SCIENTIFIC OPINION

EFSA Journal

ADOPTED: 29 September 2021

doi: 10.2903/j.efsa.2022.7625

Pest categorisation of chickpea chlorotic dwarf virus

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Abstract

The EFSA Panel on Plant Health conducted a pest categorisation of chickpea chlorotic dwarf virus (CpCDV) for the EU territory. The identity of CpCDV, a member of the genus *Mastrevirus* (family *Geminiviridae*) is established. Reliable detection and identification methods are available. The pathogen is not included in the EU Commission Implementing Regulation 2019/2072. CpCDV has been reported in Africa, Asia and Oceania. It has not been reported in the EU. CpCDV infects plant species in the family Fabaceae and several species of other families (Amaranthaceae, Brassicaceae, Caricaceae, Cucurbitaceae, Malvaceae and Solanaceae), including weeds. It may induce symptoms on its hosts, causing severe yield reduction. The virus is transmitted in a persistent, circulative and non-propagative manner by the leafhopper species *Orosius orientalis* and *O. albicinctus*, which are not regulated. *O. orientalis* is known to be present in some EU member states. Plants for planting (other than seeds), parts of plants and cut flowers of CpCDV hosts and viruliferous leafhoppers were identified as the most relevant pathways for the entry of CpCDV into the EU. Cultivated and wild hosts of CpCDV are distributed across the EU. Would 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. CpCDV fulfils the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest.

Keywords: pest risk, plant health, plant pest, quarantine, CpCDV, *Mastrevirus*, leafhopper transmission

Requestor: European Commission

Question number: EFSA-Q-2022-00312

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Competing interests: In line with EFSA's policy on declaration of interest, Panel member Francesco Di Serio did not participate in the adoption of this scientific opinion.

Declarations of interest: If you wish to access the declaration of interests of any expert contributing to an EFSA scientific assessment, please contact interestmanagement@efsa.europa.eu.

Suggested citation: EFSA PLH Panel (EFSA Panel on Plant Health), Bragard C, Baptista P, Chatzivassiliou E, Di Serio F, Gonthier P, Jaques Miret JA, Justesen AF, MacLeod A, Magnusson CS, Milonas P, Navas-Cortes JA, Parnell S, Potting R, Stefani E, Thulke H-H, Van der Werf W, Vincent Civera A, Yuen J, Zappalà L, Migheli Q, Vloutoglou I, Czwienczek E, Streissl F, Carluccio AV, Chiumenti M, Di Serio F, Rubino L and Reignault PL, 2022. Scientific Opinion on the pest categorisation of chickpea chlorotic dwarf virus. EFSA Journal 2022;20(11):7625, 26 pp. https://doi.org/10.2903/j.efsa.2022.7625

ISSN: 1831-4732

The EFSA Journal is a publication of the European Food Safety Authority, a European agency funded by the European Union.

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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

Chickpea chlorotic dwarf virus is one of a number of pests identified from horizon scanning and listed in Annex 1D 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 EU 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.

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search on chickpea chlorotic dwarf 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 the EPPO Global Database, the CABI databases and scientific literature databases as referred above in Section 2.1.1.

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 for chickpea chlorotic dwarf virus which could be used as reference material for molecular diagnosis. 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 chickpea chlorotic dwarf virus, following guiding principles and steps presented in the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel et al., 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) are 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, the identity of chickpea chlorotic dwarf virus is well established. It has been shown to produce consistent symptoms and to be transmissible.

Chickpea chlorotic dwarf virus (CpCDV) is classified in the species *Chickpea chlorotic dwarf virus* belonging to the genus *Mastrevirus* (family *Geminiviridae*, order *Geplafuvirales*) (ictv.global/taxonomy).

The species includes several viruses, namely CpCDV/A, CpCDV/B, CpCDV/C, CpCDV/D, CpCDV/E (https://ictv.global/vmr) from different geographic origins (Africa, Asia, Australia; Muhire et al., 2013). Isolates previously referred to as *Bean yellow dwarf virus* (Liu et al., 1997; AM849096, DQ458791; Y11023) were assigned to the species *Chickpea chlorotic dwarf virus* (https://ictv.global/ictv/proposals/2012.019abP.A.v3.Mastrevirus-17sp,rem-2sp.pdf).

Geminated CpCDV particles (Horn et al., 1993) encapsidate a monopartite circular, single-stranded (ss) DNA genome, *ca*. 2.6 kb in size. The virus genome encodes four proteins, two of which in the virus sense strand (V1 and V2) and two in the complementary strand (C1 and C2). ORF V1 encodes the capsid protein (CP, 26.6 kDa), forming two incomplete icosahedra 22x38 nm in size. Besides being the only structural protein, the CP is a multifunctional protein serving as nuclear shuttle protein and with regulatory functions on ssDNA and dsDNA accumulation. ORF V2 encodes the 10-kDA cell-to-cell movement protein. V1 and V2 expression is regulated by differential transcript splicing. Transcript splicing also regulates the replication associated protein expression from ORFs C1/C2 on the complementary strand, obtaining proteins Rep and RepA. RepA regulates the transactivation of virion-sense ORFs and contributes to establishing a cellular environment favourable to virus replication. Rep recruits the needed host factors and initiates rolling-circle DNA replication. Two non-coding regions, the large intergenic region (LIR) and the short intergenic region (SIR), are present, containing transcription initiation and termination sites (Kanakala and Kuria, 2018; Fiallo-Olivé et al., 2021). About 270 complete genome sequences of CpCDV and *ca*. 80 partial gene sequences are publicly available in GenBank database.

