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Pest categorisation of *Capsicum chlorosis virus*

EFSA Panel on Plant Health (PLH),
Claude Bragard, Paula Baptista, Elisavet Chatzivassiliou, Paolo Gonthier,
Josep Anton Jaques Miret, Annemarie Fejer Justesen, Alan MacLeod,
Christer Sven Magnusson, Panagiotis Milonas, Juan A Navas-Cortes, Stephen Parnell,
Roel Potting, Philippe Lucien Reignault, Emilio Stefani, Hans-Hermann Thulke,
Wopke Van der Werf, Antonio Vicent Civera, Jonathan Yuen, Lucia Zappalà,
Katharina Dehnen-Schmutz, Quirico Migheli, Irene Vloutoglou, Ewelina Czwieneczek,
Franz Streissl, Anna Vittoria Carluccio, Michela Chiumenti, Francesco Di Serio,
Luisa Rubino and Philippe Lucien Reignault

Abstract

The EFSA Panel on Plant Health conducted a pest categorisation of *Capsicum chlorosis virus* (CaCV) for the EU territory. The identity of CaCV, a member of the genus *Orthotospovirus* (family *Tospoviridae*), is established and reliable detection and identification methods are available. The pathogen is not included in the EU Commission Implementing Regulation 2019/2072. CaCV has been reported in Australia, China, India, Iran, Taiwan, Thailand and USA (Hawaii). In the EU, it has been reported once in Greece (Crete Island). The NPPO of Greece reported that CaCV is no longer present in Greece. CaCV infects plant species in the family Solanaceae (i.e. pepper, tomato) and several species of other families, including ornamentals. It may induce severe symptoms on its hosts, mainly on leaves and fruits, which may become unmarketable. The virus is transmitted in a persistent propagative mode by the thrips *Ceratothripoides claratris*, *Frankliniella schultzei*, *Microcephalothrips abdominalis* and *Thrips palmi*. *C. claratris* and *T. palmi* are EU quarantine pests. *M. abdominalis* is known to be present in several EU member states and it is not regulated in the EU. Plants for planting, parts of plants, fruits and cut flowers of CaCV hosts, and viruliferous thrips were identified as the most relevant pathways for the entry of CaCV into the EU. Cultivated and wild hosts of CaCV are distributed across the EU. Should the pest enter and establish in the EU territory, impact on the production of cultivated hosts is expected. Phytosanitary measures are available to prevent entry and spread of the virus in the EU. CaCV fulfils the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest.

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Correspondence: plants@efsa.europa.eu

Panel members: Claude Bragard, Paula Baptista, Elisavet Chatzivassiliou, Francesco Di Serio, Paolo Gonthier, Josep Anton Jaques Miret, Annemarie Fejer Justesen, Alan MacLeod, Christer Sven Magnusson, Panagiotis Milonas, Juan A Navas-Cortes, Stephen Parnell, Roel Potting, Philippe L Reignault, Emilio Stefani, Hans-Hermann Thulke, Wopke Van der Werf, Antonio Vicent Civera, Jonathan Yuen and Lucia Zappalà.

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Figure 2: EPPO



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Table of contents

Abstract.....	1
1. Introduction.....	4
1.1. Background and Terms of Reference as provided by the requestor.....	4
1.1.1. Background.....	4
1.1.2. Terms of reference.....	4
1.2. Interpretation of the Terms of Reference.....	4
1.3. Additional information.....	5
2. Data and methodologies.....	5
2.1. Data.....	5
2.1.1. Information on pest status from NPPOs.....	5
2.1.2. Literature search.....	5
2.1.3. Database search.....	5
2.2. Methodologies.....	5
3. Pest categorisation.....	6
3.1. Identity and biology of the pest.....	6
3.1.1. Identity and taxonomy.....	6
3.1.2. Biology of the pest.....	7
3.1.3. Host range/species affected.....	8
3.1.4. Intraspecific diversity.....	8
3.1.5. Detection and identification of the pest.....	9
3.2. Pest distribution.....	10
3.2.1. Pest distribution outside the EU.....	10
3.2.2. Pest distribution in the EU.....	10
3.3. Regulatory status.....	10
3.3.1. Commission Implementing Regulation 2019/2072.....	10
3.3.2. Hosts or species affected that are prohibited from entering the Union from third countries.....	10
3.3.3. Legislation addressing the organisms that transmit Capsicum chlorosis virus (Commission Implementing Regulation 2019/2072).....	11
3.4. Entry, establishment and spread in the EU.....	11
3.4.1. Entry.....	11
3.4.2. Establishment.....	13
3.4.2.1. EU distribution of main host plants.....	13
3.4.2.2. Climatic conditions affecting establishment.....	15
3.4.3. Spread.....	15
3.5. Impacts.....	16
3.6. Available measures and their limitations.....	17
3.6.1. Identification of potential additional measures.....	17
3.6.1.1. Additional potential risk reduction options.....	17
3.6.1.2. Additional supporting measures.....	19
3.6.1.3. Biological or technical factors limiting the effectiveness of measures.....	21
3.7. Uncertainty.....	21
4. Conclusions.....	21
References.....	22
Abbreviations.....	25
Glossary.....	26
Appendix A – Capsicum chlorotic virus host plants.....	27
Appendix B – Distribution of Capsicum chlorosis virus.....	29
Appendix C – Import data.....	30

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

Capsicum chlorosis virus (CaCV) is one of a number of pests identified from horizon scanning and listed in Annex 1 to the Terms of Reference (ToR) to be subject to pest categorisation to determine whether it fulfils the criteria of a potential Union quarantine pest 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 quarantine pest, risk reduction options will be identified.

1.3. Additional information

In 2012, EFSA Plant Health Panel performed the pest categorisation for a group of 24 tospoviruses, including Capsicum chlorosis virus (EFSA PLH Panel, 2012). The risk for the EU territory from CaCV and several other tospoviruses was assessed 'as limited but with significant uncertainty'. In addition, it was stressed 'that new experimental data on the vector range of a particular virus, or changes in the geographical distribution or prevalence of vector species, could necessitate the reallocation of viruses in this category to a higher risk category' (EFSA PLH Panel, 2012). In the present pest categorisation, new data and information on vectors and geographic distribution that may reduce the uncertainty highlighted in the conclusions of the previous pest categorisation are taken into consideration.

2. Data and methodologies

2.1. Data

2.1.1. 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 an MS, an official pest status is not always available. In order to obtain information on the official pest status for Capsicum chlorosis virus, EFSA has consulted the NPPO of Greece. The results of this consultation are presented in Section 3.2.2.

2.1.2. Literature search

A literature search on Capsicum chlorosis 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.

2.1.3. Database search

Pest information, on host(s) and distribution, was retrieved from the European and Mediterranean Plant Protection Organization (EPPO), Global Database (EPPO, online), the CABI databases and scientific literature databases as referred above in Section 2.1.2.

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 is 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.

GenBank was searched to determine whether it contained any nucleotide sequences of Capsicum chlorosis virus and the associated information. GenBank® (www.ncbi.nlm.nih.gov/genbank/) is a comprehensive publicly available database that as of August 2019 (release version 227) contained over 6.25 trillion base pairs from over 1.6 billion nucleotide sequences for 450,000 formally described species (Sayers et al., 2020).

2.2. Methodologies

The Panel performed the pest categorisation for Capsicum chlorosis virus, 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).

The criteria to be considered when categorising a pest as a potential Union quarantine pest (QP) is given in Regulation (EU) 2016/2031 Article 3 and Annex I, Section 1 of the Regulation. 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. Whilst 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 the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018). 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 derived from 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 clearly defined, 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 in a limited part of the EU or is it scarce, irregular, isolated or present infrequently? If so, the pest is considered to be not widely distributed.
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 for entry and spread.
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 pest entry, establishment, spread or impacts?
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 clearly defined, or has it been shown to produce consistent symptoms and/or to be transmissible? (Yes or No)

Yes, the identity of Capsicum chlorosis virus is well established. It has been shown to produce consistent symptoms and to be transmissible.

