Vine Virus in Australia and their impact on production
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What are viruses?

- Nucleic acid (RNA or DNA) encapsulated in a protein coat
- Require a host for replication
- Disease is a host response to infection
Grapevine viruses

• Approx. 60 viruses world wide
  – Many occur in Australia
    – Grapevine may be a minor or incidental host
  – 9 reported to infect Australian grapevines
    • *Grapevine virus A* (GVA) - Vitivirus
    • *Grapevine virus B* (GVB) - Vitivirus
    • *Grapevine fleck virus* (GFKV) - Maculavirus
    • Grapevine leafroll-associated viruses (GLRaV)-1, 3, and 4, - Ampelovirus
      – GLRaV-5 and -9 are now considered strains of GLRaV-4
    • *Grapevine leafroll-associated virus 2* - Closterovirus
    • *Grapevine rupestris stem pitting associated virus* - Foveavirus
    • *Grapevine fanleaf virus* - Nepovirus
      – Once occurred in isolated areas of Australia but has since been contained and eradicated
A survey for grapevine viruses in Australia

- Tested 218 grapevines for 30 viruses

- **8 endemic viruses:**
  - *Grapevine virus A* (38%)
  - *Grapevine virus B* (1%)
    - not associated with corky bark disease
  - *Grapevine fleck virus* (32%)
  - *Grapevine leafroll-associated virus (GLRaV-)* 1 (13%)
  - GLRaV-3 (14%),
  - GLRaV-2 (6%)
  - GLRaV-4 (1.3%), GLRaV-4 strain 5 (9%) and GLRaV-4 strain 9 (11%)
  - *Grapevine rupestris stem pitting associated virus* (94%)

- **22 viruses significant to quarantine:**
  - GLRaV-4 strain 6, GLRaV-7, GRGV, 2 tombusviruses, 15 nepoviruses, SLRSV, GVD, GFLV
  - None were detected
Virus associated diseases and problems

– Disease
  • Leafroll disease
  • Rugose wood complex
  • Shiraz disease
  • Fanleaf degeneration/decline

– Some varieties may be symptomless

– Production and sustainability

– Multiple virus infections may compound problems
Leafroll disease

- **Foliage**
  - Reddening or yellowing, veins may remain green
  - Downward rolling of the leaves
- **Fruit**
  - Colour, aroma, sugars, titratable acidity
  - Delayed ripening
  - Reduced yield, poor cluster formation and development
    - 10-70% yield losses are reported
- **Vine growth**
  - Smaller canopies,
  - Reduced cane pruning weight
- **Reduced photosynthetic capacity**
- **Graft incompatibilities**
- **Symptom expression affected by virus strain/species, climate and variety**
Leafroll disease – foliar symptoms

- Pinot Noir GLRaV-1 & -9
- Marzemino GLRaV-1
- Cabernet Franc GLRaV-3
- Pinot Gris GLRaV-1
- Cabernet Franc GLRaV-2
- Sauvignon blanc GLRaV-3

http://winetech.co.za/news_leafroll.php
Leafroll disease - fruit

Healthy (left) and Leafroll affected Chardonnay grape clusters.
http://wine.wsu.edu/research-extension/plant-health/virology/symptoms/

Healthy (right) and Leafroll affected Cabernet sauvignon grape clusters
http://wine.wsu.edu/research-extension/plant-health/virology/symptoms/

Healthy (bottom) and Leafroll affected Cabernet sauvignon yield
http://wine.wsu.edu/research-extension/plant-health/virology/symptoms/
Leafroll disease - vigour

Healthy (right) and leafroll affected Cabernet sauvignon grapevines.

Healthy (left) and leafroll affected Chardonnay grapevines.

http://wine.wsu.edu/research-extension/plant-health/virology/symptoms/
Graft incompatibilities associated with *Grapevine leafroll associated virus 2*

Photos courtesy of D.A. Golino, USDA, California, USA.
Rugose wood diseases

- GVA, GVB, RSPaV
  - Kober stem grooving - GVA
  - Rupestris stem pitting - RSPaV
  - *Corky bark and LN33 stem grooving* - GVB
  - *Corky wood* – GVD
  - Shiraz disease - GVA
  - Vein necrosis disease of 110 Richter - RSPaV

- Reduced quality and yield of fruit
- Reduced quality and production of wood
- Graft incompatibilities
- Symptomless infections occur
Kober stem grooving associated with GVA

Photo courtesy of D.A. Golino, USDA, California, USA.
Stem pitting symptoms (top, arrow) on *Vitis rupestris* (Rupestris St George); un-infected Rupestris St George (bottom).

