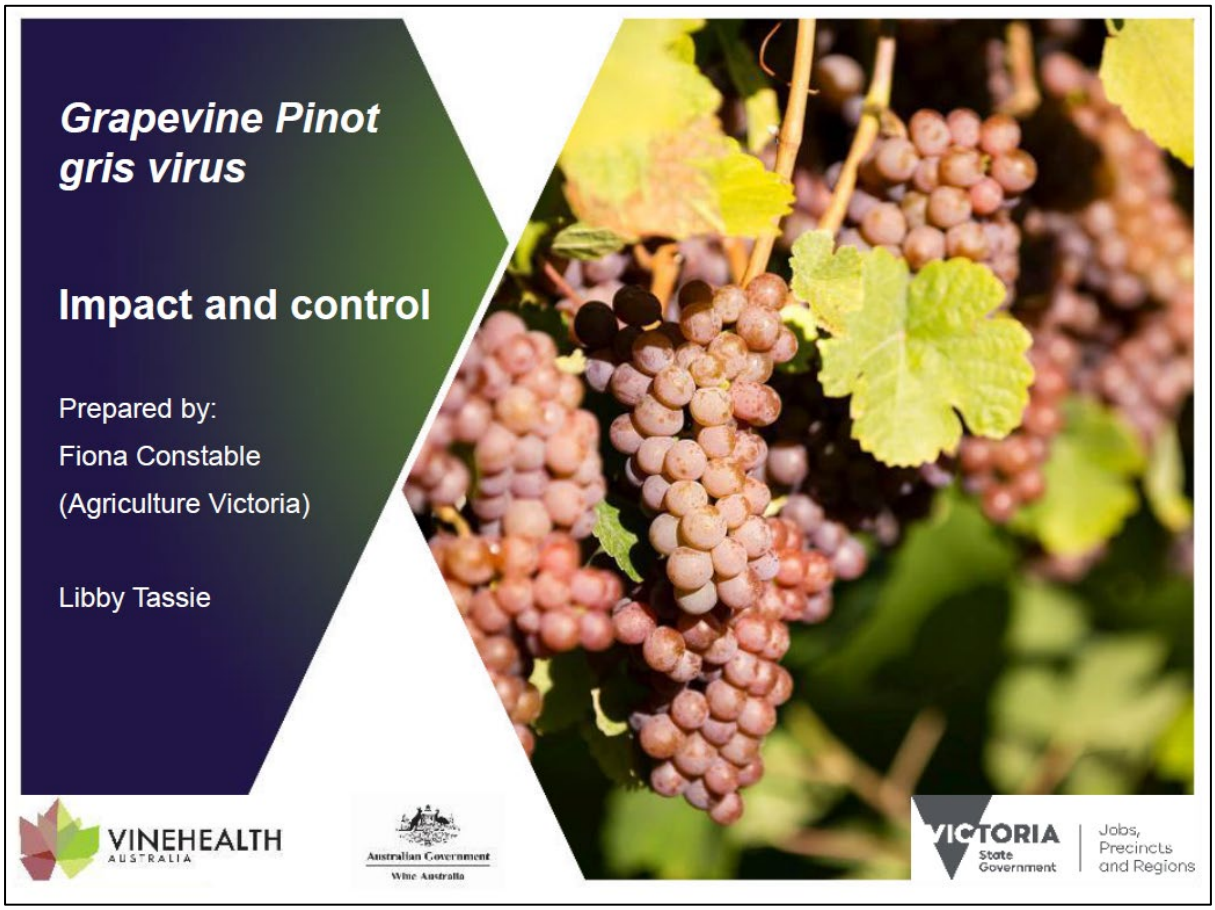