Capsicum chlorosis virus (CaCV) is classified in the species *Capsicum chlorosis orthospovirus* belonging to the genus *Orthospovirus* (family *Tospoviridae*, order *Bunyvirales*) (<https://talk.ictvonline.org/taxonomy/>). Enveloped virus particles are pleomorphic or quasi-spherical, 80–120 nm in diameter. The envelope consists of a host-derived membrane with glycoprotein projections appearing as 'spike-like' structures on the virion surface. The viral genome consists of three single-stranded ambisense or negative-sense RNA molecules, designated L (large, 8,912 nucleotides, nt), M (medium, 4,823 nt) and S (small, 3,477 nt), containing five open reading frames (ORFs). The eight terminal nucleotides of each RNA segment are conserved among the genus members, and are complementary (UCUCGUUA at the 3' end and AGAGCAAU at the 5' end), and contribute to the base-pairing of the termini of each RNA to form a panhandle structure. The L RNA is negative sense, whereas the S and M RNA segments adopt an ambisense coding strategy. The S RNA encodes the nucleocapsid (N) and a non-structural (NSs) protein in the complementary and genome-sense RNA, respectively. NSs is considered the silencing suppressor and has dsRNA-binding capabilities. The M RNA encodes a glycoprotein precursor (proteolytically processed to yield two viral glycoproteins, G_N and G_C, which constitute the protrusions from the virion envelope) in the complementary-sense and a second non-structural protein (NSm, the cell-to-cell movement protein) in the genome-sense. In infected cells, NSm forms tubular structures, trespassing plasmodesmata and contributing to the advancement of the front of infection. The L RNA encodes the viral RNA-dependent RNA polymerase (RdRp) (Plyusnin et al., 2012).

The first complete genome sequence of CaCV is from an isolate infecting tomato in Thailand and consists of three ssRNAs of 3,477, 4,823 and 8,912 nt, with a genome organisation typical of orthospoviruses (Knierim et al., 2006). The sequences are publicly available in GenBank database (DQ256123, DQ256125 and DQ256124), together with at least six more complete genome sequences and tens of partial or complete CDS sequences.

The EPPO code¹ (Griessinger and Roy, 2015; EPPO, 2019) for this species is CACV00 (EPPO, online).

3.1.2. Biology of the pest

CaCV infects several crops and ornamental plant species, inducing a variety of symptoms, frequently consisting of chlorosis, mottle, spots and ringspots, line patterns and necrosis on the leaves. In some hosts, fruits can be also affected (see Section 3.5).

As is the case of other tospoviruses, CaCV is exclusively transmitted by thrips in nature. Thrips transmit tospoviruses in a persistent propagative mode (Whitfield et al., 2005). The virus is only acquired at the larval stage by the first and early second instars. Late second-instar larvae and adults from viruliferous larvae are able to transmit the virus for their whole lifespan (Moritz et al., 2004). Thrips pupate in the soil, then the adults emerge and move to the plant and, if viruliferous, they can widely disperse the virus (Whitfield et al., 2005). Adults from non-viruliferous larvae cannot become viruliferous even if they feed on infected plants (Ohnishi et al., 2001; Assis Filho et al., 2005). No transovarial transmission has been reported for tospoviruses (Wijkamp et al., 1996).

CaCV is transmitted by thrips species (Thysanoptera, Thripidae), namely *Ceratothripoides claratrix* Shumsher, *Frankliniella schultzei* Trybom, *Microcephalothrips abdominalis* Crawford and *Thrips palmi* Karny (Premachandra et al., 2005; Halaweh and Poehling, 2009; Sharman et al., 2020). It has been shown that virus transmission by second-instar larvae of *C. claratrix* can significantly contribute to CaCV spread, because these larvae can move between neighbouring plants (Premachandra et al., 2005; Halaweh and Poehling, 2009). In experimental trials, both viruliferous adult females and males of *C. claratrix* were able to transmit the virus with similar efficiency, starting from 0 to 2 days after emergence and maintaining transmission competency for at least 8 days after emergence (Premachandra et al., 2005). Transmission of CaCV by *T. palmi* and *F. schultzei*, initially proposed based on the overlapping natural distribution of these thrips and of the virus in Australia (McMichael et al., 2002; Persley et al., 2006) has been experimentally confirmed (Chiaki et al., 2020; Sharman et al., 2020). The thrips *M. abdominalis* was recently identified as an additional vector of CaCV (Sharman et al., 2020).

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).

CaCV was detected in the body of *Thrips tabaci* and *Scirtothrips dorsalis* in Iran (Bayat et al., 2018) and Thailand (Chiemsombat et al., 2008), respectively, by RT-PCR. However, transmission tests with Japanese CaCV isolates did not confirm *T. tabaci* as a vector of this virus (Chiaki et al., 2020). The ability of *S. dorsalis* to transmit the virus has not been experimentally shown, thus remaining uncertain (Chiemsombat et al., 2008). Whether other thrips species would be involved in the virus spread is unknown.

Weeds infected by CaCV and infested by thrips vectors may be reservoirs of the virus that can be transferred to susceptible crops through natural spread of the viruliferous thrips (Sharman et al., 2020).

Tospoviruses are generally not reported as seed transmitted (Mumford et al., 1996; Kormelink et al., 1998). No seed transmission was reported for CaCV. Mechanical transmission has just an experimental relevance (EFSA PLH Panel, 2012).

3.1.3. Host range/species affected

CaCV can infect a wide variety of cultivated and wild hosts. Natural CaCV infections have been reported in species in the family Solanaceae, such as pepper (*Capsicum annuum* L.; McMichael et al., 2002; Jones and Sharman, 2005) and tomato (*Solanum lycopersicum* L.; McMichael et al., 2002). CaCV can also infect other species in the family Solanaceae. Peanut (*Arachis hypogaea* L.) and pineapple [*Ananas comosus* L. (Merr.)], are the major CaCV hosts in the families Fabaceae and Bromeliaceae, respectively (Chen et al., 2007). In the family Cucurbitaceae, zucchini (*Cucurbita pepo* L.) was reported as CaCV natural host in China (Sun et al., 2018). Ornamental plant species belonging to numerous families (Amaranthaceae, Amaryllidaceae, Apocynaceae, Araceae, Asteraceae, Begoniaceae, Gesneriaceae, Orchidaceae) are natural hosts of CaCV. Wild CaCV hosts mainly belong to Asteraceae and Solanaceae families.

Solanum tuberosum L. is reported as a CaCV host in CABI crop compendium (accessed on 9/3/2022). However, the associated publication (Steenken and Halaweh, 2011) does not mention *S. tuberosum* among the screened hosts. CaCV is also listed as a virus associated with potato in the EFSA scientific opinion on the list of non-EU viruses and viroids infecting potato and other tuber-forming *Solanum* species (EFSA PLH Panel, 2020), based on information retrieved from GenBank database, where three accessions of the CaCV NSs gene from potato are reported. These findings were recorded in 2010 from plants grown in Thailand. Since then, this information has not been further substantiated in any published peer-reviewed article and no other report of CaCV in potato has been published. Therefore, *S. tuberosum* is currently considered only as a potential host, with high uncertainty.

CaCV has been mechanically transmitted to a number of experimental hosts in the families Amaranthaceae, Asteraceae, Apocynaceae, Cucurbitaceae, Fabaceae and Solanaceae. Since CaCV infects plant species in different families, other natural hosts may exist. A detailed list of natural and experimental hosts of CaCV 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 quasi-species (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. When data on the virus genome sequence variability are limited, the reliability of detection methods is associated with uncertainty.

Several full genome sequences, including all three RNA components, and a number of complete coding sequences of CaCV as well as partial genomic sequences of several CaCV isolates from different plant hosts are currently available in the NCBI GenBank database (<https://www.ncbi.nlm.nih.gov/nucleotide/>), sharing an overall limited sequence variability at the nucleotide level. Analysis of the N gene sequences, as well as serological data, showed that CaCV belongs to the watermelon silver mottle virus (WSMoV) serogroup IV of orthotospoviruses (McMichael et al., 2002; Kunkalikar et al., 2007). Intraspecific diversity has been reported for CaCV. Phylogenetic analysis of the CaCV S RNA sequences showed that isolates clustered into two clades, one containing isolates from Australia, Thailand, Taiwan and India, and the other grouping two isolates from China and Thailand (Widana Gamage et al., 2015). The possibility that these latter isolates could represent distinct tospovirus species was hypothesised (Widana Gamage et al., 2015); however, it was not considered sufficiently

supported by the International Committee on Taxonomy of Viruses (ICTV) since it was based on the S RNA sequence only (Adkins et al., 2018). The intergenic regions (IGRs) in S RNA are highly variable among different CaCV isolates, for which the IGR sequence, structure and evolution were determined by Huang et al. (2017). By comparison of the IGR sequences, it was shown that isolates from Taiwan (CaCV-Ph, from *Phalaenopsis* orchids), China (CaCV-Hainan, from *Hymenocallis americana*) and Thailand (CaCV-NRA, from peanut) all derive from the Australian isolate CaCV-Qld-3432, after deletions in its larger IGR. The IGR of a virus isolate from India (CaCV-Ch-Pan, from pepper) also derived from CaCV-Qld-3432, although only in part. The Thai isolate CaCV-AIT (from tomato) most likely has a different origin (Huang et al., 2017). In a study on tospoviruses in Thailand, analysis of N protein sequences showed that CaCV isolates formed three distinct clades: clade I comprised Thai isolates inducing necrosis symptoms on tomato, clade II contained isolates from China (peanut) and Taiwan (*Gloxinia*) and clade III grouped isolates from tomato, pepper, peanut and gloxinia from Thailand, USA and Australia (Chiemsombat et al., 2008). Sequence variability was also associated with different biological properties of some isolates, as shown by the symptoms induced in the experimental host *Vigna unguiculata* (Chiemsombat et al., 2008).

