BRITISH COLUMBIA | Ministry of Agriculture and Food

# Grape Phylloxera – Factsheet

## *Daktulosphaira vitifoliae* (Fitch) (N.A. ver.) or *Viteus vitifoliae* (CABI/Eu

## Introduction

July 2022

Grape phylloxera, also known as *Daktulosphaira vitifoliae* (Fitch), is a pest of wine and table grapes that can be found around the world. Native to Eastern North America, grape phylloxera infests the leaves and roots of a grape vine, creating gall formations that slowly reduce the ability of a vine to successfully grow and bear fruit (Figure 1, 2 & 3). This pest is regulated in Canada by the Canadian Food Inspection Agency (CFIA) in order to limit its spread and prevent introduction into new areas currently free of the pest.

*Figure 1: Grape phylloxera galls on leaf*

Please report any new detections to CFIA.

Grape phylloxera was detected over 60 years ago in the Okanagan valley of BC and attempts to eradicate it were made by removing infested plants. Those efforts were ultimately unsuccessful, and detections of phylloxera occur from time to time in commercial vineyards in that region. It has not become a major pest in the Okanagan valley. A combination of sandy soils and cold winters as well as planting of resistant rootstock limits the proliferation of phylloxera in the Okanagan. Phylloxera was confirmed by the CFIA on Vancouver Island in 2020 and presents a new pest challenge in coastal BC grape production.

## Damage and Identification

Grape phylloxera is a very small insect with a golden tan to dark brown colour. Growing to be less than 1 millimetre long and half as wide, phylloxera is difficult to see in the field without the aid of a hand lens or microscope. Instead of looking for the insects themselves, it is helpful to look for symptoms as a result of phylloxera feeding. As populations increase, damage symptoms are more evident.

*Figure 2 (Left): Close up of fully formed leaf galls on underside of leaves. Leaves and plants can have a mix of older and new galls. Figure 3 (Right): Top side of leaf*

Search for areas of decline in your vineyard, as areas with phylloxera presence will have increasing patches of stunted, unthrifty, or dying vines. Often this starts with just a few plants which slowly expands outwards in a circular pattern. It can take 3-5 years or longer, even 10-15 years before a phylloxera infestation will reach detectable levels, and possibly longer before there is a significant decline of the vineyard. Once potential decline is seen in a field, it is important to search for leaf and root galls (Figure 2 & 3).

The leaves of invested vines will develop chlorotic patterns (a loss of green colour) and have three dimensional raised lumps on their surface (Figure 1). The underside of the leaves will have a purse, or pouch-like appearance about 5 mm across (or half the size of a pea) (Figure 2), with the opening of the pouch on the upper leaf surface displaying a soft, fuzzy looking appearance (Figure 3). The adult phylloxera will lay her eggs inside her gall, which can be seen when a fresh growth is opened. Leaf galling will not be present on all infested varieties, instead it is more likely to be seen on native North American *Vitis* vines and their hybrid cultures. Phylloxera leaf galls can be confused with Erineum mite (leaf blister mite) (Figure 4), which causes raised bumps on the top surface of leaves, and fuzzy areas on the underside of leaves.

*Figure 4: Example of Erineum mite on grape leaf, similar to phylloxera damage - at first glance.*

*Figure 5: Roots infested with grape phylloxera. Roots swell, and get distorted and bulbous*

The more destructive galling caused by grape phylloxera is that done to the roots of a vine: Root nodosities and tuberosities (Figure 5.). Both European and North American grape varieties can present root galling symptoms and host grape phylloxera, but it is the own-rooted European *Vitis vinifera* vines that are highly susceptible to the damage. Both nodosities (hooked galls on non-lignified tissues) and tuberosities (the splitting of root bark that exposes vascular systems) expose the vine to secondary infections and lower the surface area of a root system. Damaged plants can exhibit severe water and nutrient stress, with galling eventually causing the death of the vine. Damage confined to roots may be confused with nematode or root disease and should be compared to both during diagnosis.

