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Pest categorisation of carrot thin leaf virus

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Abstract

Following a request from the EU Commission, the EFSA Panel on Plant Health conducted a pest categorisation of carrot thin leaf virus (CTLV) for the EU territory. The identity of CTLV, a member of the genus *Potyvirus* (family *Potyviridae*), is well established and reliable detection methods are available. The pathogen is not included in the EU Commission Implementing Regulation 2019/2072. CTLV has been reported from the USA and Colombia. In the EU, the virus was reported in Germany and Slovenia and the NPPO of both countries confirmed these reports. No official national measures have been taken so far. In 2018, CTLV was reported from Greece on *Torilis arvensis* subsp. *arvensis*. Since then, no other reports exist. According to the NPPO, the virus did not establish in Greece. In natural conditions, CTLV infects plant species of the family *Apiaceae* (i.e., carrot, coriander, parsley and several wild weed species). The virus is transmitted in a non-persistent manner by the aphids *Myzus persicae* and *Cavariella aegopodii*, which are widely distributed in the EU. CTLV has been reported not to be transmitted by carrot seeds, while no information is available for the other hosts. Since transmission through seeds is not uncommon for potyvirids, it cannot be excluded that CTLV can be seed transmitted for some hosts. Plants for planting, including seeds for sowing, were identified as potential pathways for entry of CTLV into the EU. Cultivated and wild hosts of CTLV are distributed across the EU. Economic impact on the production of cultivated hosts is expected if further entry and spread in the EU occur. Phytosanitary measures are available to prevent further entry and spread of the virus on its cultivated hosts. Currently, CTLV does not fulfil the criterion of being absent or present with restricted distribution and under official control to be regarded as a potential Union quarantine pest, unless official control is implemented. This conclusion is associated with high uncertainty regarding the current virus distribution in the EU.

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1. Introduction

1.1. Background and Terms of Reference as provided by the requestor

1.1.1. Background

The new Plant Health Regulation (EU) 2016/2031, on the protective measures against pests of plants, is applying from 14 December 2019. Conditions are laid down in this legislation in order for pests to qualify for listing as Union quarantine pests, protected zone quarantine pests or Union regulated non-quarantine pests. The lists of the EU regulated pests together with the associated import or internal movement requirements of commodities are included in Commission Implementing Regulation (EU) 2019/2072. Additionally, as stipulated in the Commission Implementing Regulation 2018/2019, certain commodities are provisionally prohibited to enter in the EU (high risk plants, HRP). EFSA is performing the risk assessment of the dossiers submitted by exporting to the EU countries of the HRP commodities, as stipulated in Commission Implementing Regulation 2018/2018. Furthermore, EFSA has evaluated a number of requests from exporting to the EU countries for derogations from specific EU import requirements.

In line with the principles of the new plant health law, the European Commission with the Member States are discussing monthly the reports of the interceptions and the outbreaks of pests notified by the Member States. Notifications of an imminent danger from pests that may fulfil the conditions for inclusion in the list of the Union quarantine pest are included. Furthermore, EFSA has been performing horizon scanning of media and literature.

As a follow-up of the above-mentioned activities (reporting of interceptions and outbreaks, HRP, derogation requests and horizon scanning), a number of pests of concern have been identified. EFSA is requested to provide scientific opinions for these pests, in view of their potential inclusion by the risk manager in the lists of Commission Implementing Regulation (EU) 2019/2072 and the inclusion of specific import requirements for relevant host commodities, when deemed necessary by the risk manager.

1.1.2. Terms of reference

EFSA is requested, pursuant to Article 29(1) of Regulation (EC) No 178/2002, to provide scientific opinions in the field of plant health.

EFSA is requested to deliver 53 pest categorisations for the pests listed in Annex 1A, 1B, 1D and 1E (for more details see mandate M-2021-00027 on the [Open.EFSA portal](#)). Additionally, EFSA is requested to perform pest categorisations for the pests so far not regulated in the EU, identified as pests potentially associated with a commodity in the commodity risk assessments of the HRP dossiers (Annex 1C; for more details see mandate M-2021-00027 on the [Open.EFSA portal](#)). Such pest categorisations are needed in the case where there are not available risk assessments for the EU.

When the pests of Annex 1A are qualifying as potential Union quarantine pests, EFSA should proceed to phase 2 risk assessment. The opinions should address entry pathways, spread, establishment, impact and include a risk reduction options analysis.

Additionally, EFSA is requested to develop further the quantitative methodology currently followed for risk assessment, in order to have the possibility to deliver an express risk assessment methodology. Such methodological development should take into account the EFSA Plant Health Panel Guidance on quantitative pest risk assessment and the experience obtained during its implementation for the Union candidate priority pests and for the likelihood of pest freedom at entry for the commodity risk assessment of High Risk Plants.

1.2. Interpretation of the Terms of Reference

Carrot thin leaf virus (CTLV) is one of a number of pests listed in Annex 1 to the Terms of Reference (ToR) (1.1.2.1) to be subject to pest categorisation to determine whether it fulfils the criteria of a potential Union quarantine pest (QP) for the area of the EU excluding Ceuta, Melilla and the outermost regions of Member States referred to in Article 355(1) of the Treaty on the Functioning of the European Union (TFEU), other than Madeira and the Azores, and so inform European Commission decision making as to its appropriateness for potential inclusion in the lists of pests of Commission Implementing Regulation (EU) 2019/2072. If a pest fulfils the criteria to be potentially listed as a Union QP, risk reduction options for relevant host commodities will be identified to inhibit pest entry; for pests already present in the EU additional risk reduction options to slow spread and facilitate eradication will be identified.

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search on carrot thin leaf virus was conducted at the beginning of the categorisation in the ISI Web of Science bibliographic database, using the scientific name of the pest as search term. Papers relevant for the pest categorisation were reviewed, and further references and information were obtained from experts, as well as from citations within the references and grey literature.

2.1.2. Database search

Pest information, on host(s) and distribution, was retrieved from CABI crop compendium database and relevant publications. Additional searches for hosts and distribution were performed using GenBank.

Data about the import of commodity types that could potentially provide a pathway for the pest to enter the EU and about the area of hosts grown in the EU were obtained from EUROSTAT (Statistical Office of the European Communities).