The EPPO code[1] (Griessinger and Roy, 2015; EPPO, 2019) for this species is CPCDV0 (EPPO, online).

3.1.2. Biology of the pest

CpCDV infects mostly dicotyledonous plants and was shown to be associated with the stunt disease of chickpea. In natural chickpea infections, CpCDV induces stunting, leaf size reduction, phloem browning of the collar region, with leaf chlorosis or reddening symptoms depending on the chickpea variety (Horn et al., 1993). As other mastreviruses, CpCDV is transmitted by leafhoppers (family Cicadellidae, order Hemiptera) in a persistent, circulative and non-propagative manner (Fiallo-Olivé et al., 2021). Leafhopper development proceeds from eggs, through nymphs to adults on host plants. Leafhopper females lay eggs into tender plant tissue, from which nymphs emerge and develop through five instars before maturing into adults. The pupal stage is not present (Weintraub et al., 2019). Horn et al. (1993) identified the leafhopper *Orosius orientalis* as the vector of CpCDV in India. The insect can acquire CpCDV in less than 2 min and is able to transmit it in about 2 h. CpCDV persists in *O. orientalis* up to 21 days (Horn et al., 1994). Nymphs can transmit the virus, which is also retained through moulting, generating viruliferous adults (Horn et al., 1994). CpCDV was shown to be transmitted also by another member of the genus *Orosius*, *O. albicinctus*, in Syria (Kumari et al., 2004) and Pakistan (Akhtar et al., 2011). CpCDV was detected in *O. orientalis* (Horn et al., 1994) and *O. albicinctus* (Akhtar et al., 2011) by ELISA. In the past, *O. orientalis* (Matsumura) and *O. albicinctus* (Distant) were often considered as synonyms. However, a revision of the genus *Orosius* based on male genitalia and barcoding clearly established that they represent two separate species (Fletcher et al., 2017). In a study on the identification of potential CpCDV vectors, the leafhopper *Amrasca biguttula* tested positive to CpCDV; however, no transmission assay was reported to confirm the molecular data (Reddy et al., 2020, 2021); therefore, such leafhopper species is considered as a potential vector with uncertainty. In addition, the leafhopper *Neolimnus aegyptiacus* was mentioned as a vector (Hamed and Makkouk, 2002), but in the absence of experimental data supporting this statement, it is not further considered in the present pest categorisation. CpCDV infects a variety of weeds (see Appendix A), which can act as alternative hosts for virus overwintering (Plant Health Australia, 2014). No seed transmission was reported for CpCDV (Plant Health Australia, 2014). As other mastreviruses, CpCDV was not mechanically transmitted to a number of experimental hosts (Horn et al., 1993; Farzadfar et al., 2008). However, the virus was successfully graft transmitted and induced chlorotic symptoms in *Datura stramonium* and *Nicotiana tabacum* cv. Samsun, and leaf rolling in *N. tabacum* cv. White Burley, or did not cause symptoms in *Solanum lycopersicum* and *Vicia faba* (Farzadfar et al., 2008). Experimental transmission can be achieved by *Agrobacterium*-mediated inoculation (Fiallo-Olivé et al., 2021).

3.1.3. Host range/species affected

CpCDV has been originally reported in chickpea (*Cicer arietinum* L.) plants in India (Horn et al., 1993). Natural infections of this virus occur on a range of cultivated species belonging to the Fabaceae family and other cultivated plants in the Amaranthaceae (i.e. sugar beet and spinach), Brassicaceae (i.e. brown and black mustard), Caricaceae (i.e. papaya), Cucurbitaceae (i.e. cucumber, watermelon and squash), Malvaceae (e.g. cotton) and Solanaceae (i.e. pepper, tomato) families.

Other natural hosts may also exist. Noteworthy, wild weed species were also found to be infected by CpCDV. Due to the lack of mechanical transmission, the CpCDV host range is difficult to study in laboratory conditions. However, several additional species of the families Amaranthaceae (*Beta vulgaris*), Brassicaceae (*Arabidopsis thaliana*), Fabaceae (*Vicia faba*) and Solanaceae (*Nicotiana benthamiana, Nicotiana glutinosa, Nicotiana tabacum, Solanum lycopersicum, Capsicum annuum* and *Datura stramonium*) have been successfully infected by using the leafhoppers *O. albicinctus* and *O. orientalis* as vectors (Horn et al., 1994; Farzadfar et al., 2008; Akhtar et al., 2011). Virus transmission was also achieved by grafting (Farzadfar et al., 2008) or via agroinfiltration in chickpea, *N. benthamiana*, *N. glutinosa*, *N. tabacum* and *S. lycopersicum* (Kanakala et al., 2013a,b; Nahid et al.,

[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).

2008; Radouane et al., 2021; Fiallo-Olivé et al., 2021). A detailed list of natural and experimental hosts of CpCDV 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.

About 270 full genome sequences and additional dozens of partial sequences are available in GenBank, providing information about the genetic variability of CpCDV. By analysing 939 full genome sequences of members of the genus *Mastrevirus* available in GenBank, a 94% sequence identity strain demarcation threshold for mastreviruses was proposed, such that genome sequences sharing identity above the 94% threshold are to be considered as variants of the same virus strain (Muhire et al., 2013; https://ictv.global/vmr). Seventeen CpCDV variants are known so far (Kanakala and Kuria, 2018). All CpCDV variants cluster in the same clade (Kanakala and Kuria, 2018). Intraspecies recombination events occurred at high frequency and had a major role in the generation of new variants (Kraberger et al., 2015). These recombination events may result in the evolution of CpCDV as a pathogen of new hosts (Kraberger et al., 2015).

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 chickpea chlorotic dwarf virus.

