EPPO Datasheet: *Raspberry leaf curl virus*

Last updated: 2023-12-01

IDENTITY

Preferred name: *Raspberry leaf curl virus*
Taxonomic position: Viruses and viroids
Other scientific names: *RLCV*, *Raspberry leaf curl luteovirus*
Common names: American leaf curl of raspberry, leaf curl of raspberry
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EPPO Categorization: A1 list
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EU Categorization: A1 Quarantine pest (Annex II A)
EPPO Code: RLCV00

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Notes on taxonomy and nomenclature

Raspberry leaf curl virus (RpLCV) was described in the USA in the 1920s (Stace-Smith & Converse, 1987) as responsible for a severe disease of *Rubus* species. The virus has not been characterized to date and there is no information as to its precise taxonomic status. There have been some reports suggesting that RpLCV might be a *Luteovirus* (Matthews, 1982; Di Bello *et al.*, 2017) but these have never been fully confirmed. A similarly named raspberry leaf curl disease reported in Europe (Cadman and Harris, 1952) has been shown to be caused by European nepoviruses such as raspberry ringspot virus and tomato black ring virus (Stace-Smith & Converse, 1987) and is completely unrelated. For this reason, RpLCV is sometimes referred to as RpLCV (American), to separate it from the European disease. This datasheet is on the American virus only. Two forms of RpLCV, alpha and beta were distinguished by Bennet (1927) with the alpha form being limited to red and purple raspberries, whereas the beta form also infects black raspberries. In the absence of a clear characterization of the virus(es) involved, whether the alpha and beta forms represent distinct agents or strains of the same agent remains an open question. The fact that the alpha form does not protect plants from infection with the beta form (Bennett, 1930) suggests, however, that the two forms may not be closely related.

HOSTS

Natural infection has only been reported in members of the *Rubus* genus. The main crops infected are *R. idaeus* and *R. idaeus* var. *strigosus* (red raspberry), *R. occidentalis* (black raspberry), *R. neglectus* (purple raspberry) and *R. phoenicolasius* (wineberry); minor natural hosts include *R. allegheniensis* (wild blackberry), *R. procerus* (Himalaya blackberry) and *R. ursinus* (Pacific coast trailing blackberry) (Converse, 1984, Stace-Smith & Converse, 1987).

The experimental host range is slightly broader and includes some additional *Rubus* species (*R. albescen*s (tropical black raspberry), *R. baileyanus* x *R. argutus* ('Lucretia' dewberry) and *R. henryi*) as well as the Alpine strawberry (*Fragaria vesca* var. *semperflorens*) indicator (Stace-Smith & Converse, 1987).

In the EPPO region all cultivated *Rubus* spp. should be regarded as potential hosts.