The Europhyt and TRACES databases were consulted for pest-specific notifications on interceptions and outbreaks. Europhyt was a web-based network run by the Directorate General for Health and Food Safety (DG SANTÉ) of the European Commission as a subproject of PHYSAN (Phyto-Sanitary Controls) specifically concerned with plant health information. TRACES is the European Commission's multilingual online platform for sanitary and phytosanitary certification required for the importation of animals, animal products, food and feed of non-animal origin and plants into the European Union, and the intra-EU trade and EU exports of animals and certain animal products. Up until May 2020, the Europhyt database managed notifications of interceptions of plants or plant products that do not comply with EU legislation, as well as notifications of plant pests detected in the territory of the Member States and the phytosanitary measures taken to eradicate or avoid their spread. The recording of interceptions switched from Europhyt to TRACES in May 2020.

2.1.3. Information on pest status from NPPOs

In the context of the current mandate, EFSA is preparing pest categorisations for new/emerging pests that are not yet regulated in the EU and for which, when the pest is reported in a MS, an official pest status is not always available. In order to obtain information on the official pest status for this pest, EFSA has consulted the NPPOs of Germany, Greece and Slovenia. The results of this consultation with NPPOs on pest status are presented in Section 3.2.2.

2.2. Methodologies

The Panel performed the pest categorisation for CTLV, following guiding principles and steps presented in the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018), the EFSA guidance on the use of the weight of evidence approach in scientific assessments (EFSA Scientific Committee, 2017) and the International Standards for Phytosanitary Measures No. 11 (FAO, 2013) and No. 21 (FAO, 2004).

The criteria to be considered when categorising a pest as an EU regulated QP is given in Regulation (EU) 2016/2031 article 3. Table 1 presents the Regulation (EU) 2016/2031 pest categorisation criteria on which the Panel bases its conclusions. In judging whether a criterion is met the Panel uses its best professional judgement (EFSA Scientific Committee, 2017) by integrating a range of evidence from a variety of sources (as presented above in Section 2.1) to reach an informed conclusion as to whether or not a criterion is satisfied.

The Panel's conclusions are formulated respecting its remit and particularly with regard to the principle of separation between risk assessment and risk management (EFSA founding regulation (EU) No 178/2002); therefore, instead of determining whether the pest is likely to have an unacceptable impact, deemed to be a risk management decision, the Panel will present a summary of the observed impacts in the areas where the pest occurs, and make a judgement about potential likely impacts in the EU. While the Panel may quote impacts reported from areas where the pest occurs in monetary terms, the Panel will seek to express potential EU impacts in terms of yield and quality losses and not in monetary terms, in agreement with [insert appropriate reference to EFSA not reporting impacts in financial/monetary terms] Article 3 (d) of Regulation (EU) 2016/2031 refers to unacceptable social impact as a criterion for quarantine pest status. Assessing social impact is outside the remit of the Panel.

Table 1: Pest categorisation criteria under evaluation, as defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest (article 3)
Identity of the pest (Section 3.1)	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?
Absence/presence of the pest in the EU territory (Section 3.2)	Is the pest present in the EU territory? If present, is the pest widely distributed within the EU? Describe the pest distribution briefly
Regulatory status (Section 3.3)	If the pest is present in the EU but not widely distributed in the risk assessment area, it should be under official control or expected to be under official control in the near future.
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	Is the pest able to enter into, become established in, and spread within, the EU territory? If yes, briefly list the pathways
Potential for consequences in the EU territory (Section 3.5)	Would the pests' introduction have an economic or environmental impact on the EU territory?
Available measures (Section 3.6)	Are there measures available to prevent the entry into the EU such that the likelihood of introduction becomes mitigated? If already present in the EU are measures available to slow spread or facilitate eradication?
Conclusion of pest categorisation (Section 4)	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential quarantine pest were met and (2) if not, which one(s) were not met.

3. Pest categorisation

3.1. Identity and biology of the pest

3.1.1. Identity and taxonomy

Is the identity of the pest established, or has it been shown to produce consistent symptoms and/or to be transmissible?

Yes, the identity of carrot thin leaf virus is well established.

CTLV is classified as a species (*Carrot thin leaf virus*) belonging to the genus *Potyvirus* in the family *Potyviridae*, order *Patavirales* (<https://talk.ictvonline.org/taxonomy/>). CTLV is a monopartite, positive-sense single-stranded RNA virus with flexuous, filamentous particles 736–750 × 11 nm in size (Howell and Mink, 1980; Xu et al., 2014; Wylie et al., 2017). CTLV genomic RNA has been completely sequenced and the reference sequence is publicly available in GenBank database under accession number NC_025254 (Xu et al., 2014).

The virus genome consists of about 9,490 nucleotides (nt), excluding the poly(A) tail, and contains a single open reading frame (ORF), coding for a 3,066 amino acid (aa) polyprotein, with a predicted molecular weight of ca. 348 kDa. The polyprotein harbours 9 cleavage sites to produce 10 mature proteins P1, HC-Pro, P3, 6K1, CI, 6K2, VPg, NIa-Pro, NIb and CP typical of potyviruses (Xu et al., 2014).

The EPPO code¹ (Griessinger and Roy, 2015; EPPO, 2019) for this species is CTTLV0 (carrot thin leaf virus; EPPO, online).

¹ An EPPO code, formerly known as a Bayer code, is a unique identifier linked to the name of a plant or plant pest important in agriculture and plant protection. Codes are based on genus and species names. However, if a scientific name is changed the EPPO code remains the same. This provides a harmonised system to facilitate the management of plant and pest names in computerised databases, as well as data exchange between IT systems (Griessinger and Roy, 2015; EPPO, 2019).

3.1.2. Biology of the pest

CTLV is reported to induce vein clearing and leaf narrowing on carrot plants (Howell and Mink, 1976; Xu et al., 2014) and to infect plant species of the family Apiaceae, in most of which it has been associated with severe mosaic, distortion, stunting and leaf reddening (Lotos et al., 2018; Mehle et al., 2019). However, due to the co-infection with other viruses, the symptomatology observed in several natural hosts could not be conclusively ascribed solely to CTLV (Lotos et al., 2018; Mehle et al., 2019).