Stem pitting symptoms (Vines 1, 3 and 4, arrows) on Rupestris St George; un-infected Rupestris St George (Vine 2).
Corky bark associated with GVB

Photos at top courtesy of D.A. Golino, USDA, California, USA.
Vein necrosis - RSPaV

Vein necrosis symptoms on 110 Richter
Shiraz disease

• Associated with GVA
• May also affect other varieties
  – Merlot
• Shoots remain green
• Leaves hang on until winter
• Vine decline
• A similar disease in South Africa has a significant impact on fruit quality and yield
Grapevine fleck virus

• Associated with fleck symptoms on *Vitis rupestris* (Rupestris St George)
  – Clearing of the veinlets in young leaves
  – Symptoms may develop into a mosaic pattern in older leaves
  – Older leaves may also become distorted and curl upwards
  – Symptoms appear in spring during mild weather and disappear with the onset of hot temperatures
  – Reduced graft take
  – May not have a significant impact on its own
  – In combination with other viruses may be associated reduced growth/cane pruning weight
Fleck symptoms on *Vitis rupestris* (Rupestris St George).
Fanleaf disease

• Associated with nepoviruses
  – *Grapevine fanleaf virus*, *Arabis mosaic virus* and others

• Serious disease of grapevines
  – Degeneration, decline, death
  – Leaf deformation
  – Yellow mosaic and/or vein banding of the leaves.
  – Significant yield loss

• Quarantine disease for Australia:
  – Grapevine fanleaf virus was reported in Australia (SA & VIC)
  – Eradicated
Fanleaf diseases

Photos courtesy of D.A. Golino (USDA) and Canadian Food Inspection Agency.
Can a virus have a positive effect?

• Crimson seedless infected with leafroll viruses
  – Improved colour (less red)
  – Larger, crisper berries

• Some infected vines may be symptomless
  – Recent research suggests a possible reduction in photosynthetic capacity
Transmission

• Propagation
• Grafting/Top working
• Insect vectors
  • 10 mealybug species – GVA, GVB, GLRaV-1, -3 and -4
  • Some scale species – GVA, GVB, GLRaV-1, -3 and -4
  • Nematodes - Nepoviruses
• Most grapevine viruses, except Nepoviruses, are not known to be seed borne or transmitted mechanically
Virus Vectors in Australian vineyards

- Longtailed mealybug
- Citrus mealybug
- Citrophilous mealybug
- Obscure mealybug
- Nigra scale
- Long soft scale
- Plum scale
- Grapevine scale

Images: USDA ARS Photo Unit, USDA Agricultural Research Service, Bugwood.org

Images: Landcare New Zealand

Image © Lesley Ingram, Bugwood.org
Mealybugs and Scale

• May acquire and inoculate viruses within one day but may loose infectivity over a few days
• Acquisition may be influenced by virus titre
• Nymphs/crawlers may be better vectors than adults
• Transmission rates of viruses affected by insect population numbers
• May have up to 3-4 generations/year
Australian grapevines phytoplasmas

Three phytoplasmas are associated with Australian grapevine yellows:

‘*Candidatus Phytoplasma australiensis*’ (16SrXII-B)
- Occurs Australia wide
- 14 known plant host species
- Found in most regions where grapes are grown
  - Less prevalent in cooler climates

Tomato big bud phytoplasma (16SrII-D)
- Occurs Australia-wide
- Less frequently detected in grapevines compared to *Ca. P. australiensis*
- Broad host range – more than 70 plant species

Buckland Valley grapevine yellows phytoplasma (16SrXXIII-A)
- Limited distribution – Buckland Valley in Victoria
- No other known alternative hosts
Australian grapevine yellows

- Symptoms appear from late spring
- Irregular yellowing (reddening) of the leaves, which may become necrotic
- Backward curling and overlapping of the leaves
- Early leaf fall
- Tip death
- Bunch abortion or berry shrivel
- Affected shoots fail to harden off and remain rubbery
- Often only a few shoots on a vine are affected
- Significant reductions in yield have been reported
- Symptomless infections occur
AGY - Chardonnay
AGY symptoms on Shiraz
Transmission and spread of grapevine phytoplasmas in Australia

*Candidatus* Phytoplasma australiense:
- No known insect vector in Australia
  - Occurs in New Zealand – transmitted by *Oliarus atkinsonii* and *Zeoliarus oppositus*
  - *Ca. P. australiense* has not been detected in grapevines in New Zealand

**Tomato Big Bud (TBB) phytoplasma:**
- Two known vectors in other crops:
  - Common brown leafhopper (*Orosius orientalis*)
  - Green jassid (*Batrcomorphus angustatus*)
- One suspected vector in other crops:
  - The spotted leafhopper (*Austroagallia torrida*)

**Buckland Valley grapevine yellows phytoplasma**
- No known vector

Phytoplasmas may also be transmitted through planting material
Viroids

- **Six viroids:**
  - Hop stunt viroid (HpSVd), Citrus exocortis viroid (CEVd), Australian grapevine viroid (AGVd), Grapevine yellow speckle viroid-1 (GYSVd-1), GYSVd-2, GYSVd-3

- Smallest known pathogens
  - Exist as small circular ssRNA molecules

- Viroids of grapevine are found worldwide.

- Transmission:
  - Mechanical: pruning tools, farm implements, clothing, hands, contact between plants.
  - Propagation, graft transmission
Viroid disease

• Grapevine yellow speckle
  – Only associated with GYSVd
  – Expression associated with heat
  – May not have a significant impact on yield
Looks like….?

• Abiotic factors
  – Drought stress
  – Nutrition
  – Herbicide
  – Physical damage

• Correct diagnosis is essential
Summary:
Viruses affect productivity and sustainability

• Yield
  – Reduced clusters/vine
  – Reduced berry weight
  – Reduced plant growth/cane pruning weight

• Quality
  – Reduced sugars
  – Reduced terpenoids (aroma)
  – Poor colour
  – Graft incompatibilities

• Decline
  – may also be associated with graft incompatibilities

• Clonal identification

• There is a need to fully understand the impact of viruses in the Australian viticultural environment