ALMOND BOARD OF AUSTRALIA

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Recognising and managing almond viruses

Introduction

Plant viruses present a growing challenge to almond production systems in Australia, with the potential to significantly impact tree health, orchard productivity and long-term profitability. While often overlooked due to their subtle or sometimes delayed symptoms, viral infections can reduce yield, impact quality and complicate management decisions, especially in young orchards. As industry continues to adopt more intensive and mechanised planting systems and grow new varieties at scale, the risk of virus spread through nursery material and orchard operations has increased.

This factsheet provides a practical overview of key viruses known to affect almonds, their symptoms, modes of transmission, impacts and management considerations. It is intended to help growers, advisors and nursery operators identify viruses in almonds, seek confirmation through laboratory testing and implement strategies to reduce the risk of virus-spread between almond orchards.

In addition to this factsheet another useful resource on viruses in almonds is the final report of Hort Innovation funded project MT12005 - Development of molecular diagnostic tools to detect endemic and exotic pathogens of Prunus species for Australia (Constable, 2016) which can be accessed via: https://www.horticulture.com.au/growers/help-your-business-grow/research-reports-publications-fact-sheets-and-more/mt12005/

Key viruses

Apple Mosaic Virus - ApMV *(Ilarvirus)*

• Symptoms: Pale yellow/light green to white chlorotic spots, rings or mosaic patterns on leaves, leaf vein yellowing, leaf deformity, rosetted leaf formation and stunted growth.
• Transmission: Vegetative propagation methods (such as grafting and budding) along with mechanical means (such as pruning, hedging and contaminated tools). The virus can also spread via root grafts between adjacent trees. Not transmitted through seed or pollen. No insect vectors have been identified for ApMV.
• Impact: Reduced tree vigour, leaf damage, yield loss by 30–50% due to reduced photosynthesis, tree vigour and altered phenological development.

Figure 1. Leaf vein yellowing on almond leaves induced by Apple Mosaic Virus - ApMV (Ilarvirus) (Martelli, 2021)..

Prunus Necrotic Ringspot Virus - PNRSV (*Ilarvirus*)

• Symptoms: Chlorotic or necrotic ringspots, yellow mosaic pattern on leaves, leaf deformity, rosetted leaf formation, stunted growth, premature leaf drop and potential bud failure.
• Transmission: Vegetative propagation methods (such as grafting and budding) along with mechanical means (such as pruning, hedging and contaminated tools), seed and pollen. The virus can also spread via root grafts between adjacent trees. Insect vectors may include Bees, Thrips, Mites and Nematodes.
• Impact: Chronic decline in affected trees, premature leaf drop, yield loss of 30-60%, potential to spread slowly through the entire orchard.

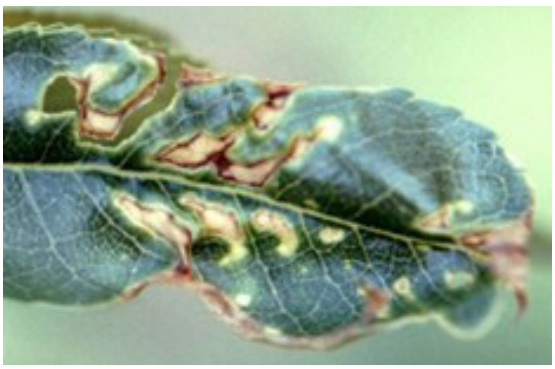

Figure 2. Necrotic spots and leaf deformation on an almond leaf induced by Prunus Necrotic Ringspot Virus - PNRSV (Ilarvirus) (Martelli, 2023).

Prune Dwarf Virus - PDV *(Ilarvirus)*

• Symptoms: Chlorotic rings, yellow mottling and line patterns on leaves, leaf distortion, premature leaf drop, rosetted leaf formation and stunted growth.
• Transmission: Vegetative propagation methods (such as grafting and budding) along with mechanical means (such as pruning, hedging and contaminated tools), seed and pollen. The virus can also spread via root grafts between adjacent trees. Insect vectors may include Bees, Thrips and Mites.
• Impact: Shortened internodes, reduced tree vigour, premature leaf drop, potential yield loss up to 60% when other viruses such as PNRSV are also present and potential to spread through the entire orchard.

Figure 3. Chlorotic ringspot on almond leaf induced by Prune Dwarf Virus - PDV (Ilarvirus) (Boari, 2022) .

Ilarvirus Genus (*generic assay used in case detection is missed through species-specific testing*)

• Symptoms: Pale yellow/light green to white chlorotic spots, necrotic ringspots, yellow mosaic pattern on leaves, leaf deformity, stunted growth, premature leaf drop, dieback and potential bud failure.
• Transmission: Mechanical (contaminated tools, pruning and hedging), vegetative propagation, root grafts, seed and pollen.
• Impact: Growth suppression, premature leaf drop, dieback, reduced yield and increased tree stress.
• Note: There are several known species within the genus Ilarvirus, including ApMV, PDV and PNRSV that can affect almonds. The assays (tests) for these three viruses (ApMV, PDV and PNRSV) are species-specific, whereas the generic Ilarvirus assay can detect a wider range of species within the genus. A positive result in a species-specific assay will also return a positive result in the generic Ilarvirus assay. However, if only the generic assay is positive, it suggests that one of these viruses or another Ilarvirus species may be present. This is due to the genetic diversity within the genus which can affect the reliability of detection when using a species-specific assay (Kinoti, et al., 2019).