Economic thresholds have not been determined for grape phylloxera, however, if plants are declining, steps should be taken to monitor and manage it on vineyards.

## Biology

Grape phylloxera is a globular aphid-like insect that has a complicated lifecycle that includes several stages (Figure 6). The life stages most commonly seen are the wingless nymphs or adults in leaf galls. Wingless nymphs and adults can sometimes be seen on the roots, depending on the time of year. The wingless females on the leaves are called gallicolae and those on the roots are called radicolae. Each of these females can lay several hundred eggs without fertilization. Eggs will hatch, go through 4 nymphal stages, and develop into another egg laying female. Depending on the susceptibility of their host plant, and the strain (biotype) of phylloxera, insects may never develop a gallicolae leaf form, instead remaining only in their root-feeding form.

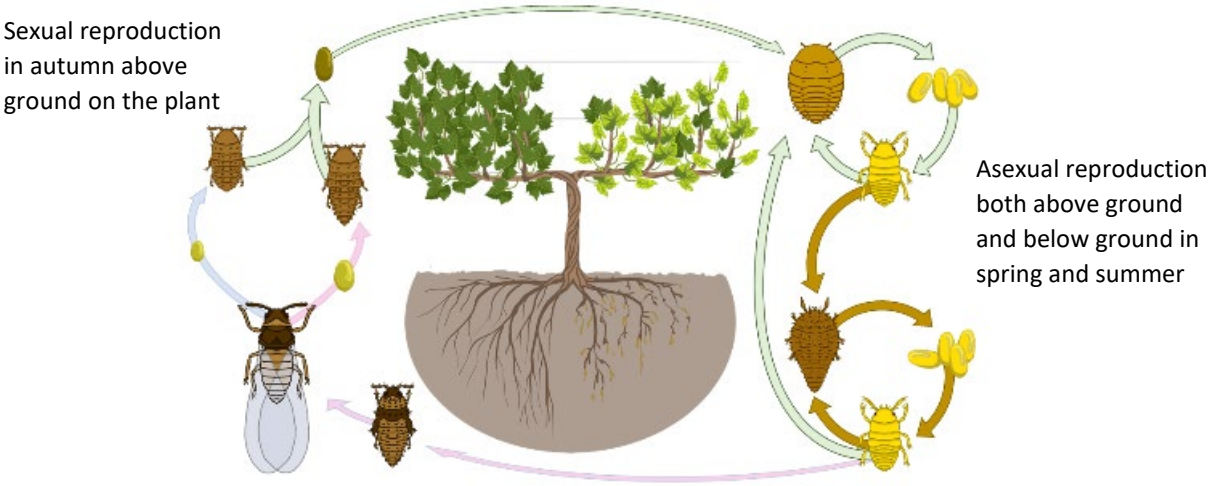


*Figure 6: Grape Phylloxera life cycle*

Phylloxera will become active in early May once plant growth begins, when overwintering eggs will hatch into nymphs and begin migrating to new growth, with first leaf galls being formed in May-June. Eggs are laid in these galls (Figure 7) and new nymphs (crawlers) emerge in 3-4 weeks depending on temperature and crawl to new leaves and the cycle repeats. This will continue through the summer. In the soil, the overwintered first instar nymphs begin feeding on roots in the spring, and form new root galls. Generations develop on the roots over the season, and remain underground unless the root quality fails as the plant declines, or the populations become too high. Crawlers can climb up plants from the soil, or fall from the leaves and move into the soil. They can also inadvertently be carried by the wind, on animals, people, or equipment to new plants. At the end of a season or when the nymphs are under stress, a last developmental cycle will be triggered to create a flying adult that lays sexually reproducing offspring. In the Pacific Northwest, it is estimated that there are 4-6 generations per year of grape phylloxera.

