernet Sauvignon

Pinot Noir early Aug GLRaV 2 & 3

Pinot noir, LR3 and LR2

GLRaV-3 Spread in Idaho
With large mealybug population



Spread of GLD

Oregon:

Vineyard with GLRaV-2, no spread over the past 10 years

Vineyard with GLRaV-3, has some spread in Willamette Valley to adjacent plants over the past 17 years (WV), slow by comparison to S. OR, WA , ID or CA

Idaho:

Spread into young plantings where certified stock was used. Incidence in new plantings approximately 10% after three years - not followed over time

Rugose Wood Complex

Rugose wood complex 5 Vitiviruses
GVA, GVB, GVC, GVE, GVF

Worldwide distribution

Vectored by Mealybugs & scale insects

Oregon, Washington and Idaho,
Vitiviruses (GVA, GVB, GVE), all are uncommon and we rarely see this disease complex

Degeneration and Decline

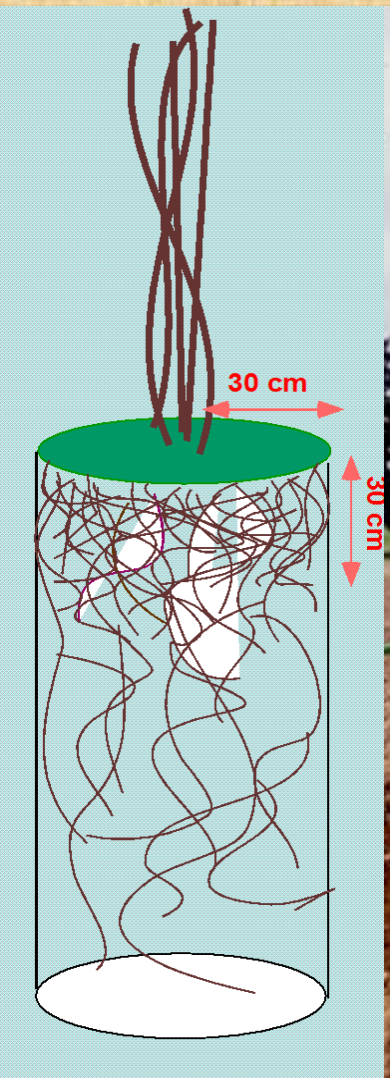
Caused by Nepoviruses, infect a broad range of plants (ToRSV, TRSV), PRMV, BLMoV, ArMV, GFLV, RpRSV, GDefV, TBRV, GBLV, GCMV, GARSV, CLRV, SLRSV

Viruses occur world-wide, but not common in grape world-wide (GFLV, ToRSV, TRSV)

One or more are common in northeastern U.S. and parts of Europe, not common in OR, WA, ID

Tomato ringspot virus detected in three vineyards in OR, moves slowly, causes graft union necrosis, decline and death, TRSV in one vineyard in WA

Nematodes on the Move



Grapevine red blotch virus (GRBV) Background

- Symptoms observed in the mid-2000s (05-06) in California, graft transmissible
- During SCRI grant on GLRaVs and mealybugs (2009-2012) many vineyards in Oregon, WA, ID and CA with red leaves were negative for GLRaVs
- Similar symptoms observed in NY

GRBV – PNW

-Sequenced 20 isolates from different cultivars and locations in PNW (very little variation)

-°Brix reduced ~2.4 points (~9-10%) in Cabernet franc (S. OR), similar reduction in Merlot in WA (11-12%)

-°Brix, pH, TA and pH less affected in Pinot noir, but anthocyanins reduced significantly

-Tested weeds within and around vineyards where GRBV was at high incidence, no confirmed weed hosts at this time. Testing in and around more vineyards in 2018

GRBV, very limited movement 40 yrs

GRBV Pinot noir on 3309 Rootstock

GRBV Pinot noir on 3309 Rootstock

GRBV Pinot noir on 3309 Rootstock

Cabernet franc, GRBV

Cabernet franc, GRBV

Merlot – 100% GRBV

Detected in All Cultivars Sampled

Barbera
Cabernet sauvignon
Cabernet franc
Grenache
Malbec
Merlot
Mourvèdre
Petit verdot
Pinot noir
Tempranillo
Chardonnay
Muscat
Pinot gris
Roussanne
Viognier