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 Capsicum chlorosis virus.

EPPO Standard PM7/139 reports methods for reliable detection and identification of tospoviruses in plants, including CaCV (OEPP/EPPO, 2020).

CaCV belongs to the tospovirus serogroup IV (McMichael et al., 2002; Kunkalikal et al., 2007) and can be serologically detected using polyclonal and monoclonal antibodies against tospoviruses of this group, although conclusive identification of the virus needs further confirmation by molecular methods (McMichael et al., 2002; Zheng et al., 2010; Manyam and Byadgi, 2014; Basavaraj et al., 2020; Hassani-Mehraban et al., 2016, EPPO/OEPP, 2020). Double-antibody sandwich ELISA kits are commercially available for the detection of CaCV.

Degenerated primers to detect several tospoviruses, including CaCV, by RT-PCR have been developed (Chu et al., 2001; Zheng et al., 2008; Chen et al., 2012; Yin et al., 2016). When these primers are used, final identification of CaCV needs cloning and sequencing or direct sequencing of the obtained PCR amplicons (Zheng et al., 2008; Haokip et al., 2016; Yin et al., 2016). Specific primers for RT-PCR-based identification of CaCV have been designed and efficiently applied in field surveys for the specific amplification of CaCV cDNAs and for the conclusive identification of the virus by more detailed sequence analyses (Krishnareddy et al., 2008; Yin et al., 2016; Basavaraj et al., 2020; Haokip et al., 2021). Hassani-Mehraban et al. (2016) designed generic and species-specific primers to detect tospoviruses in all the recognised tospovirus clades (Oliver and Whitfield, 2016; Hassani-Mehraban et al., 2019). This protocol has been validated using a set of samples infected by tospoviruses of different geographic origin (Hassani-Mehraban et al., 2016) and has been indicated by EPPO as a reference conventional RT-PCR protocol for the detection of tospoviruses, including CaCV, in leaf samples from several plant host species (EPPO/OEPP, 2020). Sequencing of the amplicons generated by the generic and the specific primers is needed for the conclusive identification of the infecting tospovirus species and virus isolate, respectively (EPPO/OEPP, 2020).

Assays to identify CaCV alone and in mixed infection with other tospoviruses have been also optimised, including a duplex RT-PCR (Haokip et al., 2021), a multiplex RT-PCR (Kunkalikal et al., 2011) and a multiplex RT-PCR-ELISA method (Charoenvilaisiri et al., 2014). Specific tests, technologically more advanced, have also been developed for detecting CaCV, including an integrated microfluidic system, based on loop-mediated isothermal amplification (LAMP) assay (Chang et al., 2013) and an amperometric immunosensor (Sharma et al., 2017). A molecular assay based on a sophisticated technology (Luminex xTAG) allows detecting simultaneously and differentiate CaCV and other three tospoviruses species (Bald-Blume et al., 2017).

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

CaCV has been reported in Australia, China, India, Iran, Taiwan, Thailand, USA (Hawaii). Global distribution of CaCV is shown in Figure 1, with details and related references summarised in Appendix B.

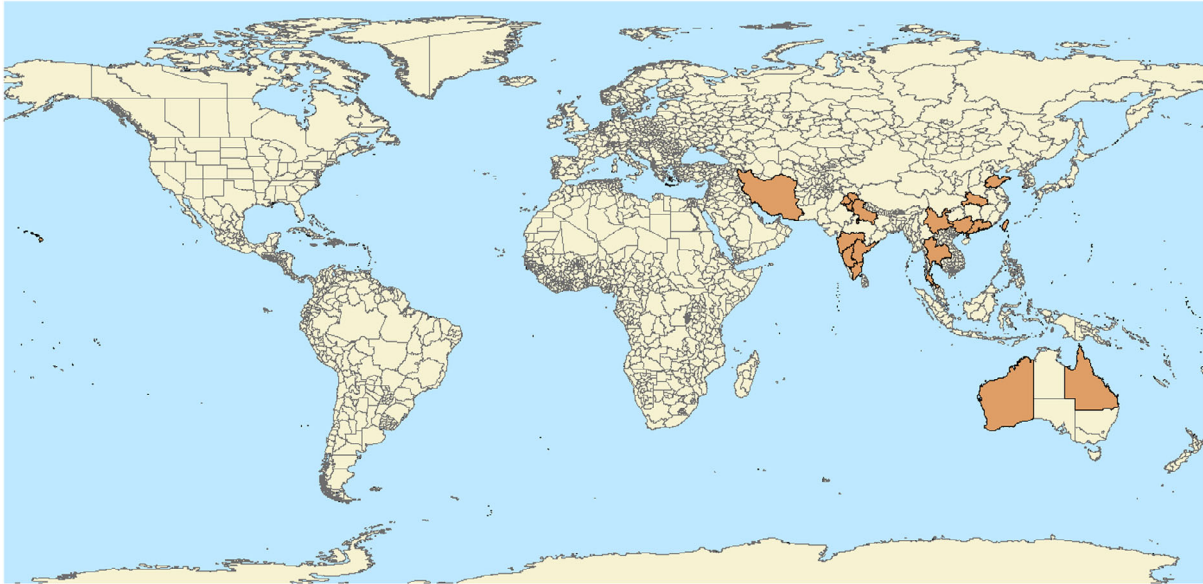


Figure 1: Global distribution map of Capsicum chlorosis virus

3.2.2. Pest distribution in the EU

Is the pest present in the EU territory? If present, is the pest in a limited part of the EU or is it scarce, irregular, isolated or present infrequently? If so, the pest is considered to be not widely distributed.

No, Capsicum chlorosis virus has been reported once in Greece (Crete Island) in 2017. However, according to the Greek NPPO the pest is no longer present in Greece.

CaCV has been reported once in Greece (Crete Island) in 2017 (Orfanidou et al., 2019). The Greek NPPO was contacted and it was clarified that, after the first report, no other finding in any region of Greece occurred since then. Therefore, the NPPO considers the pest not to be present in Greece.

3.3. Regulatory status

3.3.1. Commission Implementing Regulation 2019/2072

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

3.3.2. Hosts or species affected that are prohibited from entering the Union from third countries

Plant for planting of some hosts (Solanaceae) of CaCV are prohibited from entering the Union from third countries under Commission Implementing Regulation (EU) 2019/2072 (Table 2).