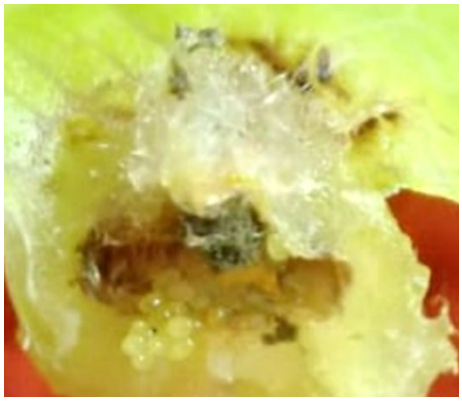

*Figure 7: Leaf gall sliced open, eggs spilling out*

Since phylloxera can reproduce both sexually and asexually, different biotypes have developed around the world. There are currently 7 identified biotypes (A to G) that are differentiated by preferred host cultivars, the degree of galling demonstrated, and their tendency to

create winged or sexual morphs. California, Oregon, and British Columbia's Okanagan Valley report that leaf galling doesn't occur or is rare. On Vancouver Island, due the significant leaf galling on hybrid varieties seen in a small number of fields where the pest has been detected, it appears similar to a biotype from eastern North America. Predominant biotypes can change over time. For example, in California in the 1980s, resistant varieties started to fail as a result of a new biotype becoming established.

There are many abiotic factors that can affect the growth and development of grape phylloxera. The insects have a preference for foliage in climates that have a long day length, cool temperatures, and high humidity. Phylloxera will also be affected by soil salinity, ionic content, pore size, and clay content, nutrient availability, pH, and $CO_2$. Phylloxera infestations tend to be more damaging in heavy soils that is prone to cracking, moving quickly to new root systems. Sandy soils prevent phylloxera from thriving and can help aid in keeping infestations contained.

## Hosts

Grape phylloxera can only survive and reproduce on species of *Vitis*, the genus that encompasses all grapes. Phylloxera co-evolved with North American vines such as *V. riparia*, *V. rupestris*, *V. berlandieri* and *V. cinerea*. These North American *Vitis* species are generally resistant to the damage caused by root infestations, making them good sources for root stock and hybrid production. These species do show strong leaf galling symptoms, which should be considered when inspecting for infestations.

European species of grapes which includes the major wine varieties, *Vitis vinifera,* are highly susceptible to attack by the root form of phylloxera and show heavy galling. Despite this susceptibility, *V. vinifera* is highly resistant to the leaf form, and is commonly paired with resistant North American *Vitis* rootstock.

## Monitoring

It is important to complete your searches knowing the impact phylloxera will have on the varietals being checked. Look for weakening areas in your field; infected areas often create patchy areas of decline. Make sure proper sanitisation protocols are being followed to prevent phylloxera from spreading to other parts of the field. Practice good biosecurity while monitoring, and tools such as boot covers, disposable gloves, and a change of clothes, can help prevent movement from infested areas to un-infested areas. Searches can be completed any time there are leaves on the vines, between May to October. The best chance for success is in late summer to early fall. Dig 15 to 30 centimetres deep within 30 centimetres of a dead or dying vine to search for root galls. Information from Washington and Oregon about root sampling is shared here: https://www.youtube.com/watch?v=itGX3IlzjJM Learn How to Scout for Phylloxera

*Figure 8: Example of root examination during fall survey*

Sticky traps can be used to scout for movement of alate phylloxera (flying adults) or movement of crawlers up stems and branches. It is possible to set up sticky traps in a field, either by creating a sticky surface by wrapping a vine with duct tape or with specialised yellow sticky traps suspended from vine canopies or support wires. Wrapping a trunk will help to catch crawlers moving up to the leaves from the soil, while the hanging traps are best used late season to catch the adult winged phylloxera. In both cases hand lenses are recommended along with an understanding of how to identify the insect in the field. For more information the province of Ontario has guides available for using sticky traps in grape vineyards.

# Control

### Cultural Control: Prevention and Biosecurity Practices

The best practice to controlling phylloxera is to prevent infestations in the first place. As phylloxera does not have any other hosts, planting into land that has never had grapes will ensure a clean site. Consider planting non-host crops for at least 5 years before planting grapes. This is a suitable alternative to planting in new land.

