

Understanding apple decline in British Columbia

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KEY TAKEAWAYS

Apple decline is a complex issue affecting orchards in BC. While the exact cause remains unknown, **multiple stressors that can affect water and nutrient movement through the tree appear to contribute to decline**. Some key insights are:

- Symptoms can include weak growth, cankers near the graft union, bark cracking, leaf yellowing or wilting, early leaf drop, and sudden tree collapse.
- Drought, winter injury, apple clearwing moth, canker-causing fungi, and other stressors can damage the graft union and restrict the movement of water and nutrients within the tree and lead to collapse.
- Maintaining balanced soil moisture, protecting graft unions, and managing insect and disease pressures can help support tree health while research continues on apple declines causes.

What is apple decline?

Apple decline is a phenomenon where healthy apple trees suddenly lose vigour, collapse, and die over a 1–3-week period. It was first widely reported in British Columbia in 2018, when growers in the Okanagan and Similkameen valleys saw tree losses in young, high-density orchards.

Apple decline does not affect all trees evenly. Growers may see patches of declining trees beside healthy ones, which can make orchard management and replant decisions difficult. For example, areas with dead or removed trees may still receive water and nutrients, leading to wasted inputs and added costs. Managing young replacement trees alongside mature trees can also be challenging, as they have different water and nutrient needs within the same irrigation and fertigation system. Apple decline can have a major financial impact, as replanted trees can take four years to produce fruit.

Researchers at Agriculture and Agri-Food Canada's Summerland Research and Development Centre, along with collaborators around Canada, are working to understand the mechanisms and stressors that lead to decline. **This factsheet outlines what is currently known about apple decline, how to recognize it in the orchard, possible contributing factors, and potential steps growers can take to reduce risk while research continues.**



Production Type

- Apples

Practice Benefit(s)

-  Pest & disease management
-  Apple health and yield

Research Location

- Okanagan Valley, BC
- Similkameen Valley, BC

Key Terms

- *Stressor*: External factors that can negatively impact plant growth, development, and productivity. These may be from the environment (e.g., soil pH) or other living organisms (e.g., pests).

What causes apple decline?

The underlying causes of apple decline are still unknown. However, researchers have observed patterns across orchards in British Columbia and are developing hypotheses around its drivers.

In modern high-density orchards, trees are often grown on dwarfing rootstocks to support early production and high yields. Dwarfing rootstocks tend to have smaller root systems and narrower graft unions, which, by nature, limit the flow of water and nutrients from the roots to the scion, providing the dwarfing effect. This can place trees under ongoing (chronic) stress, making them less able to handle additional damage or poor growing conditions.

One hypothesis is that stress to the graft union plays a key role in apple decline. These stresses can be from many sources, including drought, insects, disease, cold damage, or physical injury. When the graft union is affected, it can further restrict water and nutrient flow within the tree and cause a gradual decline within weeks or over the season.



Figure 1. Young declining apple trees. Photo by J. MacDonald, AAFC.

Table 1. Key stressors that may affect the graft union and influence water and nutrient flow in apple trees. These may contribute to apple decline, but none have been identified as main causes.

Stressor	Description
Apple clearwing moth	Larvae feed and tunnel through the graft union and surrounding vascular tissue, damaging the tree’s transport structure for moving water and nutrients.
Air bubbles in plant tissues from drought stress (Xylem embolisation)	Dry soil conditions or sudden extreme heat can cause air bubbles to form in the tree’s water-carrying pathways. These blockages can reduce water flow, especially in dwarf trees that have small root structures and narrow graft unions
Waterlogging	Soils that are saturated with water have limited oxygen, which limits the tree’s ability to take up water and nutrients.
Canker-causing fungi	Fungi can infect damaged or cracked bark and create cankers. As cankers grow, they can restrict water movement in the tree. Studies have shown canker-causing fungi to be present in nearly all trees experiencing decline. Some common fungi associated with apple decline include: <i>Cytospora</i> , <i>Diaporthe</i> , and <i>Diplodia</i> .
Winter injury	Cold damage or rapid freeze-thaw events can injure plant tissues, leaving less “healthy” plant tissue behind to adequately support the trees' water and nutrient needs.

Spotting symptoms in the orchard

Apple decline can appear unevenly within orchards and at different times throughout the growing season, making regular monitoring essential for early detection and management. Several recurring symptoms have been observed in trees that later collapse or die from apple decline. Below, we describe some of the symptoms commonly associated with decline and that can serve as useful indicators when assessing orchard health.