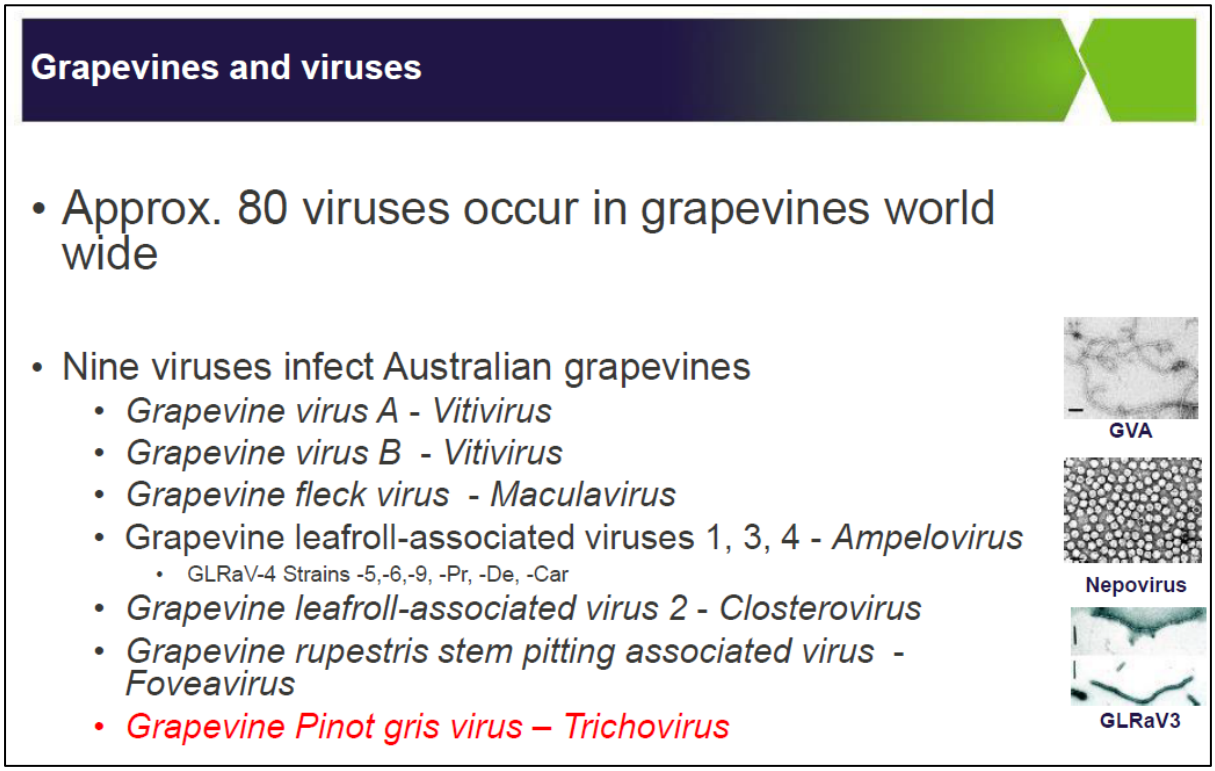
6.0 Appendices