A range of diagnostic protocols have been developed to detect and/or identify CpCDV either in host plants or in vectors. These include serological methods such as DAS-ELISA, dot-blot ELISA and tissue-blot immunoassays using specific antisera (Horn et al., 1996; Kumari et al., 2006; Farzadfar et al., 2008; Akhtar et al., 2011). Molecular diagnostic protocols based on PCR employ degenerated primers which amplify a large part of the genome of dicot-infecting mastreviruses (*ca*. 1.4 kb), followed by the use of gene-specific primers (Farzadfar et al., 2008; Kanakala et al., 2013b). Rolling circle amplification (RCA) method is also available. In particular, RCA associated with restriction fragment length polymorphism (RFLP) has been widely used for CpCDV detection and characterisation (Haible et al., 2006; Hadfield et al., 2012; Fiallo-Olivé et al., 2017; Hamza et al., 2018). Kanakala et al. (2013b) used dot-blot hybridisation with a radiolabelled probe to detect CpCDV from field plants and electron microscopy to visualise CpCDV geminate particles.

Specific primers were developed and used in multiplex PCR to detect CpCDV (Nahid et al., 2008). Next-generation sequencing techniques were employed to demonstrate that CpCDV is the causal agent of the 'hard fruit syndrome' of watermelon (Zaagueri et al., 2017).

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

To date, CpCDV has been reported in Africa, Asia and Oceania (see Figure 1). Details on CpCDV worldwide distribution are summarised in Appendix B.

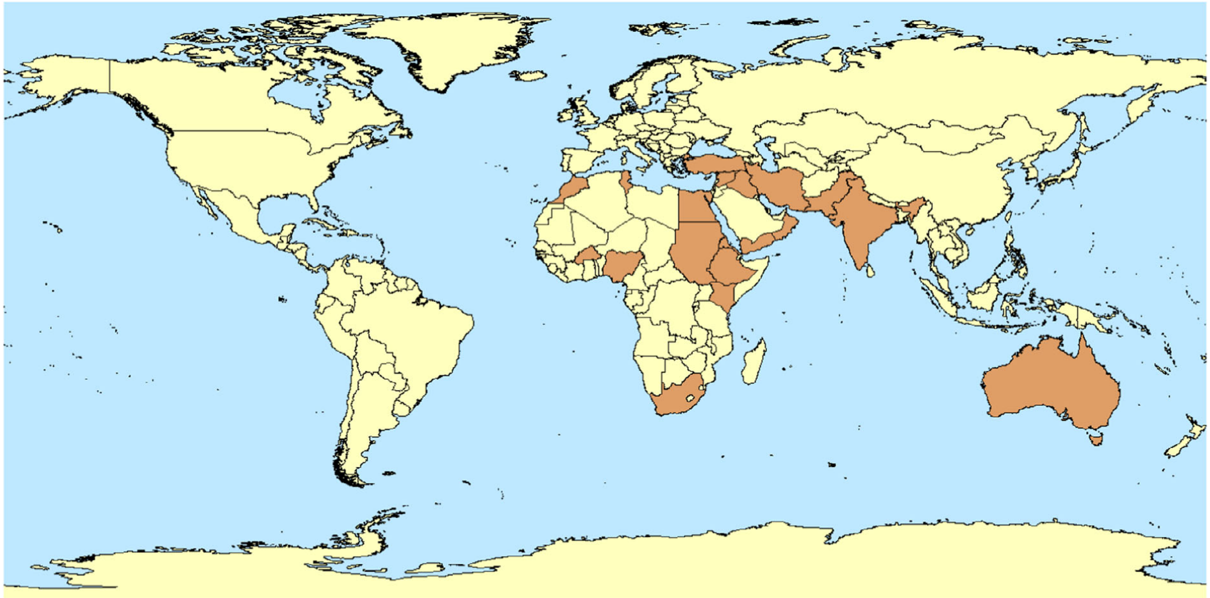

Figure 1: Global distribution of CpCDV

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**, chickpea chlorotic dwarf virus has not been reported in the EU.

To date, CpCDV has not been reported in the EU.

3.3. Regulatory status

3.3.1. Commission implementing regulation 2019/2072

CpCDV is not listed in Annex II of Commission Implementing Regulation (EU) 2019/2072 and 2021/2285, implementing acts of Regulation (EU) 2016/2031, or in any emergency plant health legislation.

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

Plants for planting (other than seeds) of some hosts (Solanaceae) of CpCDV are prohibited from entering the Union from certain third countries under Commission Implementing Regulation (EU) 2019/2072 (Table 2).

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

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	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,

		ex 0602 90 70 ex 0602 90 91 ex 0602 90 99	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 and the United Kingdom

3.3.3. Legislation addressing the organisms that vector CpCDV (commission implementing regulation 2019/2072)

The known vectors of CpCDV, the leafhoppers *Orosius albicinctus* and *O. orientalis*, are not regulated under Commission Implementing Regulation (EU) 2019/2072. *Amrasca biguttula*, a potential additional vector of CpCDV, is not regulated under Commission Implementing Regulation (EU) 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, CpCDV may enter the EU with plants for planting (other than seeds), plants, parts of plants, and cut flowers of its hosts and with viruliferous leafhoppers on CpCDV hosts and non-hosts.

Comment on plants for planting as a pathway.
Host plants for planting (other than seeds) is an entry pathway of CpCDV in the EU.