Petit syrah
Pinot meunier
Syrah
Zinfandel

Field Spread in Oregon

In some vineyards GRBV is clearly spreading, removal of symptomatic vines, more vines with symptoms following year

In other vineyards GRBV appears to not be moving over 10+ years

Some blocks clearly planted with infected vines, 100% infection in second leaf

Not sure why the difference in spread between vineyards

GRBV Vectors

Virginia Creeper leafhopper reported to transmit GRBV in greenhouse studies (WA)

Three cornered alfalfa hopper reported to transmit GRBV in greenhouse studies in CA. Repeated in NY, but not published.

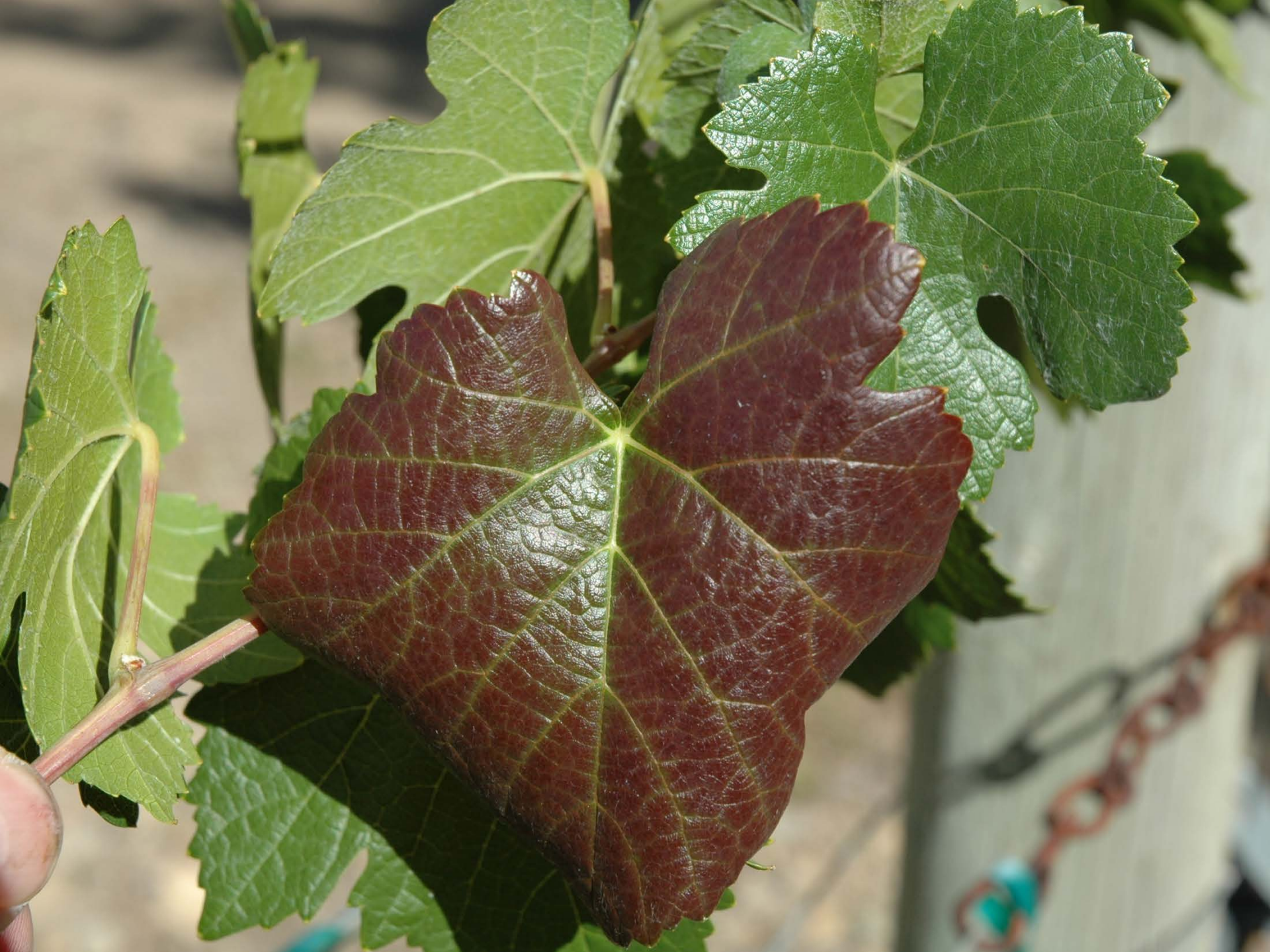
With TCAH and the VC Leafhopper, repeating transmissions has been challenging. Is there something else that is transmitting this virus?