Transmission to several experimental hosts was reported (Howell and Mink, 1980; Xu et al., 2014). Experimental hosts of the family Apiaceae inoculated mechanically or through viruliferous *Myzus persicae* Sulzer (1776) developed symptoms of stunting, thin leaf and/or vein clearing, while those of the family Chenopodiaceae developed local chlorotic lesions. Chlorotic lesions and leaf mottle were observed in the experimental hosts *Nicotiana clevelandii* and *N. benthamiana* (family Solanaceae), respectively. Mechanical and aphid-mediated inoculation of caraway (*Carum carvi*) was asymptomatic.

No transmission through carrot seeds was reported for CTLV when 100 random seedlings from a lot of 5,000 seeds collected from CTLV-infected carrot plants were indexed (Howell and Mink, 1979). However, a single isolate/cultivar combination was assayed, and it cannot be excluded that seed transmission at very low rates could occur in carrot. No other experimental data on seed transmission of CTLV have been found in the literature. Since several potyviruses can be seed-transmitted (Simmons and Munkvold, 2014; Wylie et al., 2017), this mode of transmission cannot be excluded for CTLV, especially in hosts other than carrot. Transmission by pollen is not reported for CTLV and members of the family *Potyviridae* are generally not reported to be pollen-transmitted (Card et al., 2007). The aphids *Myzus persicae* and *Cavariella aegopodii* Scopoli (1763) have been reported to easily transmit CTLV in a non-persistent manner, after an acquisition time of 5–10 min (Howell and Mink, 1980). The rapid virus spread in carrot fields of central Washington, where both aphid species are present, was mainly related to the appearance of *M. persicae* in the fields (Howell and Mink, 1977). Whether other aphid species, besides *M. persicae* and *C. aegopodi*, would be involved in the virus spread is unknown.

Weed hosts, such as wild carrots and poison hemlock (*Daucus carota* and *Conium maculatum*, respectively), becoming reservoirs of the virus and likely favouring the transmission of the virus to the cultivated carrot plants by aphids, have been reported to play a role in the epidemics of carrot thin leaf disease in Washington State (Howell and Mink, 1977).

3.1.3. Host range

Both natural and experimental hosts are known for CTLV. Natural infections have been reported in cultivated species of the family Apiaceae, such as carrot (*Daucus carota* L.), coriander (*Coriandrum sativum* L.), parsley (*Petroselinum crispum* Mill.), and in weed hosts, such as poison hemlock (*Conium maculatum* L.), spreading hedge parsley (*Torilis arvensis* Hudson, subsp. *arvensis*), goutweed (*Aegopodium podagraria* L.), parsnip (*Pastinaca sativa* L.). Other natural hosts may also exist. Several species of the families Apiaceae and Chenopodiaceae, and the solanaceous species *Nicotiana benthamiana* and *N. clevelandii* have been reported as experimental hosts of CTLV. A detailed list of natural and experimental hosts of CTLV, with their respective references, is reported in Appendix A.

3.1.4. Intraspecific diversity

Due to the error-prone viral replication system and the subsequent selection of the fittest variants in a certain environment, viruses have the typical features of quasispecies (Andino and Domingo, 2015). This means that, even in a single host, they accumulate as a cluster of closely related sequence variants slightly differing from each other. Therefore, a certain level of intraspecific diversity is expected for all viruses. This genetic variability may interfere with the efficiency of detection methods, especially when they are based on amplification of variable genomic viral sequences, thus generating uncertainties on the reliability and/or sensitivity of the detection for all the existing viral isolates.

Five full genome sequences of CTLV (ranging in size from 9,490 to 9,492 nt) and only one partial coding sequences (of about 1,600 nt) are currently available in NCBI GenBank database (<https://www.ncbi.nlm.nih.gov/nucleotide/>). Overall, the available data on genetic variability of CTLV are considered limited.

3.1.5. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes, detection and identification methods are available for CTLV.

Serological methods, also coupled with electron microscopy, were used to detect CTLV (Howell and Mink, 1980). A double-antibody sandwich ELISA kit for CTLV detection is commercially available. CTLV can also be identified by reverse transcription polymerase chain reaction (RT-PCR), using a poly-dT primer and degenerated primers for detecting most members of the family *Potyviridae* (Mackenzie et al., 1998) followed by direct sequencing of the amplicons (Moran et al., 2002). CTLV-specific primers for RT-PCR detection have been designed (Xu et al., 2014). However, considering the limited available data on CTLV genetic variability (see Section 3.1.3) and the lack of specific validation tests, there is uncertainty on whether these primer pairs may detect the majority of CTLV viral isolates. CTLV has been recently identified in parsley (Mehle et al., 2019) and in *Torilis arvensis* subsp. *arvensis* (Lotos et al., 2018) by high-throughput sequencing (HTS) and bioinformatic analysis. However, this methodology is not yet applied to large scale surveys.

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

CTLV has been reported from the semi-desert irrigated areas of north-western USA (Washington and California) (Howell and Mink, 1976; Falk et al., 1991; Xu et al., 2014). A CTLV isolate from *Ammi majus* (bishop's weed) originating from Colombia is included in the DSMZ – German Collection of Microorganisms and Cell Cultures GmbH of the Leibniz Institute (https://www.dsmz.de/search/plant-viruses?tx_kesearch_pi1%5Bsword%5D=&cHash=52c526e20f1da08c8156847b8ae6ab1b). Details on CTLV distribution outside EU are summarised in Figure 1 and in the Appendix B.