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

Table 3: Potential pathways for CpCDV 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]**
Description (e.g. host/intended use/source)		
Plants for planting, other than seeds, of CpCDV hosts*	N/A	Import of plants for planting (other than seeds) of Solanaceae from most third countries, including some of the countries in which CpCDV has been reported, is prohibited (Annex VI, 18). Import of plants for planting (other than seeds) of Solanaceae from some third countries in which CpCDV has been reported (e.g. Egypt, Morocco, Tunisia and Turkey), is not prohibited (Table 2). Import of host plants for planting other than seeds of other botanical families is not prohibited.
Plants, parts of plants, and cut flowers of CpCDV hosts	N/A	Phytosanitary certificate is requested for (i) foliage, branches and other parts of tomato *[...]* 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); (iv) *Cucurbita* spp. (Annex XI, part B).
Viruliferous leafhoppers *Orosius albicinctus* and *O. orientalis*	Nymphs and adults	No special requirements are listed for these vectors

*: Appendix A lists the hosts of CpCDV.

Import in the EU of Solanaceae host plants for planting of CpCDV is prohibited only from some third countries where CpCDV is present (Regulation 2019/2072, Annex VI, 18). Plants for planting (other than seeds), plants, parts of plants and cut flowers of CpCDV hosts can be imported to the EU with a phytosanitary certificate. *O. albicinctus* and *O. orientalis* are not regulated in the EU.

Notifications of interceptions of harmful organisms began to be compiled in Europhyt in May 1994 and in TRACES in May 2020. As on 9 September 2022, there were no records of interception of CpCDV and of the two vectors (*O. albicinctus* and *O. orientalis*) 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 and competent leafhopper vector are available in the EU and the broader establishment of the virus is only limited by the presence of competent leafhopper vector(s).

CpCDV could potentially establish wherever its hosts and vector(s) are available in the EU. Natural hosts of CpCDV, in particular members of the families Fabaceae, Solanaceae, Cucurbitaceae and Amaranthaceae, are largely cultivated in the EU. Leafhopper vectors play a major role in the epidemiology of viruses due to their ability to transmit them to weeds when the crops are not available and to spread the virus to other hosts, thus contributing to the establishment and spread of the virus after its entry (Trębicki et al., 2010). At least one of the leafhoppers able to transmit CpCDV (*O. orientalis*) and one of the weed hosts (*Xanthium strumarium*, see Appendix A) are present in EU (see Section 3.4.3).

3.4.2.1. EU distribution of main host plants

Details on production area of leguminous plants are provided in Table 4. Details on production area of some among the most cultivated host species in several EU MSs, such as peppers, spinach, tomatoes and sugar beet, are provided in Appendices C–F, respectively.

Table 4: Leguminous plants harvested green [G2000] crop production area (cultivation/harvested/production) (1,000 ha). Eurostat database, date of extraction 30 August 2022

MS/TIME	2017	2018	2019	2020	2021
Belgium	3.79	4.9	4.8	5.58	7.2 p
Bulgaria	96.55	106.57	106.39	100.03	99.56
Czechia	174.87	181.3	192.49	198.05	201.96
Denmark	1.9	0.80	0.80	0.9	0.7
Germany	274.50	283.30	306.10	331.30	337.70
Estonia	34.68	33.69	28.66	30.79	33.16
Ireland	0.83	1.14	1.11	1.1	1.03
Greece	34.85	30.66	44.52	25.62	23.8
Spain	424.16	445.96	454.98	445.45	433.82 p
France	373.98	425.36	476.52	508.82	520.83
Croatia	46.49	44.58	51.4	47.36	42.9
Italy	1,186.44	1,207.85	1,232.08	1,241.52	1,227.29
Cyprus	2.56	2.96	2.35	3.00 p	4.00 e
Latvia	29.4	19.6	32.	33.10	35.50
Lithuania	47.12	54.69	63.62	71.33	77.96
Luxembourg	1.07	0.92	0.89	0.97	1.03
Hungary	206.93	214.22	233.96	219.45	217.98
Malta	0.	0.	0.	0.	0.
Netherlands	8.50	8.65	8.63	8.70	8.42
Austria	76.73	75.65	78.89	80.01	77.96
Poland	173.3	148.14	138.41	177.64	181.11 e

MS/TIME	2017	2018	2019	2020	2021
Portugal	12.69	10.71	14.14	14.15	14.15 p
Romania	667.6	685.73	669.78	663.41	655.32
Slovenia	10.16	9.63	8.52	7.71	8.04
Slovakia	73.68	75.53	75.66	74.18	75.46
Finland	2.	2.3	1.9	1.8	1.3
Sweden	0.00 n	5.18 e	1.62	3.09	0.00 n

MS: member states; :, not available; e, estimated; n, not significant; p, provisional.

3.4.2.2. Climatic conditions affecting establishment

Except for climatic conditions affecting CpCDV 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?

The virus can spread both by natural and human-assisted means.

Comment on plants for planting as a mechanism of spread.

Plants for planting (other than seeds) is a means of spread for the virus.

Natural spread of CpCDV in the field occurs through leafhopper vectors, *Orosius orientalis* and *Orosius albicinctus*, among which *O. orientalis* is known to be present in the EU territory. Uncertainty on *A. biguttula* as an additional vector exists. The virus transmission is persistent, circulative and non-propagative (Fiallo-Olivé et al., 2021). The adults are winged and able of short flights and jumps, and can be spread by wind (Trębicki et al., 2010). According to CABI, *O. orientalis* and *O. albicinctus*, which in this case are considered as synonyms, are present in Egypt, India, Iran, Israel, Japan, Myanmar, South Korea, Taiwan, Turkey and Australia (CABI, 2022). *O. albicinctus* has not been reported from the EU. *O. orientalis* has been reported in Malta (D'Urso et al., 2019). Fauna Europaea (https://fauna-eu.org, accessed September 6, 2022) reports *O. orientalis* as present in Greece, Spain and Portugal (Antonatos et al., 2020; EFSA PLH Panel et al., 2020). Notwithstanding the synonymy issues regarding *O. orientalis* and *O. albicinctus* have been recently solved (Fletcher et al., 2017) clarifying that they are two different species, there is uncertainty on their respective geographical distribution due to their possible misidentification in the past.