Apple Chlorotic Leaf Spot Virus - ACLSV (*Trichovirus mali*)

- Symptoms: Chlorotic leaf spots, Chlorotic leaf roll, line patterns, sunken spots on leaves, leaf distortion, delayed flowering, stunted growth and terminal dieback.
- Transmission: Vegetative propagation methods (such as grafting and budding) and seed along with mechanical means (such as pruning, hedging and contaminated tools). The virus can also spread via root grafts between adjacent trees. Not transmitted through pollen with no insect vectors having been identified for ACLSV.
- Impact: Reduced tree vigour, delayed flowering, premature leaf drop, decreased yields and the potential for long-term orchard decline.

Figure 4. Deformed and distorted leaves on a young almond tree that tested positive for Apple Mosaic Virus - ApMV (Ilarvirus), Prunus Necrotic Ringspot Virus - PNRSV (Ilarvirus) and Ilarvirus Genus (generic assay) (Jealous, 2025).

Figure 5. Stunted growth of a young almond tree infected with multiple viruses (left) and a healthy young tree with no viruses (right) (Jealous, 2025).

Plum Bark Necrosis Stem Pitting Associated Virus - PBNSPaV (*Ampelovirus pruni*)

• Symptoms: Bark gummosis (gumballs), bark necrosis (die-off), pitting of the vascular tissue along branches and trunks, flattening of the scaffold branches, graft union incompatibilities, chlorotic ringspots, leaf mottling and line patterns on leaves.
• Transmission: Predominately transmitted via vegetative propagation methods (such as grafting and budding) including root grafting and may be transmitted through mechanical means (such as using contaminated tools and equipment when pruning and hedging). Natural spread occurs although there are no known insect vectors, however, other species of virus in this genus are known to be transmitted by Mealybug and Scale.
• Impact: Reduced tree vigour, increased susceptibility to diseases, increased tree stress, decreased yields and graft union incompatibilities leading to long-term orchard decline.

Figure 6. Chlorotic spots on the leaves of a young almond tree that tested positive for Apple Mosaic Virus - ApMV (Ilarvirus), Prunus Necrotic Ringspot Virus - PNRSV (Ilarvirus) and Ilarvirus Genus (generic assay) (Jealous, 2025).

Management Considerations

Managing viruses in almond orchards is challenging because infections are permanent, they cannot be controlled and symptoms can be subtle, delayed or mistaken for other causes. Effective management focuses on preventing introduction, limiting spread within the orchard or between orchards and minimising the impact on tree health and yield. Multiple strategies should be used including purchase of virus-tested planting material, controlled movement of vehicles and equipment in and out of the orchard, orchard hygiene, monitoring and timely interventions. In some cases, removal of infected trees or material may be necessary to protect the wider orchard. Key considerations include:

• **Use certified/accredited virus-free planting material:** Source trees and budwood from reputable nurseries and ask for laboratory reports of virus-testing of the source material prior to tree delivery.
• **Implement strict hygiene practices:** Clean and sterilise (70% ethanol) tools and equipment between blocks to reduce mechanical transmission during pruning, hedging and grafting operations in particular when trees are symptomatic. Make good hygiene a requirement for all contractors entering the orchard.
• **Monitor orchards regularly:** Scout for symptomatic leaves, shoots and bark throughout the season to identify potential infections early. If you see something unusual don't ignore it. Seek laboratory confirmation (see below).
• **Record keeping:** Maintain accurate records of planting material, planting dates, management actions and tag and monitor symptoms to track potential virus spread and impact.
• **Manage infections promptly:** Removal of affected trees is the only cure. Minimise the potential spread of the virus/es in asymptomatic trees through good hygiene.
• **Tree removal protocols:** Poison trees before removal to prevent virus survival in roots. Excavate as many roots as possible from the soil to minimise the risk of re-infection through root grafting or other pathways. Burn all infected material. Do not mulch.
• **Soil spelling:** Allow the soil to rest after tree and root removal to ensure any remaining roots have fully decomposed or been destroyed, preventing virus transmission to replants and new plantings.

Virus Testing

Virus testing is essential, especially if suspect symptoms are observed in the orchard. Laboratory testing of suspect and symptomatic trees will confirm the presence of virus(es), identify specific strains and guides management decisions. Early detection allows for targeted removal of infected trees, minimising the risk of virus spread.

An accredited diagnostic laboratory such as AgriBio – Crop Health Services, offering both species-specific assays and broader generic assays that detect multiple viruses, can be used for virus testing almond plants. Samples should be collected using the following protocols during October-December as results may take 6 weeks allowing time for re-testing in the same season if required. It pays to contact the laboratory prior to sample collection for specific instructions.

General virus sampling protocols for almonds

General virus sampling protocols for almonds (AgriBio - Crop Health Services, 2025):

- Collect samples early in the week, keep them cool and send them to the laboratory as soon as possible i.e. same day as collection.
- Tag sampled trees with flagging tape so the same tree can be re-sampled if required.
- If possible, randomly sample 4-5 shoots (one-year-old wood) from all around the tree. If present, leaves should be left attached to the shoot sample.
- Shoots from up to five trees can be pooled to make one bulk sample. If you do this, 3-4 shoots per tree should be collected.

Note; If the infected tree needs to be identified, bag shoots from each tree individually (make sure to label the bags) so they can be tested if a positive result is found in the bulk sample.

- Wrap the plant material in a dry paper towel and seal the sample bag. Do not use a wet paper towel.
- Label all sample bags with a sample ID (e.g. property name, variety, date and time of collection) so they can be easily identified and traced back to where the sample was taken.
- Fill in a submission form and include it with the samples.
- Send the samples in a plastic express post bag or via courier ASAP.

Conclusion

Viruses may potentially infect almond orchards at any time and need careful attention to minimise their impact and spread. With the right strategies in place, including virus-free planting material, orchard hygiene, regular monitoring, testing and removing infected trees, will help limit spread. Taking these steps supports healthier trees, higher yields and more productive orchards over the long term.

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