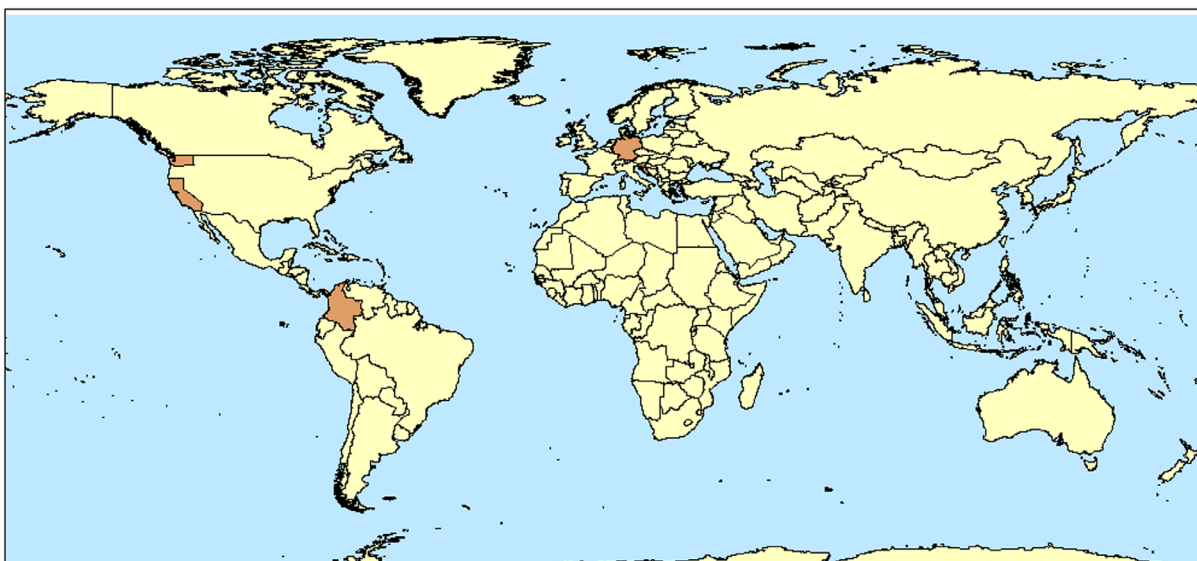


Figure 1: Global distribution map for carrot thin leaf virus (Source: literature)

3.2.2. Pest distribution in the EU

Is the pest present in the EU territory? If present, is the pest widely distributed within the EU?

Yes, CTLV has been reported in Germany, Greece and Slovenia. CTLV is not widely distributed in the EU territory, with uncertainty.

CTLV has been reported in Greece (Lotos et al., 2018), in Slovenia (Mehle et al., 2019) and in Germany (Julius Kühn-Institut, written communication).

In Greece, CTLV was detected in 2018 in mixed infection with carrot torrado virus 1 and a novel undescribed polerovirus on a wild plant (*Torilis arvensis* subsp. *arvensis*) showing leaf reddening symptoms. Apart from the symptomatic plant, no other hosts or plants were reported to be tested for CTLV infection by Lotos et al. (2018). Since there were no new occurrences after the first finding of the virus in 2018, the Greek NPPO considers that the virus is not established.

In Slovenia, the virus was detected in a private garden in mixed infection with *Apium virus Y* (ApVY) in parsley plants showing symptoms of severe mosaic, leaf distortion and stunted growth (Mehle et al., 2019). CTLV was also detected in the following years in weeds in Slovenia (NPPO Slovenia, written communication). The current status of CTLV in Slovenia is present only in some areas (central Slovenia) (NPPO Slovenia, written communication).

The German NPPO was contacted for information on the presence of CTLV and possible measures and the following information was received via the Julius Kühn Institute. According to information gathered from the Plant Protection Services of the German Federal Länder and supplemented by data available at the JKI Institute for Epidemiology and Pathogen Diagnostics, in Germany, this virus has been detected once in 2004 in the Federal Land Baden-Wuerttemberg in a carrot sample. However, there is no further information available on the circumstances of the finding. CTLV isolates from *D. carota* and *A. podagraria*, collected in Germany before 2010, are included in the DSMZ - German Collection of Microorganisms and Cell Cultures GmbH of the Leibniz Institute (https://www.dsmz.de/search/plant-viruses?tx_kesearch_pi1%5Bsword%5D=&cHash=52c526e20f1da08c8156847b8ae6ab1b). The geographical origin of these isolates was confirmed by Dr. Wulf Menzel, who dated back the first identification of CTLV in Germany in 2003 (Dr. Menzel, DSMZ, written personal communication).

CTLV was identified in weed samples (mainly *A. podagraria*, showing mosaic symptoms) which originated from different German Federal States (Rhineland Palatinate, Schleswig-Holstein and Lower Saxony). Dr. W. Menzel stated he still frequently observes diseased *A. podagraria* plants in Germany, supporting the current presence of the virus in this country. Although only selected samples from northern/central parts of Germany were assessed, due to the ubiquitous presence of hosts/vectors, wider presence of the virus in Germany could be expected (Dr. W. Menzel, written personal communication). It is not possible to estimate the actual distribution of the virus in Germany (Julius Kühn-Institut, written communication).

Based on these different publications and reports (Mehle et al., 2019, Julius Kühn-Institut, written communication), CTLV is currently present in Slovenia and Germany. However, there is uncertainty on the current virus distribution in these Member States and in the EU.

3.3. Regulatory status

3.3.1. Commission Implementing Regulation 2019/2072

CTLV is not listed in Annex II of Commission Implementing Regulation (EU) 2019/2072, the implementing act of Regulation (EU) 2016/2031.

3.3.2. Hosts of carrot thin leaf virus that are prohibited from entering the Union from third countries

None of the host plants of CTLV, either natural or experimental, are prohibited from entering the Union from third countries under Implementing Regulation 2019/2072.

3.3.3. Legislation addressing the organisms that vector carrot thin leaf virus (Commission Implementing Regulation 2019/2072)

The known vectors of CTLV, the green peach aphid *Myzus persicae* and the carrot-willow aphid *Cavariella aegopodii*, are not regulated under Commission Implementing Regulation 2019/2072.

3.4. Entry, establishment and spread in the EU

3.4.1. Entry

Is the pest able to enter into the EU territory? If yes, identify and list the pathways.

Yes, CTLV is able to enter in the EU. Potential pathway is plants for planting, including seeds.

Comment on plants for planting as a pathway.

No information on international trade of CTLV host plants for planting is available.