Table 2: List of plants, plant products and other objects that are Capsicum chlorosis virus hosts whose introduction into the Union from certain third countries is prohibited (Source: Commission Implementing Regulation (EU) 2019/2072, Annex VI).
Table laid out as Annex VI of 2019/2072

List of plants, plant products and other objects whose introduction into the Union from certain third countries is prohibited			
	Description	CN Code	Third country, group of third countries or specific area of third country
18	Plants for planting of Solanaceae other than seeds and the plants covered by entries 15, 16 or 17	ex 0602 90 30 ex 0602 90 45 ex 0602 90 46 ex 0602 90 48 ex 0602 90 50 ex 0602 90 70 ex 0602 90 91 ex 0602 90 99	Third countries other than: Albania, Algeria, Andorra, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Canary Islands, Egypt, Faeroe Islands, Georgia, Iceland, Israel, Jordan, Lebanon, Libya, Liechtenstein, Moldova, Monaco, Montenegro, Morocco, North Macedonia, Norway, Russia (only the following parts: Central Federal District (Tsentralny federalny okrug), Northwestern Federal District (Severo-Zapadny federalny okrug), Southern Federal District (Yuzhny federalny okrug), North Caucasian Federal District (Severo-Kavkazsky federalny okrug) and Volga Federal District (Privolzhsky federalny okrug)), San Marino, Serbia, Switzerland, Syria, Tunisia, Turkey and Ukraine

3.3.3. Legislation addressing the organisms that transmit Capsicum chlorosis virus (Commission Implementing Regulation 2019/2072)

Two thrips vectors of CaCV, *Ceratothripoides claratris* and *Thrips palmi*, are regulated as quarantine pests under Commission Implementing Regulation 2019/2072 (Annex IIA, 3, 21 and Annex IIA, 3, 79, respectively), while the other two thrips species, *Frankliniella schultzei* and *Microcephalothrips abdominalis*, are not regulated. *Scirtothrips dorsalis*, a potential thrips vector of CaCV (see Section 3.1.2), is regulated as quarantine pest 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, CaCV already entered one EU MS. It may further enter the EU with plants for planting (other than seeds), fruits or cut flowers of its hosts and with viruliferous thrips on CaCV hosts and non-hosts.

Comment on plants for planting as a pathway

Plants for planting (other than seeds) are the major entry pathway of CaCV and its thrips vectors.

Table 3 provides broad descriptions of potential pathways for the entry of CaCV into the EU.

Table 3: Potential pathways for Capsicum chlorosis virus into the EU 27

Pathways	Life stage	Relevant mitigations [e.g. prohibitions (Annex VI), special requirements (Annex VII) or phytosanitary certificates (Annex XI) within Implementing Regulation 2019/2072]
Plants for planting, other than seeds, of CaCV hosts*	N/A	Import of plants for planting of Solanaceae from most third countries, including those in which CaCV has been reported, is prohibited (Annex VI, 18) (Table 2). Import of hosts of other botanical families is not prohibited.
Plants, parts of plants, fruits and cut flowers of CaCV hosts	N/A	Special requirements regarding cut flowers of Orchidaceae from third countries are listed in the Annex VII at point 29. Phytosanitary certificate is requested for (i) foliage, branches and other parts of tomato or eggplant plants, without flowers or flower buds, from third countries other than Switzerland (Annex XI, part A, 3); (ii) Solanaceae cut flowers and flower buds, foliage, branches and other parts of plants, without flowers and flower buds, from Americas and Australia (Annex XI, part A, 3); (iii) cut flowers of Orchidaceae from third countries other than Switzerland, (iv) <i>Cucurbita</i> spp. (Annex XI, part B); fruits of Solanaceae from third countries other than Switzerland (Annex XI, part A, 5).
Viruliferous thrips <i>Ceratothripoides claratris</i> , <i>Frankliniella schultzei</i> , <i>Microcephalothrips abdominalis</i> and <i>Thrips palmi</i>	Young and adult stages on i) thrips host plants for planting with foliage, ii) thrips host cut flowers especially with foliage; vegetable and ornamental thrips host plants and fruits. Pupae in soil or attached to machinery and vehicles not properly cleaned	<i>C. claratris</i> and <i>T. palmi</i> are Union quarantine pests (Annex II, part A, C18); <i>M. abdominalis</i> and <i>F. schultzei</i> are not regulated in the EU. Special requirements regarding <i>T. palmi</i> are listed in the Annex VII at points 4 (for plants for planting, other than bulbs, corms, rhizomes, seeds, tubers, and plants in tissue culture), 29 (for cut flowers of Orchidaceae), 70 (for fruits of <i>Solanum melongena</i> L.) for imports from third countries. Special requirements regarding <i>C. claratris</i> are listed in the Annex VII at point 21.1 (for plants for planting of Cucurbitaceae Juss. and Solanaceae Juss., other than bulbs, corms, rhizomes, pollen, seeds, tubers, and plants in tissue culture). No special requirements are listed in the Annex VII for the other CaCV vectors (<i>F. schultzei</i> , <i>M. abdominalis</i>). Fruits, vegetables and cut flowers from third countries require a phytosanitary certificate to import into the EU (2019/2072, Annex XI, Part A and B). However, fruits of pineapple (<i>Ananas comosus</i>) are exempt by Regulation 2019/2072 (Annex XI, Part C). EU legislation (2019/2072) prohibits the import of soil from third countries (Annex VI, 19). However, phytosanitary certificate is required for soil introduced from third countries as growing medium attached to or associated with plants intended to sustain their vitality (Annex XI, A, 1). Official statement that the machinery or vehicles are cleaned and free from soil and plant debris is required (Annex VII, 2) Phytosanitary certificate for the introduction into the European Union territory of machinery and vehicles from third countries other than Switzerland is required (Annex XI, A, 1).

*: Appendix A lists the hosts of CaCV.

Import in the EU of Solanaceae host plants for planting of CaCV is prohibited (Regulation 2019/2072, Annex VI), while there are many other hosts (Appendix A) that can be imported to the EU with a phytosanitary certificate.

T. palmi and *C. claratris* are included in the list of EU quarantine pests (Annex II). *F. schultzei* and *M. abdominalis* are not regulated in the EU. Special requirements for importing plants for planting, cut flowers of Orchidaceae and fruits of *S. melongena*, include official statements regarding *T. palmi* (Regulation 2019/2072, Annex VII) (Table 3). Special requirements regarding *C. claratris* are also listed in Annex VII with respect to the import of plants for planting of Solanaceae and Cucurbitaceae (Table 3).

Fruits, cut flowers and parts of plants of CaCV hosts can be imported to the EU with a phytosanitary certificate. A phytosanitary certificate is not required for importing fruits of *A. comosus* (pineapple), which is a natural host of CaCV.

EU legislation (2019/2072) prohibits the import of soil from third countries, so that pathway can be considered as closed. However, soil can enter the EU from third countries as growing medium attached to or associated with plants intended to sustain their vitality, if accompanied by a phytosanitary certificate (Annex XI, Part A1).

EU 27 annual imports of *C. annuum*, *S. lycopersicum* and orchids from countries where CaCV is present are provided in Appendix C.

Notifications of interceptions of harmful organisms began to be compiled in Europhyt in May 1994 and in TRACES in May 2020. As of 10 March 2022, there were no records of interception of CaCV in the Europhyt and TRACES databases. However, the CaCV vector(s) *T. palmi* and *F. schultzei* were frequently intercepted on many hosts from several countries, including countries in which CaCV has been reported (Thailand, India, China and USA). A detailed analysis of *T. palmi* interceptions from 1994 to 2018 is reported in a previous EFSA scientific opinion (EFSA PLH Panel, 2019). From 1994 to 2020, Europhyt reported 1,926 interceptions of *T. palmi* (out of a total of 4,015) and two of *F. schultzei* (out of a total of 14) from countries where CaCV is present. No record of *F. schultzei* was reported in TRACES, while 11 interception notifications from countries where CaCV is present (out of a total of 59) were recorded for *T. palmi*.

3.4.2. Establishment

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

The virus can potentially establish wherever the hosts are available in the EU and the broader establishment of the virus is only limited by the presence of competent thrips vector(s). One of them (*M. abdominalis*) is already present in several EU MSs.

CaCV can potentially establish wherever its hosts and vector(s) are available in the EU. Thrips vectors play a major role in the epidemiology of the virus due to their ability to transmit the virus to weeds when the crops are not available and to spread the virus to other hosts, thus contributing to the establishment of the virus after its introduction. At least one of the thrips able to transmit CaCV (*M. abdominalis*) and some of the host weeds (*Sonchus oleraceus*, *Tagetes minuta*, *Ageratum conyzoides*, see Appendix A) are present in several EU MSs (see Section 3.4.3).

3.4.2.1. EU distribution of main host plants

Natural hosts of CaCV are widespread in the EU. Hosts of CaCV in the families Solanaceae, Fabaceae and Cucurbitaceae widely occur in the EU. Details on peppers and tomato crops production areas in individual EU MSs are provided in Tables 4 and 5, respectively.