Purchase rootstock that is resistant to phylloxera, as well as free from the pest, as even resistant roots can harbour the insect. All vines imported into BC are expected to be certified free from phylloxera. Several regimes of hot water treatments for plants before shipping or after receiving are listed in the CFIA directive "D-94-34: Import requirements for grapevine propagative material" in Appendix 4B. For example, one regime is to "Treat in hot water previously heated to 43.3°C (100°F) for 5 minutes, then remove and again immerse in another water bath previously heated to 47.8°C (118°F) for 30 minutes". There are 5 others, with varying temperatures and durations. The last one listed is "Treat in hot water previously heated to 31.7°C (89°F) for 5 minutes, then remove and again immerse in another water bath previously heated to 52.2°C (126°F) for 5 minutes". These regimes are based on ample research on efficacy and plant tolerance. The 7$^{th}$ treatment listed in Appendix 4B is a chemical dip of soil free planting stock: "Treat using a chemical dip treatment of 0.5 g of Diazinon 50% wettable powder (WP) and 2 g of Malathion 50% WP per liter of water for 20 minutes at a minimum temperature of 21°C." Note that Diazinon is no longer available in Canada. There is currently only one remaining formulation registered in Canada for dipping grapevine planting stock before planting—Malathion 85E, PCP#8372. Please refer to the Malathion 85E label for details of application and post treatment labelling of the stock. Consider doing these pre-plant treatments even for locally sourced planting stock.

Phylloxera itself does not spread quicky or effectively on its own. It is through human dispersal that grape phylloxera is introduced to new areas, and how it has become a global pest of concern. Because of its small size and ability to go unnoticed for many years after introduction, it is easy to spread undetected via infested plants and equipment, soil, and other non-plant means such as boots and clothing.

Good biosecurity practices to prevent movement of phylloxera from field to field or within a field include keeping equipment and clothing clean and insect-free. Be aware of the level of phylloxera in your region and avoid sharing equipment and workers with other growers where possible. This risk can be managed with practices such as changing clothes between vineyards, only going to one vineyard per day, working from insect-free areas to less insect-free areas of fields. Additionally, cleaning of bins, only parking in designated areas and not in the vineyard, and cleaning equipment daily are helpful to prevent spread. Developing, educating, and enforcing proper entrance protocols appropriate for each vineyard are important to maintain pest-free areas. Many countries have published guides on best practices, such as this helpful pocket guide from Queensland Australia.

Other factors will influence the choice of rootstock such as better growth on different soils, adaptions to drought or high-water conditions, improved mineral uptake, control of vigor, and improved ripening time, and even nematode resistance. However, choosing rootstock with resistance to grape phylloxera is of critical importance for long term success in a region with presence of the pest. Some helpful guides for selecting rootstock: UC Davis Rootstock Selection or Vinehealth Australia Rootstock.

## Biological control

There are several insect species that have been associated with grape phylloxera or are being studied for control of the pest, however, none cause significant control of phylloxera. These include two species of flies (*Leucopis simplex* and *Lestodiplosis grassator*), a predatory bug (*Ceratocapsus modestus),* a tiny ladybeetle (S*cymnus cervicalis*), a nematode (*Heterorhabditis bacteriophora*) and some fungi. Naturally occurring generalist predators feeding on the insects within the galls including lacewing larvae (Neuroptera) may contribute to phylloxera control. Phylloxera do not produce honeydew like their aphid relatives, so they likely are not attractive to ants.

## Chemical control

Insecticides are available in Canada to help control grape phylloxera. There is no spray threshold for phylloxera on either leaves or roots of grapevines, but if leaf galls are noticed, it is a good idea to plan a foliar spray. Because phylloxera reproduces quickly asexually there is risk that insecticide-resistant phylloxera biotypes could occur if repeated applications of the same insecticide are done over multiple seasons. However, by following the production guide information from British Columbia or Ontario this risk will be minimal. Timing of foliar applications should occur when new leaves are emerging and shoots are at least 20 cm long, or when first leaf galls are noticed. This will be in June in coastal British Columbia. If leaf galls are seen later in the summer, about a month after the first application, a second application can be made. Annual applications can help keep phylloxera populations down even in the roots. It may only be necessary to apply once every 2-3 years, depending on pest pressure and plant health.