Akin other viruses, CTLV moves together with the host plants. Therefore, host plants for planting are a potential entry pathway, although there is no evidence of trade of plants for planting of CTLV hosts from non-EU countries in Eurostat. Conversely, import of fresh and chilled edible hosts, such as carrot, from countries where CTLV is present is reported in Eurostat. The data on these commodities are aggregated with other non-CTLV host plants (Table 3). *A. majus*, one potential host of CTLV, is used as a cut flower, but no information on import of this commodity is available in Eurostat. Fresh produce for consumption or floristry could provide a potential pathway for virus entry. Aphid vectors could acquire the virus from infected fresh produce and cut flowers, and later transmit it, as shown for other potyviruses such as papaya ringspot virus and zucchini yellow mosaic virus from melons, and plum pox virus from peach fruits (Lecoq et al., 2003; Gildow et al., 2004). However, considering the relatively unlikely set of events involved (aphids feeding on imported fresh produce or cut flowers then moving to susceptible plants) this pathway is considered as minor for the virus introduction and is not listed in Table 2. CTLV is transmitted by aphids in a non-persistent way, which implies that viruliferous aphids will lose the ability to transmit the virus within a short period of time corresponding to few feeding probes (reviewed by Gadhave et al., 2020). Therefore, the aphid pathway is considered as negligible and is not listed in Table 2.

No transmission through carrot seeds was reported for CTLV (Howell and Mink, 1979). However, a single isolate/cultivar combination was tested, and no other seed transmission assays were reported in the literature. Since some potyviruses can be seed-transmitted (Simmons and Munkvold, 2014; Wylie et al., 2017), this transmission mode cannot be excluded for CTLV based on current knowledge. Therefore, seeds for sowing of host plant species could provide an open entry pathway, with uncertainty. There is no information in Eurostat on seeds of CTLV host plants imported from third countries in which this virus is present. Potyviruses are generally not transmitted by soil and there is no evidence that this pathway may be relevant in the case of CTLV.

Table 2: Potential entry pathways for CTLV into the EU 27

Pathways	Life stage	Relevant mitigations [e.g. prohibitions (Annex VI) or special requirements (Annex VII) within Implementing Regulation 2019/2072]
<i>Daucus carota</i> , <i>Coriandrum sativum</i> , <i>Pastinaca sativa</i> , <i>Aegopodium podagraria</i> , <i>Petroselinum crispum</i> plants for planting (including seeds)	Not applicable	None

Table 3: EU 27 annual imports of carrots, turnips, salad beetroot, salsify, celeriac, radishes and similar edible roots, fresh or chilled (CN 0706 90) from countries where carrot thin leaf virus is present, 2016–2020 (Hundreds of kg) Source Eurostat. Extraction date 26.8.2021. 'na' stands for data not available

Source/Year	2016	2017	2018	2019	2020
Colombia	na	0,00	na	na	na
United States (incl. Navassa/2000)	60,89	31,82	150,85	13,7	119,48

Notifications of interceptions of harmful organisms began to be compiled in Europhyt in May 1994 and in TRACES in May 2020. As at 21st September 2021 there were no records of interception of CTLV in the Europhyt and TRACES databases.

3.4.2. Establishment

Is the pest able to become established in the EU territory?

Yes, the virus could potentially establish wherever the hosts are available in the EU.

CTLV is reported to be present in Germany and Slovenia, which indicates that the establishment of the virus is possible at least in some parts of the EU territory.

3.4.2.1. EU distribution of main host plants

Natural and cultivated hosts of CTLV are widespread in the EU. Carrot, one of the CTLV hosts, widely occurs in the EU as commercial crop. Details on the carrot production areas in individual EU MSs are provided in Table 4. Parsley, another natural host of CTLV, is also cultivated in the EU, with several MSs (Belgium, Netherlands, France, Poland, Spain) reported to be among the top 10 global exporters of parsley (<https://www.tridge.com/intelligences/parsley/export>). *A. majus* grows spontaneously in EU MSs, especially in the Mediterranean area, where it is also used for medicinal purposes and as cut flower (Hossain and Al Touby, 2020). However, association of CTLV with *A. majus* is uncertain (see section 3.2.1 and Appendix A).

Table 4: Carrot area (cultivation/harvested/production) (1,000 ha). Eurostat database, date of extraction 17/5/2021

MS/TIME	2016	2017	2018	2019	2020
Belgium	5,85	5,65	5,65	5,63	5,10
Bulgaria	0,41	1,15	1,52	1,09	0,59
Czechia	0,81	0,83	0,70	0,78	0,84
Denmark	2,14	2,19	2,20	2,25	2,02
Germany	11,21	12,55	12,96	13,73	13,79
Estonia	0,31	0,34	0,35	0,35	0,43
Ireland	0,80	0,79	0,73	0,79	0,77
Greece	0,96	0,91	0,94	0,96	0,91
Spain	6,71	6,44	6,55	6,67	6,89
France	12,79	12,81	12,35	12,55	12,70
Croatia	0,70	0,60	0,30	0,35	0,25
Italy	11,62	10,99	11,62	11,08	10,77
Cyprus	0,06	0,06	0,07	0,05	0,05
Latvia	0,40	0,40	0,50	0,51	0,40
Lithuania	1,83	1,55	1,63	1,65	1,56
Luxembourg	0,02	0,03	0,03	0,03	0,03
Hungary	1,74	1,57	1,45	1,61	1,60
Malta	0,00	0,00	0,00	0,00	0,00
Netherlands	9,20	9,35	9,18	9,91	9,59
Austria	1,81	1,84	1,83	1,88	1,87
Poland	22,55	22,37	22,67	22,50	22,50
Portugal	1,89	2,06	1,72	1,72	2,34
Romania	8,44	8,29	8,31	8,24	8,21
Slovenia	0,26	0,26	0,25	0,26	0,28
Slovakia	0,22	0,19	0,28	0,39	0,49
Finland	1,70	1,77	1,84	1,84	1,72
Sweden	2,00	1,70	1,76	1,71	1,62

MS: Member State.

3.4.2.2. Climatic conditions affecting establishment

Except for the climatic conditions affecting the hosts, no eco-climatic constraints exist for CTLV.

3.4.3. Spread

Following its establishment in the EU, CTLV could potentially spread by aphid transmission. Human-assisted spread cannot be excluded.

Comment on plants for planting as a mechanism of spread.

Local trade of CTLV-infected plants for planting could favour the spread of the virus.