Amrasca biguttula, for which transmission experiments have not been performed yet, is considered widespread in southern East Asia, and present in Ghana (Africa) and Christmas Island and Guam (Oceania).

Human activities (trade of plants for planting other than seeds, ornamental plants, parts of plants, cut flowers and grafting) may contribute to further spread of the virus and/or viruliferous leafhoppers to larger distances.

3.5. Impacts

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

Yes, should the virus be introduced and able to establish in the EU, an economic impact is expected.

Chickpeas infected by CpCDV are severely stunted with shortening of internodes and phloem browning. Leaf colour changes differ depending on the variety: leaves of Kabuli type chickpeas mostly show yellow, whereas those of Desi type become red (Horn et al., 1993). In India, it has been reported that if plants are infected at early growth stages, the pod production is aborted, with a yield loss of 100%, whereas in the case infection occurs at the flowering stage, the yield loss is up to 75–100% (Horn et al., 1995). In Sudan, stunt incidence was documented on chickpea, ranging between 7–25% and 25–62% depending on the season (Hamed and Makkouk, 2002). In Iran, an incidence of

3.4% and 1.8% was reported in faba bean and lentil, respectively (Shahmohammadi et al., 2020). In India, CpCDV induced stunting along with leaf curling in hot pepper (*Capsicum annuum*) (Byun et al., 2014). Mild chlorosis and stunting symptoms were shown to be induced by CpCDV on sugar beet plants in Iran (Farzadfar et al., 2008). Beside stunting, *Cucurbita pepo* plants showed leaf curling and yellow mottling, and a reduced fruit production in Egypt (Fahmy et al., 2015). Stunting, leaf curling and chlorosis were described in French bean (Liu et al., 1997) and spinach, which also showed vein thickening (Hamza et al., 2018). In Tunisia, CpCDV caused the hard fruit syndrome of watermelon, consisting of fruit and seed deformation, hardness and discoloration of the flesh bearing whitish inserts, associated with a bad taste (Zaagueri et al., 2017). The incidence in the field varied up to 70%, depending on the year (Zaagueri et al., 2017). Severe symptoms consisting of leaf dwarfing, yellowing and curling were described in papaya and tomato (Ouattara et al., 2017). Based on these data, should the virus enter and establish in the EU, an impact is 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 CpCDV on its hosts.

3.6.1. Identification of potential additional measures

Phytosanitary measures (prohibitions) are currently applied to some host plants for planting other than seeds (see Section 3.3.2).

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 5.

Table 5: Selected control measures (a full list is available in EFSA PLH Panel et al., 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 (Blue underline = Zenodo doc, Blue = WIP)	RRO summary	Risk element targeted (entry/establishment/spread/impact)
Require pest freedom	Plants for planting (other than seeds), plants, parts of plants and cut flowers of CpCDV 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	Growing plants in glass or plastic or in insect-proof greenhouses would impair the spread of the virus by leafhoppers.	Entry (reduce contamination/infestation)/Spread/Impact
Managed growing conditions	Growing crops in ventilated tunnels may significantly reduce the entrance of *O. orientalis* (Weintraub et al., 2008)	Entry (reduce contamination/infestation)/Spread/Impact
Crop rotation, associations and density, weed/volunteer control	Controlling or avoiding the presence of weeds potentially hosting CpCDV and/or its vector 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	Partially CpCDV-resistant chickpea cultivar has been reported (Hamed and Makkouk, 2002)	Establishment/Impact

Control measure/Risk reduction option (Blue underline = Zenodo doc, Blue = WIP)	RRO summary	Risk element targeted (entry/establishment/ spread/impact)
Roguing and pruning	Removal of symptomatic plants would decrease the virus inoculum	Spread/Impact
Timing of planting and harvesting	Delay chickpea planting by 3–4 weeks and shortening the irrigation intervals have been reported to reduce the CpCDV incidence in Sudan (Hamed and Makkouk, 2002).	Impact
Biological control and behavioural manipulation	Potential biological control agents against *O. albicinctus* have been reported (Bindra and Singh, 1970). No biological control against *O. orientalis* is available (Plant Health Australia, 2014)	Spread/Impact
Chemical treatments on crops including reproductive material	Chemical control of CpCDV vectors may impair virus spread.	Entry/Spread/Establishment/ Impact
Chemical treatments on consignments or during processing	Chemical control of CpCDV vectors on consignments or during processing may impair virus spread.	Entry/Spread
Post-entry quarantine and other restrictions of movement in the importing country	Post-entry quarantine of plants for planting (other than seeds), plants, plant parts and cut flowers of some hosts of CpCDV (e.g. ornamental host plants for research, breading or other experimental purposes) could potentially mitigate the risk of entry of CpCDV and its leafhopper vectors into the EU	Entry/Establishment/Spread

3.6.1.2. Additional supporting measures

Potential additional supporting measures are listed in Table 6.