In Canada, Movento (spirotetramat, group 23), Clutch (clothianidin, group 4A), and Assail (acetamiprid, group 4A) are registered for foliar application to grapevines for control for grape phylloxera. Movento is fully systemic and is slow acting, and best applied on the early side of the application window. Clutch and Assail are considered locally systemic, and quick acting, killing exposed phylloxera and other sucking insects relatively quickly. Movento is not approved for use in table grapes. Do not apply any products during bloom. Organic options include insecticidal soap, summer oils, and pyrethrins based products. Check labels for more details.

Maintaining plants with known phylloxera infestation includes good plant care and ensuring that plants are not resource limited and have adequate water and nutrition. These plants can be maintained and harvested until decline is too significant or the plant dies. With good management and insecticide applications, plants can survive a long time with some phylloxera. Do not move infested plants or soil off site, as the pest can be spread. However, phylloxera cannot survive off the plant for very long, possibly only a day or two depending on temperature and moisture. At cool temperatures in soil, phylloxera can survive a long time. If an infested plant is to be removed take care not to move soil to new locations. It is ideal to extract the plant and leave it in the alley until all tissues are dehydrated to ensure the pest has not survived.

For optimal pest management, use a combination of methods, including choosing suitable and clean planting sites, clean stock, ensure good plant health through adequate water and fertilizer, and well timed and

appropriate foliar insecticide application when pest pressure warrants. In addition, ensure good biosecurity practices are in place to prevent field to field movement.

## Further Information

There is a wealth of good information on grape phylloxera management online. Here are some useful references, some of which were referred to in this factsheet.


1. Canadian Food Inspection Agency, Grape Phylloxera Introduction, Factsheet, Regulations: https://www.inspection.gc.ca/plant-health/plant-pests-invasive-species/insects/grape-phylloxera/eng/1600973215467/1600973216014
2. Ontario Ministry of Agriculture Food and Rural Affairs, Phylloxera Factsheet: http://www.omafra.gov.on.ca/english/crops/facts/88-125.htm
3. Ontario Publication 360C, Crop Protection Guide for Grapes: http://www.omafra.gov.on.ca/english/crops/pub360/pub360C.pdf
4. British Columbia Ministry of Agriculture, Grapes resources and information: https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/crop-production/grapes
5. Lowery, T. (2020). Best Practises Guide Update - 5.3 Insect And Mite Pests of Grape. British Columbia Wine Grape Council. http://www.bcwgc.org/sites/default/files/file-uploads/2020-10/Insect%20and%20Mite%20Pests%20of%20Grape%20-%20October%202020%20Edition.pdf
6. Pest Control Products Recommended for Use on Grapes in British Columbia, June 2022: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/animal-and-crops/plant-health/grape_pesticides.pdf
7. Washington State University, Viticulture and Enology, Grape Phylloxera Management Resources: https://wine.wsu.edu/extension/pest-management/phylloxera/
8. Grape Phylloxera Biology and Pest Management in the Pacific Northwest: https://catalog.extension.oregonstate.edu/ec1463
9. Biosecurity Guidelines for Farm Visitors: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/animal-and-crops/plant-health/phu-biosecurity-guidelines-farm-visitors.pdf
10. Disinfestation and Sanitation Practices: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/animal-and-crops/plant-health/phu-disinfection_and_sanitation_practices_ss.pdf
11. Farm Biosecurity Australia, Viticulture: https://www.farmbiosecurity.com.au/industry/viticulture/



**Prepared by: Emily Grove, Plant Health Technician, and Tracy Hueppelsheuser, Entomologist, Plant and Animal Health Branch, British Columbia Ministry of Agriculture and Food, Abbotsford**