Spread in the field would be mainly by aphid transmission in a non-persistent manner. *M. persicae* and *C. aegopodii*, which are present in the EU (Figures 2 and 3), have been identified as CTLV vectors (Howell and Mink, 1977). Contribution of other aphid species to CTLV spread in the field could be possible. Wild hosts may represent natural reservoirs of the virus that could be transmitted by aphids to cultivated crops. At least two wild host species (*T. arvensis* and *A. podagraria*) have been reported to be infected by CTLV in the EU (see Section 3.1.3). Spread through seeds has been excluded in carrot (Howell and Mink, 1979), but there is no data regarding other natural hosts (i.e. *T. arvensis*, coriander, parsnip, parsley). In addition, trade of CTLV-infected plants for planting could favour the spread of the virus. However, information on such a trade is not available.

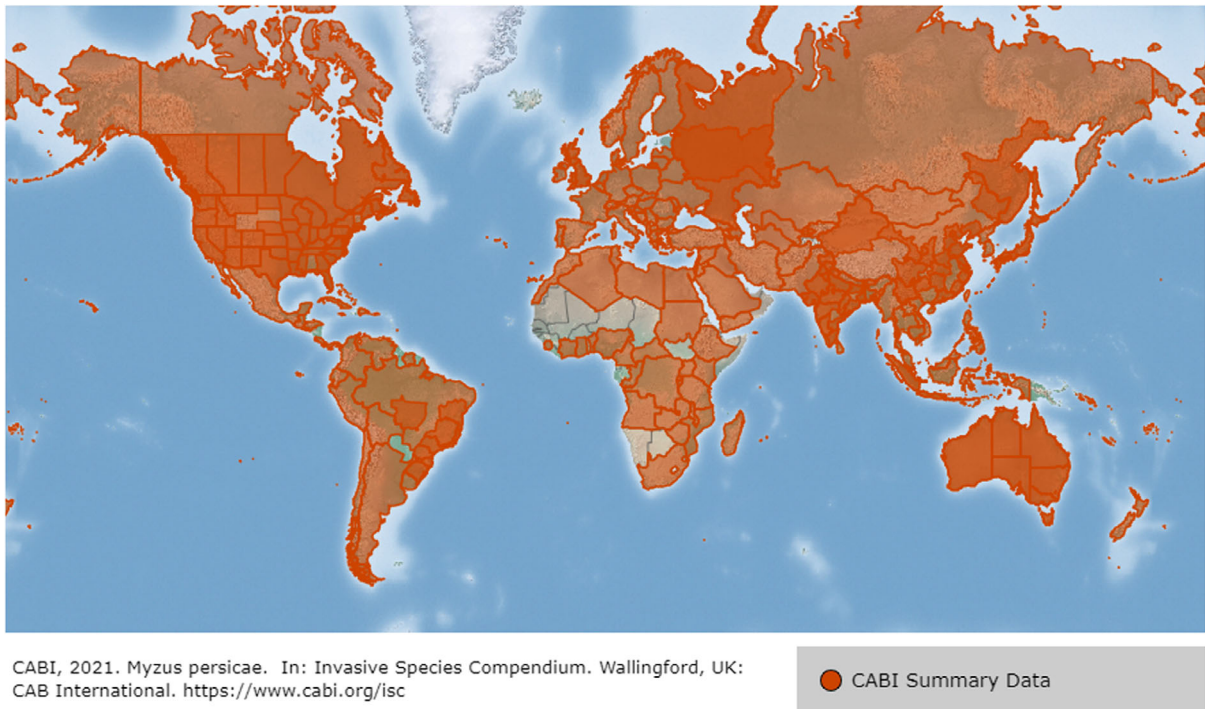


Figure 2: Global distribution map for *Myzus persicae* (extracted from the CABI Crop Compendium accessed on 17 May 2021)

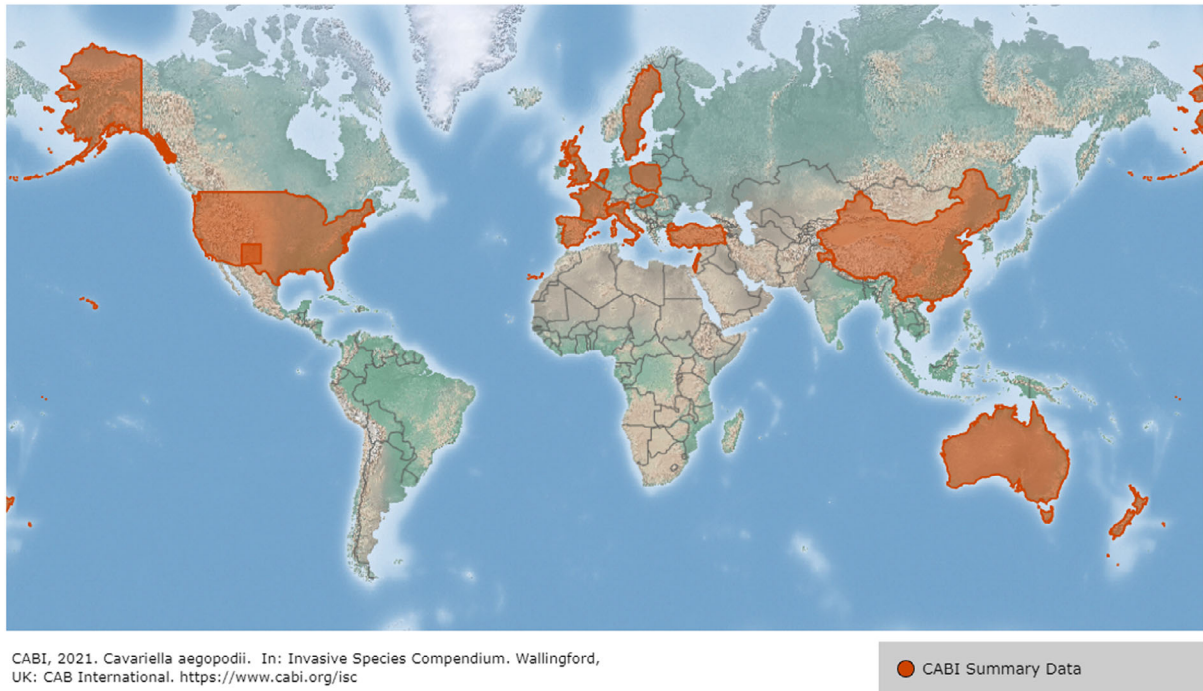


Figure 3: Global distribution map for *Cavariella aegopodii* (extracted from the CABI Crop Compendium accessed on 9 June 2021)

3.5. Impacts

Would the pests' introduction have an economic or environmental impact on the EU territory?