Pinot noir on 44-53 Rootstock

This is NOT Red Blotch, cause unknown, but it is spreading


Tested negative for GLRaVs and GRBaV


Another unknown –
Pinot noir on 110R rootstock



Virus Look Alikes

Drought

Phosphorous Deficiency

Magnesium Deficiency

Summary for Oregon

In the Willamette Valley, GLRaV-2 is most common
No evidence of spread over past seventeen years, likely due to reworking vineyards
GLRaV-3, limited spread over last 15 years,
GRBV present with significant spread in some cases, ToRSV limited, slow in field spread

In Southern Oregon, GLRaV-3, most common of the Leafroll viruses, grape mealybug found there, GRBV present and spreading

In Eastern Oregon GLRaV-3 is present,(but relatively few samples tested), GRBV situation not clear, not many samples tested

Virus Management – 101

START CLEAN

Remember - We The People - Are the BEST virus vectors

We can transmit viruses anywhere in the world in 24h

We can establish a vineyard with infected plants and have 100% infection before the first harvest

Bringing in infected material we can put existing vineyards at risk from a virus not previously known to exist in our area

Please, Please, Please – No suitcase introductions

Virus Status of FPS Grape Introductions from 1998-2018

Approximately 50% of introductions were Virus Positive

Country of Origin	No. Intros	Regulated Virus Positive	RSP Positive	% Virus Positive
Argentina	67	6	14	29.9
Armenia	6	1	3	66.7
Australia	24	4	12	66.7
Austria	2	1	1	100.0
Azerbaijan	42	7	4	26.2
Brazil	1	1	0	100.0
Bulgaria	5	4	1	100.0
Canada	46	22	11	71.7
Chile	8	4	1	62.5
Croatia	28	22	3	89.3
Cyprus	5	3	2	100.0
France	326	61	166	69.6
Georgia	41	32	9	100.0
Germany	43	3	18	48.8
Greece	44	26	1	61.4

Country of Origin	No. Intros	Regulated Virus Positive	RSP Positive	% Virus Positive
Hungary	13	6	2	61.5
Iran	18	5	0	27.8
Israel	30	22	0	73.3
Italy	175	48	41	50.9
Japan	5	2	1	60.0
Korea (North)	8	4	1	62.5
Mexico	4	1	0	25.0
New Zealand	14	1	11	85.7
Portugal	197	37	88	63.5
South Africa	56	14	1	26.8
Spain	64	18	19	57.8
Switzerland	7	2	1	42.9
Turkey	1	0	0	0.0
Turkmenistan	61	15	3	29.5
United States	769	216	129	44.9

Virus Management - 102

Start Clean – There are no viricides, once infected no in field treatment available to cure virus infection

Scion and rootstocks need to be clean, using grafted plants doubles the risk (topworking)

Be aware of virus risk from adjacent vineyards

Scout for symptoms and vectors then TEST – DON'T GUESS

Keep good records (plant source, map symptomatic vines, treatments applied etc.)

Rogue infected vines, know when to bite the bullet and replant vineyard

Questions?

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