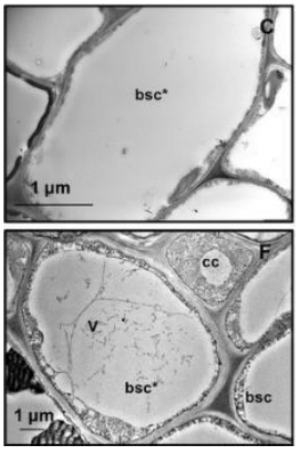
6.1 Workshop presentation: Grapevine Pinot Gris Virus. Impact and control





Grapevine Pinot gris virus (GPGV)

- New to science virus: described in 2012
- Detected in Pinot gris with symptoms of leaf mottling and deformation (GLMD) in Italy
- GPGV has been detected in more than 135 grapevine varieties worldwide
  - Wine and table grapes and rootstocks
- Reported in Australia in 2016
- Infects the vascular tissue
  - Phloem
  - Bundle sheath cells around phloem
  - Moves systemically within the plant

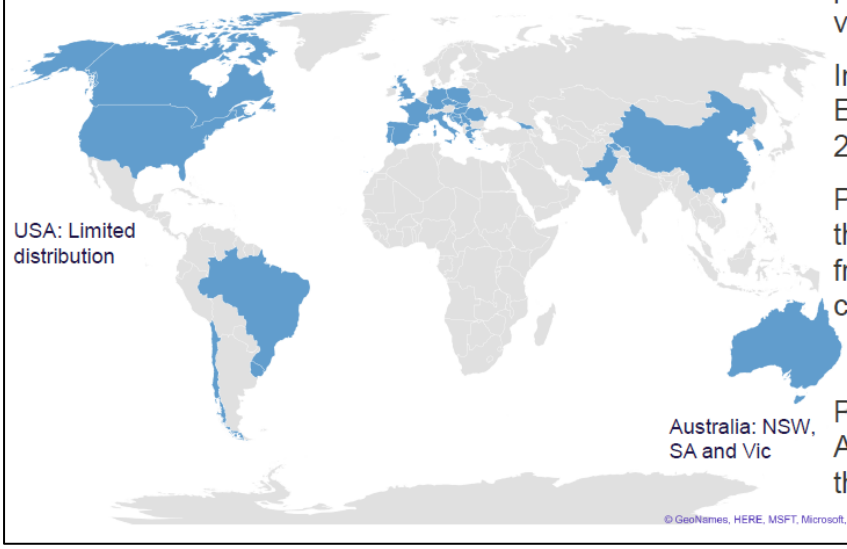


Top: Healthy bundle sheath cell (bsc)

Bottom: GPGV infected bundle sheath cell (bsc)

Tarquini, G. et al. Protoplasma (2018) 255: 923. https://doi.org/10.1007/s00709-017-1198-5

GPGV is found in many grape growing regions worldwide



Global and regional movement via infected propagation material or viruliferous insect vectors.

Increasing spread within Europe and globally after 2002.

Possible introduction into the Veneto region of Italy from Eastern European countries after 2002.

Probably introduced into Australia before 2014 but in the last 10-20 years

GPGV: disease and impact

GPGV is associated with symptoms in

- **Pinot gris, Pinot blanc, Pinot noir, Gewurztraminer, Tocai friulano and Glera (Prosecco)**

- **Leaf mottling and deformation**
  - **More pronounced early in the growing season**
- **Stunting due to shortened internodes**
- **Fruit yield and quality may be affected**
  - **Low bunch weight and bunch numbers in Pinot Gris, Gewürztraminer and Glera (Prosecco)**



Traminer with GLMD Source: Dr. Pasquale Saldarelli

GPGV: disease and impact

Other symptoms have been observed in GPGV infected grapevines, but the specific association is unclear:

- **bunch shatter, delayed budburst, desiccated inflorescence, delayed ripening, poor lignification, millerandage, shoot tip necrosis, zig zag shoot growth**

Pinot gris with GLMD. Source: Dr. Pasquale Saldarelli





Pinot gris with GLMD. Source: Dr. Pasquale Saldarelli

The association between GPGV and disease is complex

Experimentally, under glasshouse conditions, GPGV has been shown to cause GLMD in Pinot gris

Field expression is likely to be more complex

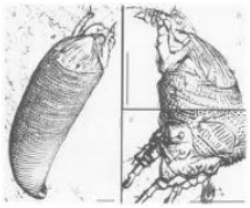
- **GPGV has been found on its own and with other viruses in both GLMD affected and asymptomatic grapevines**
- **Symptomless and asymptomatic infections occur**
  - **Varietal responses to GPGV may differ**
  - **Some varieties may not show symptoms**
  - **Symptoms may not be expressed in sensitive varieties every year**
  - **Symptoms may fade later in the season**
  - **Genetic variants of GPGV can be associated with symptomless infections**
- **Environment may affect the severity of GLMD expression**
  - **E.g. soil type, climate**
- **The impact in many vineyards with low levels of GLMD may be negligible**

GPGV Transmission

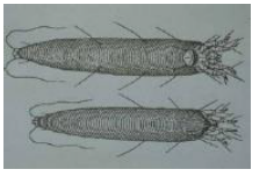
Insect vectors:
***Colomerus vitis* (Bud and blister mite)**