Yes, CTLV may induce symptoms in carrot, coriander, parsley and parsnip. The introduction (or re-introduction) of CTLV is likely to have yield and quality impacts on the EU territory. The magnitude of the impact in the EU conditions is uncertain.

Carrot, coriander, parsley and parsnip plants are cultivated hosts of CTLV in which the virus induces symptoms of stunting, thin leaf, chlorosis and/or vein clearing (Xu et al., 2014). Parsley plants simultaneously infected by CTLV and *Apium virus Y* showed severe mosaic, distortion, and stunted growth (Mehle et al., 2019), but uncertainty exists on the role of CTLV in mixed infections with other viruses. CTLV reduced root yields by 14–22% in greenhouse-grown carrots (cv. Red Core Chatenay) and by 24–28% their seed yields after being transplanted to a field plot in Washington State (Howell and Mink, 1979). In a survey performed from 1975 to 1979 in south-western Washington, CTLV was among the most prevalent viruses in wild carrot and poison hemlock (7% incidence) (Howell and Mink, 1981). Howell and Mink (1980) reported that in some fields of central Washington nearly all the carrots were infected by the virus at harvest time. No information has been provided on the extent of damage in Germany.

Based on the above, it is expected that the introduction (or re-introduction) of CTLV is likely to cause yield and quality impacts on the EU territory. Nevertheless, the magnitude of the impact under EU conditions is uncertain.

3.6. Available measures and/or potential specific import requirements and limits of mitigation measures

Are there measures available to prevent the entry into the EU such that the risk becomes mitigated?

No measures are in force to prevent the entry of CTLV into the EU on host plants and seeds. Potential measures exist to mitigate the risk of entry and spread (see Section 3.6.1).

3.6.1. Identification of potential additional measures

Potential control measures on hosts that are imported are listed in Table 5.

Table 5: Selected control measures (a full list is available in EFSA PLH Panel, 2018) for pest entry (and spread when applicable) in relation to currently unregulated hosts and pathways

Special requirements summary (with hyperlink to information sheet if available)	Control measure summary in relation to carrot thin leaf virus
Pest freedom	Used to mitigate likelihood of infestation by specified pest at origin, hence to mitigate entry Host plants and plant products originating from a CTLV-free country or a CTLV-free area or a CTLV-free place of production would impair the introduction of the virus
Managed growing conditions	Used to mitigate likelihood of infestation at origin Avoiding the presence of wild Apiaceae weeds potentially hosting CTLV at the edges of the fields would impair spread and incidence of the virus. Use of CTLV-free seeds.
Growing plants in isolation	Used to mitigate likelihood of infestation by specified pest in vicinity of growing site Growing plants in insect-proof greenhouses would impair the spread of the virus by aphids
Certification of reproductive material (voluntary/official)	Used to mitigate pests that are included in a certification scheme Certified seeds and plant for planting would avoid spread of the virus
Chemical treatments on crops including reproductive material	Used to mitigate likelihood of infestation of pests susceptible to chemical treatments Chemical control of possible vectors would impair the virus spread
Roguing and pruning	Used to mitigate likelihood of infestation by specified pest (usually a pathogen) at growing site where pest has limited dispersal Roguing of symptomatic plants would decrease the inoculum in the field
Inspections	Used to mitigate likelihood of infestation by specified pest at origin Inspection to identify early symptoms may contribute to improve the efficacy of roguing.
Cleaning and disinfection of facilities, tools and machinery	Used to mitigate likelihood of entry or spread of soil borne pests Disinfection of tools could reduce virus spread
Phytosanitary certificate and plant passport	Used to attest which of the above requirements have been applied Phytosanitary certificate and plant passport would reduce virus entry and spread

3.6.1.1. Biological or technical factors limiting the effectiveness of measures to prevent the entry of the pest

- Asymptomatic plants may reduce the efficacy of inspections and roguing.
- Symptoms caused by CTLV on some hosts may be not specific or may be due to mixed infection with other viruses, thus making CTLV detection by visual inspection inefficient
- The limited information of genome variability of CTLV could reduce the efficiency of detection methods used to certify the sanitary status of plant material

- Limited information on natural aphid vectors may reduce the efficiency of measures to mitigate the pest spread
- Weeds providing the natural reservoir of the virus may favour virus establishment and spread

3.7. Uncertainty

- Current distribution of the pest in the EU
- Natural host range
- Existence of other aphid vectors
- Seed transmission
- Host plants for consumption as a potential pathway for virus introduction and trade volumes of plants for planting and seeds for sowing
- Magnitude of impact

4. Conclusions

CTLV has been reported in Germany since early 2000s in both crops and weeds. Reports in Slovenia are more recent and the pest has restricted distribution (central Slovenia). No official national measures have been taken so far in these Members States. CTLV was reported from Greece on *Torilis arvensis* subsp. *arvensis*. Since then, no other reports exist. According to the Greek NPPO, the virus did not establish in Greece. The virus can be considered as present with restricted distribution in some Member States of the EU and so far not under official control. Therefore, currently CTLV does not fulfil the criterion of being absent or present with restricted distribution and under official control to be regarded as a potential Union quarantine pest, unless official control is implemented. This conclusion is associated with high uncertainty regarding the current virus distribution in the EU.