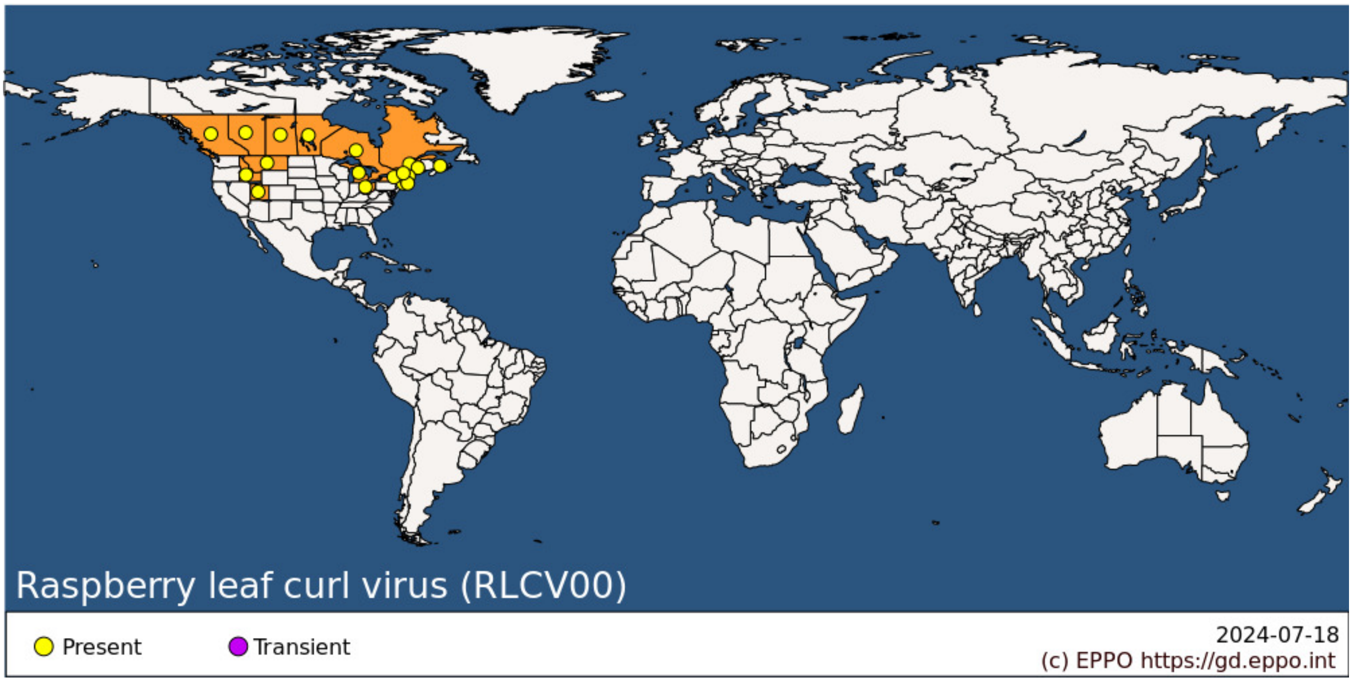
Host list: *Rubus allegheniensis*, *Rubus idaeus var. strigosus*, *Rubus idaeus*, *Rubus occidentalis*, *Rubus phoenicolasius*, *Rubus procerus*, *Rubus ursinus*, *Rubus x neglectus*

GEOGRAPHICAL DISTRIBUTION

RpLCV has only been reported from North America, in USA and Canada (Martin *et al.*, 2013; EFSA, 2020). It has been reported principally in the northeastern United States and southeastern Canada and in the Rocky Mountain regions of both countries, but not west of the Rocky Mountains in the USA, possibly due to the absence of its vector, the aphid *Aphis rubicola* on *Rubus* in that area (Stace-Smith & Converse, 1987; Martin *et al.*, 2013).

It should be stressed that despite having been reported as a prevalent virus in raspberry crops in both countries, it is unclear whether RpLCV still occur in crops there (Guzman Martinez, 2020), as indicated by the fact that recent efforts to characterize RpLCV have been performed using wild plants with RpLCV-like symptoms (Diaz-Lara *et al.*, 2015; Di Bello *et al.*, 2017; Guzman Martinez, 2020).

RpLCV is still indicated by USDA Aphis as widely prevalent, presumably in wild *Rubus*, in five States, Montana, Utah, Ohio, Connecticut and Maine (USDA APHIS Widely prevalent viruses of the United States website, accessed 2023-11-14).



North America: Canada (Alberta, British Columbia, Manitoba, Ontario, Prince Edward Island, Québec, Saskatchewan), United States of America (Connecticut, Idaho, Maine, Massachusetts, Michigan, Montana, New Hampshire, New York, Ohio, Rhode Island, Utah, Vermont)

BIOLOGY

Movement of RpLCV within *Rubus* plants is relatively slow and seems to be confined to phloem tissue (Bennett, 1927) but the evidence points to a systemic and graft-transmissible nature since it has been transmitted by patch and petiole-insert grafting (Stace-Smith & Converse, 1987). There is no information about seed or pollen-transmissibility of RpLCV (EFSA, 2020).