Table 4: Pepper (*Capsicum*) crop production area (cultivation/harvested/production) (1,000 ha). Eurostat database, date of extraction 15 February 2022

MS/TIME	2017	2018	2019	2020	2021*
Belgium	0.10	0.09	0.10	0.10	:
Bulgaria	3.35	2.95	3.22	2.72	:
Czechia	0.00	0.42	0.27	0.29	:
Denmark	0.00	0.00	0.00	0.00	0.00
Germany	0.09	0.11	0.11	0.11	:
Estonia	0.00	0.00	0.00	0.00	0.00
Ireland	0.00	0.00	0.00	0.00	0.00
Greece	4.03	3.84	3.39	3.45	:
Spain	20.50	20.58	21.43	21.75	:
France	0.96	0.95	0.94	1.16	:
Croatia	1.02	1.02	0.56	0.68	:
Italy	10.32	10.52	10.28	10.01	:
Cyprus	0.03	0.04	0.03	0.04	:
Latvia	0.00	0.00	0.00	0.00	0.00
Lithuania	0.00	0.00	0.00	0.00	0.00
Luxembourg	0.00	0.00	0.00	0.00	0.00
Hungary	2.57	1.91	1.85	1.57	:
Malta	0.00	0.00	0.00	0.00	0.00
Netherlands	1.32	1.31	1.50	1.53	:
Austria	0.18	0.16	0.16	0.16	:
Poland	3.63	3.71	3.70	3.20	:
Portugal	1.21	0.93	0.85	1.28	:
Romania	9.71	9.96	10.78	9.82	:
Slovenia	0.16	0.16	0.20	0.23	:
Slovakia	0.31	0.27	0.22	0.17	:
Finland	0.01	0.01	0.01	0.01	:
Sweden	0.00	0.00	0.00	0.00	:

*: not reported yet.

Table 5: Tomato crop production area (cultivation/harvested/production) (1,000 ha). Eurostat database, date of extraction 15 February 2022

MS/TIME	2017	2018	2019	2020	2021*
Belgium	0.52	0.55	0.57	0.62	0.62
Bulgaria	5.01	4.52	5.15	3.09	2.60
Czechia	0.24	0.30	0.16	0.26	0.31
Denmark	0.03	0.03	0.03	0.03	0.03
Germany	0.37	0.40	0.39	0.38	:
Estonia	0.00	0.00	0.00	0.01	:
Ireland	0.01	0.01	0.01	0.01	0.01
Greece	13.32	16.02	15.01	15.82	15.13
Spain	60.85	56.13	56.94	55.47	59.92
France	5.75	5.74	5.66	5.95	4.90
Croatia	0.45	0.49	0.32	0.40	0.39
Italy	99.75	97.09	99.02	99.78	95.45
Cyprus	0.26	0.29	0.28	0.26	0.28
Latvia	0.00	0.00	0.00	0.00	0.00
Lithuania	0.55	0.57	0.56	0.68	0.70

MS/TIME	2017	2018	2019	2020	2021*
Luxembourg	0.00	0.00	0.00	0.00	0.00
Hungary	2.19	2.50	2.41	1.82	1.92
Malta	0.00	0.00	0.00	0.00	0.00
Netherlands	1.79	1.79	1.80	1.87	:
Austria	0.18	0.20	0.20	0.20	0.20
Poland	12.64	13.11	13.50	8.40	8.70
Portugal	20.87	15.83	15.89	15.04	17.71
Romania	22.21	22.97	23.78	22.47	22.84
Slovenia	0.20	0.19	0.22	0.26	:
Slovakia	0.60	0.59	0.48	0.22	:
Finland	0.11	0.10	0.09	0.10	0.11
Sweden	0.04	0.04	0.04	0.05	0.04

*: not reported yet.

3.4.2.2. Climatic conditions affecting establishment

Except for climatic conditions affecting CaCV hosts and vectors, no eco-climatic constraints exist for the virus itself.

3.4.3. Spread

Describe how the pest would be able to spread within the EU territory following establishment?

Natural spread of CaCV in the field is mediated by thrips vectors, among which *M. abdominalis* is known to be present in the EU territory. Human activities (trade of plants for planting (other than seeds), ornamental plants, cut flowers, movement of soil and machinery) contribute to further spread of the virus and/or viruliferous thrips to larger distances.

Comment on plants for planting as a mechanism of spread

Plants for planting (other than seeds) is a major mean of spread for the virus and for its thrips vectors, one of which, *M. abdominalis*, is already present in several EU MSs.

The spread in the field of CaCV is mediated by several thrips species, including *C. claratris*, *F. schultzei*, *M. abdominalis* and *T. palmi*. *C. claratris* and *T. palmi* are not known to be present in the EU. *F. schultzei* is a pantropical insect reported to occur in some EU member States (Belgium, Hungary, Netherlands, Spain) (Vierbergen and Mantel, 1991; Vierbergen, 1995; Loomans, 2006; Szénási et al., 2016; CABI, 2022). However, the occurrences of *F. schultzei* are possibly the result of repeated entry into the EU. In particular, the reports from the Netherlands refer to findings of populations of *F. schultzei* in greenhouse on Cactaceae and in bulb propagation rooms (Vierbergen and Mantel, 1991; Vierbergen, 1995), and it is unlikely that, probably primarily due to temperature requirements of this pantropic species, it could establish outdoors. Up to now in the EU no established incursions are known (Bert Vierbergen, personal communication on April 2022). In contrast, *M. abdominalis*, which has been recently shown to be a vector of CaCV (Sharman et al., 2020), is known to be present and established in several EU MSs, including Bulgaria, France, Hungary, Italy, Slovakia and Slovenia (Figure 2). Would CaCV be introduced in these MSs, the virus could spread in nature and establish by the already present populations of *M. abdominalis*. Host weeds could act as reservoirs for CaCV contributing to its establishment and spread by viruliferous thrips (Sharman et al., 2020). Although thrips have moderate dispersal potential by themselves, they can be spread by wind (Ptatscheck et al., 2018). Flights up to 3.5 km were recorded for *T. palmi* and *F. schultzei* in Brazil (Lemes Fernandes and de Sena Fernandes, 2015).

Trade of plant for planting (excluding seeds), ornamental plants, parts of plants (cut flowers, fruits) and movement of soil and machinery contribute to further spread of the virus and/or viruliferous thrips to larger distances.

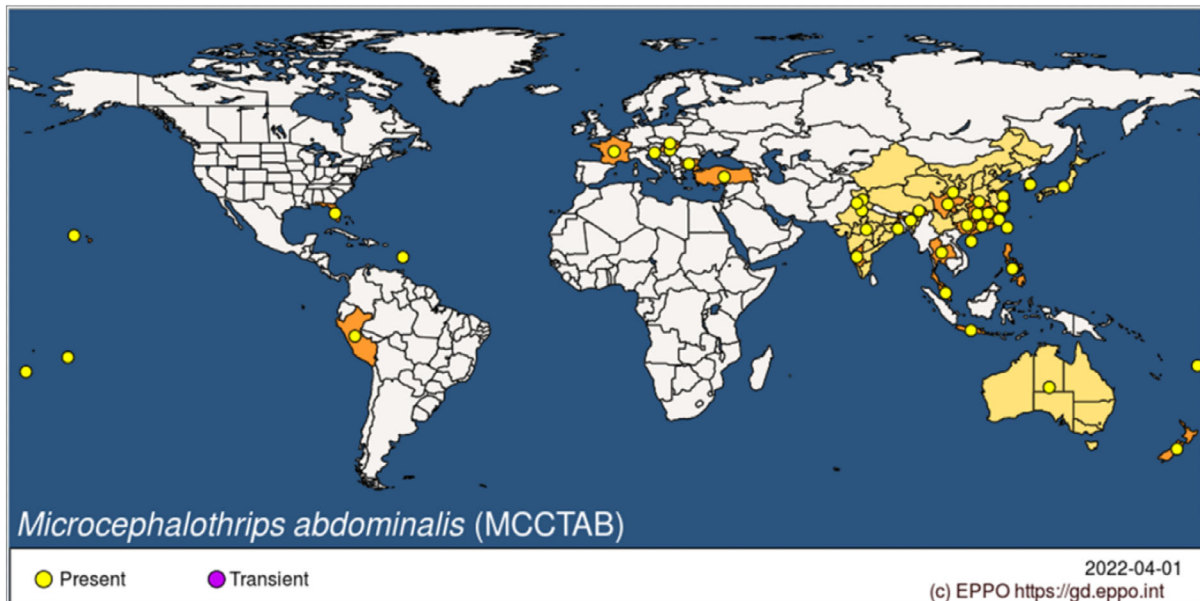


Figure 2: Global distribution map for *Microcephalothrips abdominalis* (extracted from the EPPO Global Database accessed on 1 April 2022, last updated by EPPO on 25/6/2021)

3.5. Impacts

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

Yes, would the virus be introduced in the EU an economic impact can be expected.