Table 6: Selected supporting measures (a full list is available in EFSA PLH Panel, 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	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). The effectiveness of sampling and subsequent inspection to detect pests may be enhanced by including trapping and luring techniques. Inspections in the field to detect early virus symptoms may be effective in reducing the field inoculum and may contribute to improve the efficacy of roguing.	Entry/Establishment/Spread
Laboratory testing	Serological and molecular methods are available and can be used in laboratory testing	Entry/Spread
Sampling	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	Entry/Spread

Supporting measure	Summary	Risk element targeted (entry/establishment/spread/impact)
	also apply to other phytosanitary procedures, notably selection of units for testing. For inspection, testing and/or surveillance purposes the sample may be taken according to a statistically based or a non-statistical sampling methodology. Sampling is considered necessary as part of other RROs.	
Phytosanitary certificate and plant passport	A phytosanitary certificate and plant passport would reduce virus entry and spread.	Entry/Spread
Certified and approved premises	The risk is reduced if plants for planting of CpCDV hosts are from virus-free approved premises	Entry/Spread
Certification of reproductive material (voluntary/official)	The risk is reduced if plants for planting of CpCDV hosts are from virus-free approved premises and are certified as pest-free	Entry/Spread
Delimitation of Buffer zones	Delimitation of a buffer zone is an effective measure to prevent spread of the virus in the EU	Spread
Surveillance	Surveillance is an effective measure to define pest-free areas or pest-free places of production as well as to prevent further spread of the virus	Spread

3.6.1.3. Biological or technical factors limiting the effectiveness of measures

- CpCDV asymptomatic infections and infected plants showing symptoms similar to those induced by other viruses or abiotic factors may reduce the efficacy of inspections.
- Infected weeds favouring establishment and spread are difficult to monitor.
- The occurrence of one of the proven vectors of CpCDV (*O. albicinctus*) may reduce the efficacy of any measure taken in those EU MSs where this vector occurs.

3.7. Uncertainty

There is no key uncertainty that may cast doubt on the conclusion of the pest categorisation.

4. Conclusions

Chickpea chlorotic dwarf 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 7 provides a summary of the PLH Panel conclusions.

Table 7: 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 chickpea chlorotic dwarf virus (CpCDV) is clearly defined	None
Absence/presence of the pest in the EU (Section 3.2)	CpCDV is not present in the EU	None
Pest potential for entry, establishment and spread in the EU (Section 3.4)	CpCDV could enter in the EU with plants for planting (other than seeds), parts of plants and cut flowers of its hosts. Viruliferous vectors are additional entry pathways	None

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 CpCDV could have negative impact on the EU yield and quality production of the cultivated hosts.	None
Available measures (Section 3.6)	Phytosanitary measures are currently in place banning the import of plants for planting of CpCDV hosts in the family Solanaceae. Request of phytosanitary certificate is in place for plants, parts of plants and cut flowers of CpCDV hosts. Additional control measures are available to further mitigate the risk of entry, establishment, spread and impact of CpCDV in the EU.	None
Conclusion (Section 4)	CpCDV fulfils the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest.	None
Aspects of assessment to focus on/ scenarios to address in future if appropriate:	Additional information on the presence and distribution of leafhopper vectors and virus natural host range would improve knowledge on the virus epidemiology	

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Abbreviations

EPPO	European and Mediterranean Plant Protection Organisation
FAO	Food and Agriculture Organisation
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. 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 – Chickpea chlorotic dwarf virus host plants/species affected

Source: WoS

Host status	Host name	Plant family	Common name	Reference
Cultivated hosts	*Cicer arietinum*	Fabaceae	Chickpea	
	Lens culinaris	Fabaceae	Lentil	Makkouk et al. (2002, 2003a)
	Phaseolus vulgaris	Fabaceae	Bean	Farzadfar et al. (2002)
	Vicia faba	Fabaceae	Fava bean	Makkouk et al. (2003b); Kraberger et al. (2015); Shahmohammadi et al. (2020)
	Pisum sativum	Fabaceae	Pea	Kraberger et al. (2013)
	Beta vulgaris	Amaranthaceae	Sugar beet	Farzadfar et al. (2002)
	Spinacia oleracea	Amaranthaceae	Spinach	Hamza et al. (2018)
	Brassica juncea	Brassicaceae	Brown mustard	Reddy et al. (2021)
	Brassica nigra	Brassicaceae	Black mustard	Reddy et al. (2021)
	Carica papaya	Caricaceae	Papaya	Fiallo-Olivé et al. (2017); Ouattara et al. (2017)
	Citrullus lanatus	Cucurbitaceae	Watermelon	Zaagueri et al. (2017); Radouane et al. (2019)
	Cucumis sativus	Cucurbitaceae	Cucumber	Hameed et al. (2017)
	Cucurbita sp.	Cucurbitaceae	Squash	Fahmy et al. (2015)
	Abelmoschus esculentus	Malvaceae	Okra	Zia-Ur-Rehman et al. (2017)
	Gossypium arboretum	Malvaceae	Tree cotton	Hameed et al. (2019)
	Gossypium hirsutum	Malvaceae	Cotton	Manzoor et al. (2014); Hameed et al. (2017)
	Capsicum annuum	Solanaceae	Bell pepper	Akhtar et al. (2014)
	Solanum lycopersicum	Solanaceae	Tomato	Zia-Ur-Rehman et al. (2015)
Wild weed hosts	*Xanthium strumarium*	Asteraceae	Rough cocklebur	Mubin et al. (2012)
	Aeschynomene virginica	Fabaceae	Virginia jointvetch	Reddy et al. (2021)
	Cajanus cajan	Fabaceae	Pigeon pea	Kraberger et al. (2015)
	Sesbania bispinosa	Fabaceae	Spiny sesbania	Nahid et al. (2008)
	Heteropogan contartus	Poaceae	Tussock grass	Reddy et al. (2021)
Artificial/ experimental hosts	*Beta vulgaris*	Amaranthaceae	Sugar beet	Horn et al. (1993)
	Arabidopsis thaliana	Brassicaceae	Mouse-ear cress	Liu et al. (1997)
	Cicer arietinum	Fabaceae	Chickpea	Horn et al. (1993)
	Lens esculenta	Fabaceae	Lentil	Horn et al. (1993)
	Phaseolus vulgaris	Fabaceae	Bean	Horn et al. (1993)
	Pisum sativum	Fabaceae	Pea	Horn et al. (1993)
	Vicia faba	Fabaceae	Fava bean	Farzadfar et al. (2008)
	Nicotiana benthamiana	Solanaceae	Benthi	Horn et al. (1993); Liu et al. (1997); Kanakala et al. (2013a); Manzoor and Bibi (2016); Khalid et al. (2017);