RpLCV is transmitted in a persistent manner by its aphid vector, *A. rubicola* (Stace-Smith & Converse, 1987). Studies with the alpha form have indicated that *A. rubicola* requires a minimum acquisition access feeding period of 2 h to acquire the virus from infected plants. Once acquired, the aphid is able to transmit the agent for many days, probably for the duration of its life (Stace-Smith & Converse, 1987). All life stages of the aphid can transmit RpLCV to host plants but the agent is not transmitted to the next aphid generation through the egg (Stace-Smith & Converse, 1987). *A. rubicola* is reported to be a somewhat inefficient vector because even under optimal conditions with a significant vector population, the number of infected plants remains low (Bolton, 1970; Tan *et al.*, 2022).

Although no experimental data exist to prove it, it is assumed that in North America the small blackberry aphid, *A. rubifolii*, may transmit RpLCV to blackberry since blackberry is not a host for *A. rubicola* (Stace-Smith & Converse, 1987). This point is however controversial and uncertain since Converse (1984) indicated that experiments he performed to demonstrate that *A. rubifolii* could transmit RpLCV gave negative results.

Experimentally, RpLCV has also been shown to be transmitted by *A. idaei* (Stace-Smith, 1962), with a minimum access period of one day and aphids remaining viruliferous for up to 11 days. *A idaei* occurs in Eurasia, which has led to the suggestion that it could contribute to RpLCV spread should the virus be introduced in Europe (Stace-Smith & Converse, 1987).

DETECTION AND IDENTIFICATION

Symptoms

In the year of infection, most infected *Rubus* plants may show no symptoms or only a mild down-curling of the tips of leaves. However, in the following year, leaves on both primocanes and fruiting canes are markedly curled downwards and may be yellowed. New canes are stunted and branched, and the plants develop a rosetted appearance. Fruits are small and are usually misshapen and crumbly (Stace-Smith & Converse, 1987, Martin *et al.*, 2013). Chronically infected raspberry plants are susceptible to winter injury and may die. However, significant losses from this disease are reported as rare, because RpLCV spreads slowly in the field (Martin *et al.*, 2013). Some blackberry cultivars show symptoms similar to those on raspberry, whereas other cultivars remain symptomless (Stace-Smith & Converse, 1987).

Morphology

Since RpLCV has not been characterized, there is no indication about the morphology of its particles.

Detection and inspection methods

Since RpLCV has not been characterized, no serological or molecular tests are available for its detection. The characteristic symptoms of the disease can often be diagnosed directly in infected raspberry and blackberry but such symptoms should be distinguished from leaf curling induced by the feeding of large numbers of non-viruliferous *A. idaei* colonizing raspberry and *A. rubifolii* colonizing blackberry (Stace-Smith & Converse, 1987). Symptoms should also be distinguished from raspberry leaf curl induced in some *R. idaeus* cultivars by infection with the European nematode-transmitted viruses, raspberry ringspot virus and tomato black ring virus (Stace-Smith & Converse, 1987).

R. phoenicolasius (wineberry) is a sensitive indicator plant in which RpLCV is reported to induce pronounced leaf curl symptoms within 10 days of aphid inoculation. However, results from graft-inoculation tests usually take longer (Stace-Smith & Converse, 1987). *R. idaeus* can also be used as an indicator but symptoms may take 2-12 months to appear after graft inoculation. The two forms of RpLCV (alpha and beta) are both detected by such bioassays (EPPO, 1991). Both red and black raspberry must be inoculated to distinguish between the alpha and beta forms since only the beta form is reported to infect black raspberry (Stace-Smith & Converse, 1987).

It should be considered that the availability of reference isolates of RpLCV that can be used as positive controls in such indexing bioassays is unclear, as indicated by the fact that recent efforts to identify RpLCV relied on the use wild plants with RpLCV-like symptoms (Diaz-Lara *et al.*, 2015; Di Bello *et al.*, 2017; Guzman Martinez, 2020) rather than on the use of well characterized reference isolates.

PATHWAYS FOR MOVEMENT

In North America, the only geographical area where the RpLCV occurs naturally, spread to raspberry is by the small raspberry aphid *A. rubicola*. In addition to natural spread by aphids, the agent can also be spread through the distribution of planting material derived by vegetative propagation from infected plants. Long distance spread with the movement of viruliferous aphids associated with commodities is also possible. There is no information about seed or pollen-transmissibility of RpLCV (EFSA, 2020).