CaCV induces a variety of symptoms on its hosts. In pepper, young leaves show marginal and interveinal chlorosis, curling and deformation, whereas chlorosis, ringspot and line patterns develop on old leaves. Fruits are small and distorted, with dark necrotic lesions and scars, thus becoming unmarketable (Persley et al., 2006; Brakta et al., 2014). In tomato, CaCV infection causes chlorotic spots and blotches on leaves, which possibly develop necrotic rings and purple ring spotting, and leaflet necrosis; the virus may also induce discoloration of fruits with concentric rings (Persley, 2003; Persley et al., 2006; Kunkalikal et al., 2007, 2010). Discolorations with concentric rings have also been reported on fruits of tomato plants infected by CaCV (Kunkalikal et al., 2007). In peanut, CaCV symptoms consist of chlorotic spots, ringspot and blotches on leaves, internode length and leaf size reduction, as well as necrosis and wilting of the terminal leaves and buds, and stunting of the plants (Persley et al., 2006; Chen et al., 2007). Infected *Hoya* spp. plants show ringspots, line patterns, chlorotic blotches and necrotic etching (Persley et al., 2006).

Capsicum chlorosis virus (CaCV) has been reported as the agent of a serious disease in major capsicum production areas in Australia, where it infects also tomato and peanuts (Persley et al., 2006; Pappu et al., 2009). An incidence ranging from 1 to 10% has been reported in Australian capsicum cultivated areas, with peaks up to 60% (Persley et al., 2006).

In southern China, CaCV was reported as the causal agent of a widely occurring disease of peanuts, with an incidence up to 20% in some fields, where large yield losses were observed especially in plants infected at early growing stages (Chen et al., 2007). In India, disease incidence higher than 20% and up to 36% was recorded in chili pepper and ornamental amaryllis (*Hippeastrum hybridum*) cultivations, respectively (Krishnareddy et al., 2008; Basavaraj et al., 2020).

Based on the above, if the pest would become established in the EU, an impact can be expected. However, there is uncertainty on the magnitude of this impact.

3.6. Available measures and their limitations

Are there measures available to prevent pest entry, establishment, spread or impacts such that the risk becomes mitigated?

Measures are available to prevent entry, establishment and spread of CaCV on some of its hosts and vectors (see Section 3.3 and 3.4.1).

3.6.1. Identification of potential additional measures

Additional potential risk reduction options and supporting measures are shown in Sections 3.6.1.1 and 3.6.1.2.

3.6.1.1. Additional potential risk reduction options

Potential additional control measures are listed in Table 6.

Table 6: Selected control measures (a full list is available in EFSA PLH Panel, 2018) for pest entry/establishment/spread/impact in relation to currently unregulated hosts and pathways. Control measures are measures that have a direct effect on pest abundance

Control measure/ Risk reduction option (<u>Blue underline</u> = Zenodo doc, Blue = WIP)	RRO summary	Risk element targeted (entry/establishment/ spread/impact)
Require pest freedom	Plant for planting (other than seeds), ornamentals and cut flowers of CaCV hosts must come from a country officially free from the virus or from a pest-free area or from a pest-free place of production.	Entry/Spread/Impact
Growing plants in isolation	Description of possible exclusion conditions that could be implemented to isolate the crop from pests and if applicable relevant vectors. E.g. a dedicated structure such as glass or plastic greenhouses.	Entry (reduce contamination/infestation)/Spread/Impact
Managed growing conditions	Growing plants in insect-proof greenhouses would impair the spread of the virus by thrips.	Entry (reduce contamination/infestation)/Spread/Impact
Crop rotation, associations and density, weed/volunteer control	Crop rotation, associations and density, weed/volunteer control are used to prevent problems related to pests and are usually applied in various combinations to make the habitat less favourable for pests. The measures deal with (1) allocation of crops to field (over time and space) (multi-crop, diversity cropping) and (2) to control weeds and volunteers as hosts of pests/vectors. Avoiding the presence of wild plants potentially hosting CaCV and crop rotation with non-host species, would impair the spread and incidence of the virus	Establishment/Spread/Impact
Use of resistant and tolerant plant species/varieties	Resistant plants are used to restrict the growth and development of a specified pest and/or the damage they cause when compared to susceptible plant varieties under similar environmental conditions and pest pressure. It is important to distinguish resistant from tolerant species/varieties. Although CaCV resistance has been identified in <i>Capsicum chinense</i> , commercial <i>C. annuum</i> resistant to this virus are not yet available (Widana Gamage et al., 2016)	Entry/Establishment/Spread/Impact

Control measure/ Risk reduction option (<u>Blue underline</u> = Zenodo doc, Blue = WIP)	RRO summary	Risk element targeted (entry/establishment/ spread/impact)
Roguing and pruning	<p>Roguing is defined as the removal of infested plants and/or uninfested host plants in a delimited area, whereas pruning is defined as the removal of infested plant parts only without affecting the viability of the plant.</p> <p>Removal of symptomatic plants would decrease the virus inoculum.</p>	Establishment/Spread/ Impact
Timing of planting and harvesting	<p>The objective is to produce phenological asynchrony in pest/crop interactions by acting on or benefiting from specific cropping factors such as cultivars, climatic conditions, timing of the sowing or planting and level of maturity/age of the plant seasonal timing of planting and harvesting.</p> <p>Planting after peak thrips incidence combined with other management options, which has been shown to mitigate the impact caused by another thrips-transmitted tospovirus (i.e. tomato spot wilt virus, TSWV) in peanut (Srinivasan et al., 2018), could potentially be also effective in the case of CaCV.</p>	Entry (reduce contamination/ infestation)/Spread/Impact
Biological control and behavioural manipulation	<p>Pest control such as:</p> <ol style="list-style-type: none"> Biological control Sterile insect technique (SIT) Mating disruption Mass trapping <p>Biological control strategies against some of thrips vectors have been reported (EFSA PLH Panel, 2019)</p>	Establishment/spread/ impact
Chemical treatments on crops including reproductive material	Chemical control of CaCV vectors may impair virus spread. However, insecticide-resistant populations have been often reported (Shi et al., 2020; Bao et al., 2014; EPPO, 2020; Srinivasan et al., 2018)	Spread/Establishment/ Impact
Chemical treatments on consignments or during processing	<p>Use of chemical compounds that may be applied to plants or to plant products after harvest, during process or packaging operations and storage.</p> <p>The treatments addressed in this information sheet are:</p> <ol style="list-style-type: none"> fumigation; spraying/dipping pesticides; surface disinfectants; process additives; protective compounds <p>Double insecticide dips applied after harvest on orchid blossoms reduced > 95% thrips infestation (Mann et al., 1995). However, insecticide-resistant populations have been often reported (Shi et al., 2020; Bao et al., 2014; EPPO, 2020; Srinivasan et al., 2018)</p>	Entry/Spread
Physical treatments on consignments or during processing	<p>This information sheet deals with the following categories of physical treatments: irradiation /ionisation; mechanical cleaning (brushing, washing); sorting and grading; and removal of plant parts (e.g. debarking wood). This information sheet does not address heat and cold treatment (information sheet 1.14); roguing and pruning (information sheet 1.12).</p> <p>Post-harvest irradiation treatments are described to control thrips (Yalemar et al., 2001; Nicholas and Follet., 2018).</p>	Entry/Spread