- Mites can acquire GPGV during 4 hours
- Related viruses are transmitted in a semipersistent manner by other mites i.e. the virus remains in the insect for a longer period but does not propagate and is lost upon moulting.
- There may be no latent period





Propagation material



Grafting/Top working

GPGV is not known to be seed borne or transmitted mechanically

Look alike diseases

- Bud and rust mite damage
- Restricted spring growth
  - Spring frost damage
  - Water stress
- Nutrient deficiencies
- Herbicides
- Other pests or pathogens
- **Detection and diagnosis of GPGV infection requires an accurate laboratory based test**



Bud mite damage. F. Constable



Chlorsulfuron damage



Phomopsis. http://grapepathology.blogspot.com/



Downy mildew. https://www.agric.wa.gov.au/table-grapes/downy-mildew-grapevines



Herbicide damage. Photo by Fritz Westover, Texas A&M University



Manganese deficiency in Riesling. (Source: Progressive Viticulture, LLC ©)



Boron deficiency: Zinfandel Source: Progressive Viticulture, LLC ©



Stunted shoot, deformed leaves, and chlorosis leaf symptoms of zinc deficiency in Pinot noir. (Source: Progressive Viticulture, LLC ©)

GPGV spread and GLMD symptom development

1. Spread

- Infected grapevines are a source of GPGV infection
  - Propagation material and vectors
  - Bud/blister mites are dispersed by wind, equipment, people, planting/grafting material
- Rate of GPGV spread is impacted by vector density and possibly by variety
  - e.g. GLMD spreads more quickly in Pinot gris compared to Traminer in Italy

GPGV spread and GLMD symptom development

2. Symptom development

- Vines can become GPGV infected within the first year of planting
- GLMD could take as long as seven years to develop after GPGV infection
- GLMD expression is variable from year to year
- Impact of GLMD on yield can be variable, depending upon the variety and symptom severity
  - Up to 85% yield loss reported (bunch weight and/or numbers)
  - Up to 43% reduced vigour (pruning weight)
- Symptomless infections occur
- GLMD is not reported in Australia, although GPGV has been detected

Alternative hosts

- *Ascelpias syricaca* (Common Milkweed)
- *Chenopodium album* (Fat Hen)
- *Fraxinius* species (Ash species)
- *Rubus* species (e.g. Raspberries and Blackberries)
- *Rosa* species (e.g. Rose)
- *Silene latifolia* subsp. *alba* (White Campion)
  - Tested for GPGV because they showed virus-like symptoms including chlorotic spots and mottling.
  - Infection of these hosts implies the existence of another vector
  - Importance in spread of GPGV is unknown



Virus infection is for life

GPGV control - Prevention is better than cure

- **Use pathogen tested grapevine material**
  - **Viruses, including GPGV, not detected**
- **Certification = High health planting material**
- **Developing GPGV free germplasm**
  - **Heat treatment and/or chemotherapy & tissue culture for virus eradication**
  - **Annual testing for viruses**
    - **Symptomless infections occur**
  - **Removal of infected grapevines**
  - **Vector control to prevent further spread**
  - **Insect proof facilities reduce risk to high-health material**
  - **Control alternative hosts**
  - **Accurate diagnosis – laboratory testing**

Virus management

VINE IMPROVEMENT & NURSERY SECTOR

- Include GPGV testing as part of standard virus screens that underpin certification for production of high - health propagation material.
- Undertake active mite control in nursery and source blocks.
- Undertake active control of alternative GPGV hosts in nursery and source blocks as they are identified.
- Monitor vines for signs of GLMD but note that visual symptoms do not often reflect GPGV status

Virus management

WINE GRAPE OR TABLE GRAPE GROWER

- Undertake GPGV testing of all scion and rootstock material prior to top working.
- Request GPGV as part of a virus screen in planting or replanting situations.
- Undertake active control of
  - bud and blister mite to minimise within block spread of GPGV.
  - alternative GPGV hosts as they are identified.
- GPGV - not known to be mechanically transmitted by touch, pruning or harvesting equipment.
- Monitor vines for signs of GLMD - note that visual symptoms do not often reflect GPGV status.