Researchers are still investigating the relationship between these symptoms and the eventual collapse or death of trees. **These symptoms should be considered general indicators of orchard health rather than definitive predictors of apple decline.**

Spring

Early symptoms often appear in both the canopy and near the graft union. Stressed trees may have small, weak, spindly leaves, visible cankers near the graft union, which may or may not be associated with winter injury, insects, or disease. Apple clearwing moth activity has been shown to be associated with the presence of cankers.

Summer

Symptoms may intensify as the season progresses. Cankers can expand, bark may crack or peel, and leaves may wilt, yellow, or drop. Apple clearwing moths activity typically peaks in July, but larval activity under the bark of apple trees continues for 1-2 years. In severe cases, and especially during periods of drought and/or heat stress, trees may completely collapse.

Fall

Declining trees can show unusual fall behaviour. Leaves may senesce early, changing colour earlier than healthy trees or, conversely, remain on the tree along with underdeveloped, immature fruit into the winter, rather than dropping normally.

Figure 2. Common symptoms of apple decline. Apple clearwing moth larvae burrowing through the graft union (top left), apple clearwing moth pupae sticking out of trunk (top right), apple tree with spindly leaves (middle left), early leaf senescence (middle right), canker forming on apple trunk (lower left), and fungal fruiting bodies (lower right).



What practices are available to manage apple decline?

The causes of apple decline are not yet fully understood, and there are currently no established preventative or curative management options. **However, maintaining a healthy graft union with good growing conditions can help reduce tree stress and damage.**

Starting in the nursery, proper grafting techniques are essential for developing a strong, healthy graft union. Select high-quality budwood and non-juvenile rootstocks, graft during dormancy, and allow enough time for callus development before planting. Protecting the graft union with white latex paint can also help reflect UV radiation and reduce trunk surface temperatures that contribute to stress. **It may also be worth considering using alternative dwarf or semi-dwarfing rootstocks with larger trunk diameters that have more capacity to transport water and nutrients effectively, even when damaged.** This [brief on Honeycrisp rootstock selection](#) may be helpful in making these decisions.

Since trees affected by apple decline have also been associated with infestations of apple clearwing moth and canker-causing fungi, it is important to monitor and manage these pests and diseases. The BC Ministry of Agriculture and Food provides a helpful factsheet on apple clearwing moth (see: [Apple Clearwing Moth](#)) and its management.

Maintaining balanced soil moisture is also key. Although water restrictions in the Okanagan significantly influence practices, it is important to avoid significant heat stress where possible. This might include overhead shading or evaporative cooling, and drip irrigation to maintain good soil moisture. Building organic matter in the soil, especially on otherwise coarse, well-drained soils, may increase the water holding capacity of the soil. This can be done by mulching or planting non-competitive plants in the tree rows. Mow-and-blow can be used to support soil organic matter. This practice involves using a side discharge mower when mowing alleyways that will direct the clippings onto the tree row, where they decompose and are gradually incorporated into the soil.

What's next?

While many questions about apple decline remain, our understanding of apple decline continues to improve. Researchers are currently investigating the associations between biotic (apple clearwing moth, fungal pathogens) and abiotic (cold damage, drought stress) stressors on various rootstock and scion varieties. This will provide a better understanding of how apple decline occurs in orchards and methods to support tree recovery and productivity.

Figure 3. Young declining apple tree in an orchard. Symptoms include early senescence and spindly leaves (right). Photo by J. MacDonald, AAFC.



About this brief

This brief was prepared by Nisa Chavez from the BC Food Web team, with the help of Jesse MacDonald and Hao Xu, and is based on the following scientific journal articles:

- Xiao, H., Hao, W., Storoschuk, G., MacDonald, J. L., & Sanfaçon, H. (2022). Characterizing the virome of apple orchards affected by rapid decline in the Okanagan and Similkameen valleys of British Columbia (Canada). *Pathogens (Basel)*, 11(11), 1231. <https://doi.org/10.3390/pathogens11111231>
- Xu, H., Hannam, K. D., MacDonald, J. L., & Ediger, D. (2023). Field investigation into tree fates from recent apple tree decline: Abrupt hydraulic failure versus gradual hydraulic loss. *Stresses*, 3(1), 256-269. <https://doi.org/10.3390/stresses3010019>

Want to learn more?

- For any questions regarding this research, contact Jesse MacDonald at jesse.macdonald@AGR.GC.CA

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