Control measure/ Risk reduction option (<u>Blue underline</u> = Zenodo doc, Blue = WIP)	RRO summary	Risk element targeted (entry/establishment/ spread/impact)
Cleaning and disinfection of facilities, tools and machinery	<p>The physical and chemical cleaning and disinfection of facilities, tools, machinery, transport means, facilities and other accessories (e.g. boxes, pots, pallets, palox, supports, hand tools). The measures addressed in this information sheet are: washing, sweeping and fumigation.</p> <p>Cleaning and disinfection of tools and machinery may reduce virus entry and spread through viruliferous thrips pupae</p>	Entry/Spread
Limits on soil	Use of pest-free soil or growing media may reduce virus entry and spread through viruliferous thrips pupae	Entry/Spread
Soil treatment	<p>The control of soil organisms by chemical and physical methods listed below:</p> <p>a) Fumigation; b) Heating; c) Solarisation; d) Flooding; e) Soil suppression; f) Augmentative Biological control; g) Biofumigation</p> <p>Soil treatments in greenhouses may target thrips pupae</p>	Entry/Establishment/impact
Waste management	<ul style="list-style-type: none"> Treatment of the waste (deep burial, composting, incineration, chipping, production of bio-energy. . .) in authorised facilities and official restriction on the movement of waste. <p>Treatment of waste may target thrips pupae</p>	Establishment/Spread
Controlled atmosphere	<p>Treatment of plants by storage in a modified atmosphere (including modified humidity, O₂, CO₂, temperature, pressure).</p> <p>Controlled atmosphere has been indicated as a treatment to reduce <i>T. palmi</i> population at source (EFSA PLH Panel, 2019)</p>	Entry/Spread (via commodity)
Post-entry quarantine and other restrictions of movement in the importing country	<p>This information sheet covers post-entry quarantine (PEQ) of relevant commodities; temporal, spatial and end-use restrictions in the importing country for import of relevant commodities; Prohibition of import of relevant commodities into the domestic country.</p> <p>'Relevant commodities' are plants, plant parts and other materials that may carry pests, either as infection, infestation or contamination.</p> <p>Post-entry quarantine of plants for planting (other than seeds) of some hosts of CaCV (e.g. ornamental host plants for research, breeding or other experimental purposes) could potentially mitigate the risk of entry of CaCV and its thrips vectors into the EU.</p>	Establishment/Spread

3.6.1.2. Additional supporting measures

Potential additional supporting measures are listed in Table 7.

Table 7: Selected supporting measures (a full list is available in EFSA PLH Panel et al., 2018) in relation to currently unregulated hosts and pathways. Supporting measures are organisational measures or procedures supporting the choice of appropriate risk reduction options that do not directly affect pest abundance

Supporting measure	Summary	Risk element targeted (entry/establishment/spread/impact)
Inspection and trapping	<p>Inspection is defined as the official visual examination of plants, plant products or other regulated articles to determine if pests are present or to determine compliance with phytosanitary regulations (ISPM 5).</p> <p>The effectiveness of sampling and subsequent inspection to detect pests may be enhanced by including trapping and luring techniques.</p> <p>Inspections in the field to identify early symptoms may be effective and may contribute to improve the efficacy of roguing. However, symptoms induced by CaCV are similar to those caused by other viruses, such as TSWV.</p>	Entry/Establishment/Spread
Laboratory testing	Examination, other than visual, to determine if pests are present using official diagnostic protocols. Diagnostic protocols describe the minimum requirements for reliable diagnosis of regulated pests.	Entry
Sampling	<p>According to ISPM 31, it is usually not feasible to inspect entire consignments, so phytosanitary inspection is performed mainly on samples obtained from a consignment. It is noted that the sampling concepts presented in this standard may also apply to other phytosanitary procedures, notably selection of units for testing.</p> <p>For inspection, testing and/or surveillance purposes, the sample may be taken according to a statistically based or a non-statistical sampling methodology.</p> <p>For inspection, testing and/or surveillance purposes, the sample may be taken according to a statistically based or a non-statistical sampling methodology.</p>	Entry
Phytosanitary certificate and plant passport	<p>An official paper document or its official electronic equivalent, consistent with the model certificates of the IPPC, attesting that a consignment meets phytosanitary import requirements (ISPM 5)</p> <ul style="list-style-type: none"> a) export certificate (import) b) plant passport (EU internal trade) <p>A phytosanitary certification and plant passport would reduce virus entry and spread.</p>	Entry/Spread
Certified and approved premises	Mandatory/voluntary certification/approval of premises is a process including a set of procedures and of actions implemented by producers, conditioners and traders contributing to ensure the phytosanitary compliance of consignments. It can be a part of a larger system maintained by the NPPO in order to guarantee the fulfilment of plant health requirements of plants and plant products intended for trade. Key property of certified or approved premises is the traceability of activities and tasks (and their components) inherent the pursued phytosanitary objective. Traceability aims to provide access to all trustful pieces of information that may help to prove the compliance of consignments with phytosanitary requirements of importing countries.	Entry/spread

Supporting measure	Summary	Risk element targeted (entry/establishment/spread/impact)
Certification of reproductive material (voluntary/official)	Plants come from within an approved propagation scheme and are certified pest free (level of infestation) following testing; used to mitigate against pests that are included in a certification scheme The risk is reduced if plants for planting of CaCV hosts are from virus-free approved premises	Entry/Spread
Delimitation of Buffer zones	ISPM 5 defines a buffer zone as 'an area surrounding or adjacent to an area officially delimited for phytosanitary purposes in order to minimise the probability of spread of the target pest into or out of the delimited area, and subject to phytosanitary or other control measures, if appropriate' (ISPM 5). The objectives for delimiting a buffer zone can be to prevent spread from the outbreak area and to maintain a pest-free production place (PFPP), site (PFPS) or area (PFA).	Spread
Surveillance	Surveillance would be an efficient supporting measure.	Spread

3.6.1.3. Biological or technical factors limiting the effectiveness of measures

- Asymptomatic plants and symptoms similar to those induced by other viruses may reduce the efficacy of inspections.
- The occurrence of one of the proven vectors of CaCV (*M. abdominalis*) may reduce the efficacy of any measure taken in those EU MSs where this vector occurs.

3.7. Uncertainty

- Natural host range.
- Presence in the EU of *F. schultzei* and/or other thrips species able to transmit the virus.
- Efficiency of virus transmission by other thrips vectors present in the EU.
- Magnitude of the impact of CaCV under the EU conditions.

4. Conclusions

Capsicum chlorosis virus fulfils the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest. Table 8 provides a summary of the PLH Panel conclusions.

Table 8: 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 Capsicum chlorosis virus (CaCV) is clearly defined	None
Absence/presence of the pest in the EU (Section 3.2)	CaCV has been reported once in Greece (Crete Island). However, according to the Greek NPPO, the pest is no longer present in Greece.	None
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)	CaCV could enter in the EU with plants for planting, ornamental plants, parts of plants and cut flowers of its hosts. Viruliferous individuals of the vector species <i>C. claratris</i> , <i>Frankliniella schultzei</i> , <i>Microcephalothrips abdominalis</i> and <i>Thrips palmi</i> are additional entry pathways	Natural host range. Presence in the EU of other thrips species able to transmit the virus. Efficiency of EU endemic thrips species to transmit the virus

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Key uncertainties
Potential for consequences in the EU (Section 3.5)	Introduction and further spread of CaCV could have negative impact on the EU yield and quality production of the cultivated hosts.	Magnitude of the impact of CaCV under the EU conditions.
Available measures (Section 3.6)	Phytosanitary measures are currently in place banning the import of plants for planting of CaCV hosts in the family Solanaceae. Special requirements and/or request of phytosanitary certificate are in place for ornamental plants, parts of plants and cut flowers of CaCV hosts. Additional control measures are available to further mitigate the risk of entry, establishment, spread and impact of CaCV in the EU.	None
Conclusion (Section 4)	CaCV fulfils the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest.	
Aspects of assessment to focus on/scenarios to address in future if appropriate:	Additional information on natural host range and thrips vectors would decrease uncertainties on potential entry and spread pathways.	