Table 6: The Panel's conclusions on the pest categorisation criteria defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Key uncertainties
Identity of the pest (Section 3.1)	The identity of carrot thin leaf virus is well established	None
Absence/presence of the pest in the EU (Section 3.2)	CTLV has been reported in Germany and Slovenia. Reports in Germany and Slovenia have been confirmed by the NPPOs of the respective Member States. CTLV was reported from Greece on <i>Torilis arvensis</i> subsp. <i>arvensis</i> . Since then, no other reports exist. According to the NPPO, the virus did not establish in Greece.	The geographic distribution in the EU is associated with uncertainty
Regulatory status (Section 3.3)	The pest is not regulated in the EU	None
Pest potential for entry, establishment and spread in the EU (Section 3.4)	CTLV is able to enter in the EU. The main potential pathway is host plants for planting, including seeds for sowing. The potential of CTLV for entry through host plants for planting is considered limited because of lack of evidence for this trade. Entry through infected seeds may be possible for some hosts. If CTLV were to enter in the EU territory, it could become established and further spread.	Natural host range Seed transmission for some natural hosts Existence of other aphid vectors Trade volumes of plants for planting and seeds for sowing of CTLV hosts
Potential for consequences in the EU (Section 3.5)	Introduction and further spread of CTLV could have negative impact on the EU yield and quality production of the cultivated hosts of CTLV	Magnitude of the impact of CTLV under the EU conditions.
Available measures (Section 3.6)	No specific phytosanitary measures are currently in place, but potential control measures are available to mitigate the risk of entry, establishment and spread of CTLV in the EU	None

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Key uncertainties
Conclusion (Section 4)	CTLV does not fulfil the criterion of being absent or present with restricted distribution and under official control to be regarded as a potential Union quarantine pest, unless official control is implemented.	High uncertainty exists on the current virus distribution in the EU.
Aspects of assessment to focus on/scenarios to address in future if appropriate:	Given the very limited available information on this virus, the development of a full PRA will not allow to resolve the uncertainties identified in the present categorisation until more data on distribution and host range become available.	

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Abbreviations

EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization
IPPC	International Plant Protection Convention
ISPM	International Standards for Phytosanitary Measures
MS	Member State
PLH	EFSA Panel on Plant Health
RT-PCR	reverse transcription polymerase chain reaction
TFEU	Treaty on the Functioning of the European Union
ToR	Terms of Reference

Glossary

Containment (of a pest)	Application of phytosanitary measures in and around an infested area to prevent spread of a pest (FAO, 2018).
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO, 2018).
Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled (FAO, 2018).
Eradication (of a pest)	Application of phytosanitary measures to eliminate a pest from an area (FAO, 2018).
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 2018).
Greenhouse	A walk-in, static, closed place of crop production with a usually translucent outer shell, which allows controlled exchange of material and energy with the surroundings and prevents release of plant protection products (PPPs) into the environment.
Impact (of a pest)	The impact of the pest on the crop output and quality and on the environment in the occupied spatial units.
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO, 2018).
Pathway	Any means that allows the entry or spread of a pest (FAO, 2018).

Phytosanitary measures	Any legislation, regulation or official procedure having the purpose to prevent the introduction or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO, 2018).
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO, 2018).
Risk reduction option (RRO)	A measure acting on pest introduction and/or pest spread and/or the magnitude of the biological impact of the pest should the pest be present. A RRO may become a phytosanitary measure, action or procedure according to the decision of the risk manager.
Spread (of a pest)	Expansion of the geographical distribution of a pest within an area (FAO 2018).

Appendix A – Carrot thin leaf virus host plants

Source: Web of Science and Scopus

Host status	Host name	Plant family	Common name	Reference
Cultivated hosts	<i>Daucus carota</i>	Apiaceae	Carrot	Howell and Mink (1976), Xu et al. (2014)
	<i>Coriandrum sativum</i>	Apiaceae	Coriander	Xu et al. (2014)
	<i>Petroselinum crispum</i>	Apiaceae	Parsley	Mehle et al. (2019)
	<i>Ammi majus</i>	Apiaceae	Bishop's weed	DSMZ catalog
Wild weed hosts	<i>Conium maculatum</i>	Apiaceae	Poison hemlock	Howell and Mink (1977, 1981)
	Wild <i>Daucus carota</i>	Apiaceae	Wild carrot	Howell and Mink (1977, 1981)
	<i>Pastinaca sativa</i>	Apiaceae	Parsnip	(Dr. D. Kutnjak, written personal communication/Slovenian NPPO. This host is associated with uncertainty due to the identification in a pool of weeds containing <i>P. sativa</i> as unique Apiaceae species)
	<i>Torilis arvensis</i> subsp. <i>arvensis</i>	Apiaceae	Spreading hedgeparsley	Lotos et al. (2018)
	<i>Aegopodium podagraria</i>	Apiaceae	Goutweed, bishop's weed	(Dr. W. Menzel, written personal communication)
Artificial/ experimental host	<i>Pimpinella anisum</i>	Apiaceae	Anise	Xu et al. (2014)
	<i>Carum carvi</i>	Apiaceae	Caraway	Xu et al. (2014)
	<i>Daucus carota</i>	Apiaceae	Carrot	Howell and Mink (1980), Xu et al. (2014)
	<i>Anthriscus cerefolium</i>	Apiaceae	Chervil	Xu et al. (2014)
	<i>Coriandrum sativum</i>	Apiaceae	Coriander	Xu et al. (2014)
	<i>Anethum graveolens</i>	Apiaceae	Dill	Xu et al. (2014)
	<i>Petroselinum crispum</i>	Apiaceae	Parsley	Xu et al. (2014)
	<i>Pastinaca sativa</i>	Apiaceae	Parsnip	Xu et al. (2014)
	<i>Conium maculatum</i>	Apiaceae	Poison hemlock	Howell and Mink (1980), Xu et al. (2014)
	<i>Chenopodium quinoa</i>	Chenopodiaceae	Quinoa	Howell and Mink (1980), Xu et al. (2014)
	<i>C. amaranticolor</i>	Chenopodiaceae		Howell and Mink (1980) Xu et al. (2014)
	<i>C. murale</i>	Chenopodiaceae		Xu et al. (2014)
	<i>Beta macrocarpa</i>	Chenopodiaceae	Beet	Xu et al. (2014)
	<i>Nicotiana benthamiana</i>	Solanaceae		Xu et al. (2014)
<i>N. clevelandii</i>	Solanaceae		Howell and Mink (1980), Xu et al. (2014)	

Appendix B – Distribution of carrot thin leaf virus

Distribution records based on literature search.

Region	Country	Sub-national (e.g. State)	Status	References
North America	USA	Washington, California		Howell and Mink (1976), Falk et al. (1991), Xu et al. (2014)
South America	Colombia			DSMZ isolate
EU (27)	Germany			Confirmed by NPPO, DSMZ isolate
	Slovenia			Mehle et al. (2019)
	Greece			Lotos et al. (2018)