PEST SIGNIFICANCE

Economic impact

In North America, RpLCV is reported to have caused major yield losses of up to 20-40% as well as decreased fruit quality. Infected plants are greatly weakened and, after a few years, many suffer severe winter injury and die. However, natural spread of the disease in the field is reported as slow because *A. rubicola* appears to be a rather inefficient vector (Bolton, 1970; Tan *et al.*, 2022). Martin *et al.* (2013) indicated for example that 'significant losses from this disease are rare, because RpLCV spreads slowly in the field'. Indeed, during surveys carried out in 1975 and 1976 in Quebec (Canada) only 3 of the 200 surveyed plots contained plants with disease symptoms ascribed to raspberry leaf curl (Caron *et al.*, 1977).

The incidence of RpLCV seems to have greatly declined since the 1970s, possibly as a consequence of the use of clean propagation stock. In 2020 Guzman Martinez indicated that there has been no report of observation of RpLCV in commercial *Rubus* plots since the paper by Caron *et al.* in 1977 (Guzman Martinez, 2020). This may explain why recent efforts at characterizing the virus could only be performed using wild plants wit RpLCV-like symptoms (Diaz-Lara *et al.*, 2015; Di Bello *et al.*, 2017; Guzman Martinez, 2020).

Overall, while RpLCV has been described in the 20th century as causing a very damaging disease, its impact seems to have gradually diminished over the years to the point that it may no longer have any significant impact on commercial *Rubus* production in the USA and Canada.

Control

The most efficient control strategy involves the development and use of RpLCV-free propagation material as described in EPPO Standard PM 4/10(2) Certification scheme for *Rubus* (EPPO, 2009). The roguing of infected plants and the use of aphicides to limit populations of the *A. rubicola* vector have also been effectively used to reduce the spread and control the impact of RpLCV (Stace-Smith & Converse, 1987).

Commercial *Rubus* varieties are nearly all susceptible to RpLCV but there is some variability in the susceptibility to colonization by the *A. rubicola* vector. Therefore, the use of varieties with reduced susceptibility to *A. rubicola* can also be envisioned as a control measure (Stace-Smith & Converse, 1987).

Phytosanitary risk

RpLCV is able to cause an important disease in infected *Rubus* plants. Its natural aphid vector, *A. rubicola* and its suspected vector *A. rubifolii*, are not established in the EPPO region. However, the experimental vector, *A. idaei*, is common on raspberry in the EPPO region and could result in widespread dissemination of the agent should infected plants or viruliferous vector aphids be introduced in the region. Despite the fact that the virus is not characterized, it has been considered justified by several EPPO countries to prevent establishment and spread of RpLCV.

PHYTOSANITARY MEASURES

Appropriate phytosanitary measures to import plants for planting of *Rubus* hosts into the EPPO region could require that these plants are produced in a pest free area, in a pest free place/site of production, or shown to be free from RpLCV by appropriate diagnostic methods. A number of EPPO countries already ban the import of *Rubus* plants for planting (other than seeds) from areas where the pest is present (EU, 2019).

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ACKNOWLEDGEMENTS

This datasheet was extensively revised in 2023 by Thierry Candresse [INRAE, France] and by Miroslav Glasa [Slovak Academy of Sciences, Slovak Republic]. Their valuable contribution is gratefully acknowledged.

How to cite this datasheet?

EPPO (2024) *Raspberry leaf curl virus*. EPPO datasheets on pests recommended for regulation. Available online. https://gd.eppo.int

Datasheet history

This datasheet was first published in the EPPO Bulletin in 1978 and revised in the two editions of 'Quarantine Pests for Europe' in 1992 and 1997, as well as in 2023. It is now maintained in an electronic format in the EPPO Global Database. The sections on 'Identity', ‘Hosts’, and 'Geographical distribution' are automatically updated from the database. For other sections, the date of last revision is indicated on the right.

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Co-funded by the European Union