Host status	Host name	Plant family	Common name	Reference
				Zaagueri et al. (2017); Hamza et al. (2018); Shahmohammadi et al. (2020)
	Nicotiana glutinosa	Solanaceae	Tobacco	Horn et al. (1993); Kanakala et al. (2013a)
	Nicotiana tabacum	Solanaceae	Tobacco	Horn et al. (1993); Liu et al. (1997); Farzadfar et al. (2008); Kanakala et al. (2013a); Hameed et al. (2019)
	Solanum lycopersicum	Solanaceae	Tomato	Liu et al. (1997); Farzadfar et al. (2008); Khalid et al. (2017)
	Datura stramonium	Solanaceae	Jimsonweed	Horn et al. (1993); Liu et al. (1997); Farzadfar et al. (2008)

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Appendix B – Distribution of chickpea chlorotic dwarf virus

Distribution records based on CABI and other sources

Region	Country	Status (CABI)	References
Africa	Burkina-Faso		Ouattara et al. (2020)
	Egypt	Present	CABI and EPPO (2005); Fahmy et al. (2015)
	Eritrea	Present, no details	Kumari et al. (2008)
	Ethiopia	Present	CABI and EPPO (2005); Abraham et al. (2000)
	Kenya		Avedi et al. (2020)
	Morocco		Radouane et al. (2019)
	Nigeria	Present	Fiallo-Olivé et al. (2017)
	South-Africa		Liu et al. (1997); Halley-Stott et al. (2007)
	Sudan	Present	CABI and EPPO (2005); Hamed and Makkouk (2002)
	Tunisia	Present	Zaagueri et al. (2017)
Asia	India	Present	Byun et al. (2014)
	Iran	Present	Makkouk et al. (2002)
	Iraq	Present	El-Muadhidi et al. (2001)
	Oman	Present	Akhtar et al. (2014)
	Pakistan	Present	Horn et al. (1996); Nahid et al. (2008)
	Syria	Present	Kumari et al. (2004)
	Turkey		Kraberger et al. (2013)
	Yemen	Present	CABI
Oceania	Australia		Thomas et al. (2010)

Appendix C – Peppers (*Capsicum* spp.) [V3600] crop production area

Eurostat database (cultivation/harvested/production) (1,000 ha); date of extraction 30 August 2022

MS/TIME	2017	2018	2019	2020	2021
Belgium	0.10	0.09	0.10	0.10	0.11 p
Bulgaria	3.35	2.95	3.22	2.72	2.99
Czechia	0.00 n	0.42	0.27	0.29	0.31
Denmark	0.00 n	0.00 n	0.00 n	0.00 n	0.00 n
Germany	0.09	0.11	0.11	0.11	0.12
Estonia	0.00	0.00	0.00	0.00	0.00
Ireland	0.00 n	0.00 n	0.00 n	0.00 n	0.00 n
Greece	4.03	3.84	3.39	3.45	3.40
Spain	20.50	20.58	21.43	21.75	22.24
France	0.96	0.95	0.94	1.16	1.36
Croatia	1.02	1.02	0.56	0.68	0.80
Italy	10.32	10.52	10.28	10.01	9.67
Cyprus	0.03	0.04	0.03	0.04 p	0.04 p
Latvia	0.00 n	0.00 n	0.00 n	0.00 n	0.00 n
Lithuania	0.00 n	0.00 n	0.00 n	0.00 n	0.00 n
Luxembourg	0.00 n	0.00 n	0.00 n	0.00 n	0.00 n
Hungary	2.57	1.91	1.85	1.57	1.65 e
Malta	0.00 n	0.00 n	0.00 n	0.00 n	0.00 n
Netherlands	1.32	1.31	1.50	1.53	1.63
Austria	0.18	0.16	0.16	0.16	0.17
Poland	3.63	3.71	3.70	3.20	5.90
Portugal	1.21	0.93	0.85	1.28	1.23 p
Romania	9.71	9.96	10.78	9.26	10.37
Slovenia	0.16	0.16	0.20	0.22	0.19
Slovakia	0.31	0.27	0.22	0.17	0.18
Finland	0.01	0.01	0.01	0.01	0.01
Sweden	0.00	0.00	0.00	0.00	0.00

MS, member states; :, not available; e, estimated; n, not significant; p, provisional.