GPGV detection

- Symptom expression is not a reliable indicator of GPGV infection
  - Symptomless infections
  - Look alike diseases
- Accurate diagnostic tests are required:
  - Appropriate sampling
    - Sample at least two shoots per vine (one per side) or 10 leaves that have been randomly selected over the canopy
    - GPGV can be detected year round when a sensitive laboratory based test (RT-PCR) is used
  - Verified laboratory based test should be used

The Australian Wine Research Institute –
Virus testing service
Telephone: 08 8313 7426
Email: commercialservices@awri.com.au

Agriculture Victoria - Crop Health Services
Telephone: (03) 9032 7515
Email: CHS.Reception@ecodev.vic.gov.au

GPGV is present in Australia

The distribution and agronomic impact of GPGV and GLMD in Australia is unknown

The genetic diversity of GPGV and impact on disease in Australia is unknown

The impact of the Australian environment on disease expression in GPGV infected grapevines is unknown

The efficiency of vector transmission in Australia is unknown

- *Colomerus vitis* is a likely vector in Australia

The role of alternative hosts in Australia is unknown

- Some alternative hosts occurring overseas also occur in Australian vineyards

In the absence of this knowledge it is important to control for GPGV


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Wine Australia
VINEHEALTH
AUSTRALIA
Australian Government
Wine Australia
VICTORIA

6.2 Grapevine Pinot Gris Virus: Management and sampling

Current recommended management strategies for GPGV across the viticulture supply chain.

NUCLEUS COLLECTION	VINE IMPROVEMENT AND NURSERY SECTOR	WINE GRAPE OR TABLE GRAPEGROWER
• **Actively test nucleus collection for GPGV** • **Undertake rogueing or virus elimination on positives.** • **Undertake active mite control.** • **Consider use of grapevine tissue culture and /or insect proof screening to hold high health germplasm to minimise risk of infection and preserve our heritage material** • **Good vineyard hygiene practice**	• Include GPGV testing as part of standard virus screens that underpin certification for production of high - health propagation material. • Undertake active mite control in nursery and source blocks. • Undertake active control of alternative GPGV hosts in nursery and source blocks as they are identified. • Monitor vines for signs of GLMD but note that visual symptoms do not often reflect GPGV status • Good vineyard hygiene practice	• Ensure you undertake GPGV testing of all scion and rootstock material prior to top working. • Ensure you request GPGV as part of a virus screen in planting or replanting situations. • Undertake bud and blister mite control to minimise within block spread of GPGV. • Undertake active control of alternative GPGV hosts as they are identified. • GPGV is not known to be mechanically transmitted by touch or via pruning or harvesting equipment. • Monitor vines for signs of GLMD but note that visual symptoms do not often reflect GPGV status • Good vineyard hygiene practice

To test for GPGV in grapevine material:

1. Virus testing locations in Victoria and South Australia
Crop Health Services, Victoria
Web: http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/diagnostic-services
Ph: 03 9032 7323 / 03 9032 7515 or email: chs.reception@ecodev.vic.gov.au

AWRI Commercial Services, South Australia.
Web: https://www.awri.com.au/commercial_services/virus-testing/
Ph: 08 8313 7426 or email: commercialservices@awri.com.au

2. Sampling protocols

Sampling methodology - take vine samples preferably in autumn, winter and spring

- contact the relevant testing services, for protocol.
- a minimum of two shoots, one from each side of a grapevine, or 10 leaves with petioles, randomly collected across an entire grapevine was shown to pick up GPGV in the preliminary sampling trial.

6.3 Grapevine Pinot Gris Virus: Fact sheet

https://www.wineaustralia.com/getmedia/93f5bf06-9a5f-4244-88a3-8c1a20c3661c/RD_Factsheets_GrapevinePinotGrisVirus_Jan2019_W2