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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
PZ	Protected Zone
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.
Hitchhiker	An organism sheltering or transported accidentally via inanimate pathways including with machinery, shipping containers and vehicles; such organisms are also known as contaminating pests or stowaways (Toy and Newfield, 2010).
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. An 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 – Capsicum chlorotic virus host plants

Source: CABI Crop Compendium 2021 (<https://www.cabi.org/publishing-products/crop-protection-compendium/>) and other references

Host status	Plant family	Host name	Common name	Reference
Cultivated hosts	Amaranthaceae	<i>Amaranthus</i> sp.		Sharma and Kulshrestha (2014)
	Amaryllidaceae	<i>Haemanthus multiflorus</i>	Blood lily	Chen et al. (2009)
	Amaryllidaceae	<i>Hippeastrum hybridum</i>	Red trumpet lily	Zheng et al. (2011)
	Amaryllidaceae	<i>Scadoxus multiflorus</i>	Blood lily	Chen et al. (2009)
	Apocynaceae	<i>Hoya</i>		CABI (online)
	Apocynaceae	<i>Hoya australis</i>	Native hoyo	Persley et al. (2006)
	Apocynaceae	<i>Hoya calycina</i>	Waxflower	Melzer et al. (2014)
	Araceae	<i>Zantedeschia</i> spp.	Calla-lilies	Chen et al. (2012)
	Asteraceae	<i>Rudbeckia</i> sp.	Coneflower	Bayat et al. (2018)
	Bromeliaceae	<i>Ananas comosus</i>	Pineapple	CABI (online), Sharman et al. (2020)
	Cucurbitaceae	<i>Cucurbita pepo</i>	Marrow	Sun et al. (2018)
	Fabaceae	<i>Arachis hypogaea</i>	Groundnut, peanut	CABI; Chen et al. (2007)
	Gesneriaceae	<i>Gloxinia</i> sp.	Gloxinia	Hsu et al. (2000), Chen et al. (2012)
	Orchidaceae	<i>Phalaenopsis amabilis</i>		Zheng et al. (2008)
	Solanaceae	<i>Capsicum (annuum and chinense)</i>	Peppers	Jones and Sharman (2005), Krishnareddy et al. (2008), McMichael et al. (2002), Zheng et al. (2008)
	Solanaceae	<i>Capsicum annuum</i>	Bell pepper	Sunpapao (2012)
Solanaceae	<i>Solanum lycopersicum</i>	Tomato	Kunkalikal et al. (2007)	
Cultivated/wild hosts	Asteraceae	<i>Chromolaena odorata</i>	Feji cao	Chen et al. (2022)
	Asteraceae	<i>Sonchus oleraceus</i>	Common sowthistle	CABI (online)
	Asteraceae	<i>Tagetes minuta</i>	Marigold	CABI (online)
	Asteraceae	<i>Emilia sonchifolia</i>	Red tasselflower	CABI (online)
	Asteraceae	<i>Ageratum conyzoides</i>	Billy goat weed	CABI (online)
	Asteraceae	<i>Praxelis clematidea</i>		Sharman et al. (2020)
	Solanaceae	<i>Physalis</i>	Alkekengi	Chiemsombat et al. (2008)
Experimental hosts	Amaranthaceae	<i>Chenopodium quinoa</i>	Quinoa	McMichael et al. (2002)
	Amaranthaceae	<i>Chenopodium amaranticolor</i>	Magenta spreen	McMichael et al. (2002)
	Asteraceae	<i>Lactuca sativa</i>	Lettuce	McMichael et al. (2002)
	Asteraceae	<i>Leucanthemum paludosum</i>	Creeping daisy	McMichael et al. (2002)
	Apocynaceae	<i>Vinca rosea</i>	Rosy periwinkle	Haokip et al. (2016), Kunkalikal et al. (2011)
	Cucurbitaceae	<i>Luffa acutangula</i>	Angled luffa	Steenken and Halaweh (2011) (with uncertainty due to a single ELISA positive test not further confirmed)

Host status	Plant family	Host name	Common name	Reference
	Fabaceae	<i>Cassia tora</i>	Sicklepod	Chen et al. (2007)
	Fabaceae	<i>Cyamopsis tetragonoloba</i>	guar	Chen et al. (2007)
	Fabaceae	<i>Glycine max</i>	Soybean	Chen et al. (2007), Kunkalikal et al. (2011)
	Fabaceae	<i>Phaseolus mungo</i>	Black gram	Chen et al. (2007)
	Fabaceae	<i>Phaseolus vulgaris</i>	Bean	Chen et al. (2007), McMichael et al. (2002)
	Fabaceae	<i>Pisum sativum</i>	Pea	Chen et al. (2007)
	Fabaceae	<i>Sesbania cannabina</i>	Riverhemp	Chen et al. (2007)
	Fabaceae	<i>Vigna unguiculata</i>	Common cowpea	Haokip et al. (2016), McMichael et al. (2002)
	Solanaceae	<i>Capsicum frutescens</i>	Chilli	Kunkalikal et al. (2011)
	Solanaceae	<i>Datura stramonium</i>	Jimsonweed	Chen et al. (2007), Zheng et al. (2008)
	Solanaceae	<i>Nicotiana rustica</i>		Chen et al. (2007), Zheng et al. (2008), Kunkalikal et al. (2011)
	Solanaceae	<i>Nicotiana edwardsonii</i>		Zheng et al. (2008)
	Solanaceae	<i>Nicotiana glutinosa</i>		Chen et al. (2007), Kunkalikal et al. (2011)
	Solanaceae	<i>Nicotiana occidentalis</i>		Chen et al. (2007)
	Solanaceae	<i>Nicotiana benthamiana</i>		Knierim et al. (2006), Zheng et al. (2008), Chen et al. (2007)
	Solanaceae	<i>Nicotiana tabacum</i>	Tobacco	Steenken and Halaweh (2011)
	Solanaceae	<i>Petunia hybrid</i>	Petunia	Chen et al. (2007), Kunkalikal et al. (2011)
	Solanaceae	<i>Physalis floridana</i>	Hairy groundcherry	Chen et al. (2007)
	Solanaceae	<i>Physalis maxima</i>	Dwarf cape gooseberry	Kunkalikal et al. (2011)

Appendix B – Distribution of Capsicum chlorosis virus

Distribution records based on CABI (CABI, online) and on Scopus and Web of Science

Region	Country	Subnational (e.g. State)	Status	Reference	
Asia	China	Shandong	Present	CABI (online)	
		Yunnan	Present	CABI (online)	
	India	Guangdong			Chen et al. (2007)
		Guangxi			Meng et al. (2013)
		Hubei			Zhang et al. (2021)
		Himachal Pradesh	Present	CABI (online)	
		Tamil Nadu	Present	Haokip et al. (2016)	
		Uttar Pradesh	Present	Mandal et al. (2012)	
		Karnataka			Mandal et al. (2012)
		Andhra Pradesh			Mandal et al. (2012)
		Maharashtra			Mandal et al. (2012)
		Punjab			Mandal et al. (2012)
Haryana			Mandal et al. (2012)		
New Delhi			Basavaraj et al. (2020)		
Iran	Present	CABI (online)			
Taiwan	Present	CABI (online)			
Thailand	Present	CABI (online)			
North America	United States	Hawaii	Present	CABI (online)	
Oceania	Australia	Queensland	Present	CABI (online)	
		Western Australia	Present	CABI (online)	
		East Kimberley	Present	Jones and Sharman (2005)	

Appendix C – Import data

EU imports of fruits of the genus Capsicum or Pimenta (*Capsicum annuum*: HS 0709 60) (Source Eurostat) (Hundreds of kg) Source: Eurostat. Extraction date: 7.3.2021.

Product Partner/Period	Fresh or chilled fruits of the genus Capsicum or Pimenta				
	2017	2018	2019	2020	2021
Australia	1.01				0.02
China	0.01	13.76	100.05	162.18	0.01
India	6456.37	3756.12	7004.07	6070.96	1502.23
Iran, Islamic Republic of		5.30	125.95	8.12	477.50
Thailand	682.20	777.61	650.60	492.89	593.71
Taiwan					
United States (incl. Navassa Island (part of 'UM') from 1995 to 2000)	0.05	2.87		11.28	0.14

EU imports of tomato (*Solanum lycopersicum*: HS 0702 00) (Source Eurostat) (Hundreds of kg) Source: Eurostat. Extraction date: 7.3.2021.

Product Partner/period	Tomatoes, fresh or chilled				
	2017	2018	2019	2020	2021
Australia			2.52		
China					
India			0.01		0.79
Iran, Islamic Republic of	363.79			11.13	
Thailand	0.08	0.08	0.02	0.02	0.04
Taiwan					
United States (incl. Navassa Island (part of 'UM') from 1995 to 2000)		0.11	0.04	0.13	0.42

EU imports of orchid cut flowers (HS 0603 13) (Source Eurostat) (Hundreds of kg) Source: Eurostat. Extraction date: 07.03.2021.

Product Partner/period	Fresh cut orchids and buds, of a kind suitable for bouquets or for ornamental purposes				
	2017	2018	2019	2020	2021
Australia					
China	0.96	42.38	92.68		
India		304.20	172.65	0.02	
Iran, Islamic Republic of					
Thailand	24,574.65	22,040.91	20,759.27	11,759.16	12,926.76
Taiwan	302.99	902.13	324.96	537.13	1,195.40
United States (incl. Navassa Island (part of 'UM') from 1995 to 2000)	0.20	0.05			0.03