Appendix D – Spinach [V2500] crop production area

Eurostat database (cultivation/harvested/production) (1,000 ha); date of extraction 30 August 2022

MS/TIME	2017	2018	2019	2020	2021
Belgium	5.09	4.59	4.69	4.54	4.44 p
Bulgaria	0.07	0.13	0.09	0.15	0.07
Czechia	0.00 n	0.39	0.47	0.33	0.63
Denmark	0.05	0.26	0.37	0.27	0.21
Germany	3.85	3.48	3.46	3.97	4.32
Estonia	0.00	0.00	0.00	0.00	0.00
Ireland	0.28 d	0.23 B	0.23	0.23	0.23 e
Greece	9.97	7.57	6.77	6.92	6.99
Spain	4.35	4.5	4.3	4.86	5.11
France	5.31	6.06	5.89	5.32	4.97
Croatia	0.00 n	0.00 N	0.00 n	0.00 n	0.00 n
Italy	5.97	6.59	6.29	6.14	6.08
Cyprus	0.06	0.06	0.08	0.08 p	0.08 p
Latvia	0.00 n	0.00 N	0.00 n	0.00 n	0.00 n
Lithuania	0.02	0.04	0.15	0.1	0.04
Luxembourg	0.00	0.00	0.00	0.00	0.00
Hungary	0.37	0.45	0.47	0.46	0.45 e
Malta	0.00 n	0.00 N	0.00 n	0.00 n	0.00 n
Netherlands	2.92	3.14	3.39	3.3	3.49
Austria	0.67	0.77	0.77	0.64	0.57
Poland	1.09 e	1.03 E	0.7 e	0.5	0.5
Portugal	0.54	0.44	0.55	0.99	0.87 p
Romania	0.12	0.12	0.13	0.11	0.09
Slovenia	0.03	0.03	0.03	0.04	0.03
Slovakia	0.17	0.09	0.17	0.17	0.1
Finland	0.02	0.01	0.04	0.07	0.08
Sweden	0.04	0.07	0.07	0.07	0.08

MS, member states; :, not available; b, break in time series; d, definition differs (see metadata); e, estimated; n, not significant; p, provisional.

Appendix E – Tomatoes [V3100] crop production area

Eurostat database (cultivation/harvested/production) (1,000 ha); date of extraction 30 August 2022

MS/TIME	2017	2018	2019	2020	2021
Belgium	0.52	0.55	0.57	0.62	0.62 p
Bulgaria	5.01	4.52	5.15	3.09	3.07
Czechia	0.24	0.3	0.16	0.26	0.26
Denmark	0.03	0.03	0.03	0.03	0.03
Germany	0.37	0.4	0.39	0.38	0.4
Estonia	0.00	0.00	0.00	0.01	0.01
Ireland	0.01	0.01	0.01	0.01	0.01 e
Greece	13.32	16.02	15.01	15.82	16.09
Spain	60.85	56.13	56.94	55.47	56.11
France	5.75	5.74	5.66	5.95	6.22
Croatia	0.45	0.49	0.32	0.4	0.29
Italy	99.75	97.09	99.02	99.78	102.06
Cyprus	0.26	0.29	0.28	0.26 p	0.28 p
Latvia	0.00	0.00	0.00 n	0.00 n	0.00 n
Lithuania	0.55	0.57	0.56	0.68	0.72
Luxembourg	0.00	0.00	0.00	0.00	0.00
Hungary	2.19	2.5	2.41	1.82	1.92 e
Malta	0.00 n	0.00 n	0.00 n	0.00 n	0.00 n
Netherlands	1.79	1.79	1.8	1.87	1.85
Austria	0.18	0.2	0.2	0.2	0.2
Poland	12.64	13.11	13.5	8.4	8.7
Portugal	20.87	15.83	15.89	15.04	17.78 p
Romania	22.21	22.97	23.78	17.47	17.35
Slovenia	0.20	0.19	0.22	0.26	0.21
Slovakia	0.60	0.59	0.48	0.22	0.24
Finland	0.11	0.1	0.09	0.1	0.09
Sweden	0.04	0.04	0.04	0.05	0.04

MS: member states; :, not available; e, estimated; n, not significant; p, provisional.

Appendix F – Sugar beet (excluding seed) [R2000] crop production area

Eurostat database (cultivation/harvested/production) (1,000 ha); date of extraction 30 August 2022

MS/TIME	2017	2018	2019	2020	2021
Belgium	62.47	62.7	57.61	56.75	55.2 p
Bulgaria	0.00	0.00	0.00	0.00	0.00
Czechia	66.10	64.76	59.21	59.68	61.23
Denmark	34.40	34.30	29.00	33.20	33.20
Germany	406.70	413.90	408.70	386.00	390.70
Estonia	0.00	0.00	0.00	0.00	0.00
Ireland	0.00	0.00	0.00	0.00	0.00
Greece	6.50	1.43	1.61	1.74	1.41
Spain	36.67	35.3	30.18	27.62	29.55 p
France	486.10	485.85	446.60	420.89	402.16
Croatia	19.53	14.07	11.58	10.46	10.2
Italy	37.97	34.41	29.97	27.27	30.14
Cyprus	0.00	0.00	0.00	0.00	0.00
Latvia	0.00	0.00	0.00	0.00	0.00
Lithuania	17.15	15.54	14.12	13.99	14.68
Luxembourg	0.00	0.00	0.00	0.00	0.00
Hungary	18.65	15.77	14.08	12.91	12.17
Malta	0.00	0.00	0.00	0.00	0.00
Netherlands	85.35	85.2	79.18	81.46	80.51
Austria	42.68	31.25	27.88	26.32	37.85
Poland	231.72	238.92	240.78	245.92	250.57 e
Portugal	0.11	0.00	0.00	0.00	0.00 n
Romania	28.20	25.72	22.73	21.33	19.44
Slovenia	0.00 n	0.00 n	0.18	0.11	0.13
Slovakia	22.38	21.91	21.72	21.08	21.8
Finland	11.80	9.80	10.50	11.00	11.30
Sweden	30.99	30.64	27.16	29.75	28.7

MS: member states; :, not available; e, estimated; n, not significant; p, provisional.