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Pest categorisation of *Colletotrichum fructicola*

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Abstract

The EFSA Plant Health Panel performed a pest categorisation of *Colletotrichum fructicola* Prihast., a well-defined polyphagous fungus of the *C. gloeosporioides* complex which has been reported from all the five continents to cause anthracnose, bitter rot and leaf spotting diseases on over 90 cultivated and non-cultivated woody or herbaceous plant species. The pathogen is not included in EU Commission Implementing Regulation 2019/2072. Because of the very wide host range, this pest categorisation focused on *Camellia sinensis, Citrus sinensis, C. reticulata, Fragaria* × *ananassa, Malus domestica, M. pumila, Persea americana, Prunus persica, Pyrus pyrifolia* and *P. bretschneideri* for which there was robust evidence that *C. fructicola* was formally identified by morphology and multilocus gene sequencing analysis. Host plants for planting and fresh fruits are the main pathways for the entry of the pathogen into the EU. There are no reports of interceptions of *C. fructicola* in the EU. The pathogen has been reported from Italy and France. The host availability and climate suitability factors occurring in some parts of the EU are favourable for the establishment of the pathogen. Economic impact on the production of the main hosts is expected if establishment occurs. Phytosanitary measures are available to prevent the re-introduction of the pathogen into the EU. Although the pathogen is present in the EU, there is a high uncertainty on its actual distribution in the territory because of the re-evaluation of *Colletotrichum* taxonomy and the lack of systematic surveys. Therefore, the Panel cannot conclude with certainty on whether *C. fructicola* satisfies the criterium of being present but not widely distributed in the EU to be regarded as a potential Union quarantine pest unless systematic surveys for *C. fructicola* are conducted and *Colletotrichum* isolates from the EU in culture collections are re-evaluated.

Keywords: Anthracnose, bitter rot, Glomerella leaf spot, pest risk, plant health, plant pest

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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

Colletotrichum fructicola Prihast., L. Cai & K.D. Hyde is one of a number of pests listed in Annex 1 to the Terms of Reference (ToR) (Section 1.1.2) to be subject to pest categorisation to determine whether it fulfils the criteria of a regulated 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 regulated pest, specific import requirements for relevant host commodities will be identified; for pests already present in the EU additional risk reduction options to inhibit spread will be identified.

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search on *C. fructicola* 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 European and Mediterranean Plant Protection Organization (EPPO) Global Database (EPPO, online), the CABI databases and scientific literature databases as referred above in Section 2.1.1.

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

2.2. Methodologies

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

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

The Panel's conclusions are formulated respecting its remit and particularly with regard to the principle of separation between risk assessment and risk management (EFSA founding regulation (EU) No 178/2002); therefore, instead of determining whether the pest is likely to have an unacceptable impact, deemed to be a risk management decision, the Panel will present a summary of the observed impacts in the areas where the pest occurs, and make a judgement about potential likely impacts in the EU. 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 defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

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

3. Pest categorisation

3.1. Identity and biology of the pest

3.1.1. Identity and taxonomy

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

Yes, the identity of the pathogen is well-established; the pathogen has been shown to produce consistent symptoms and to be transmissible.

The genus *Colletotrichum* includes endophytes, saprobes as well as plant pathogens, the latter being responsible for several diseases of many crops worldwide (Cannon et al., 2012; Udayanga et al., 2013). In the past, cultural and morphological characters (size and shape of conidia and appressoria, presence or absence of setae, colour and growth rate of the colonies, etc.) were used to identify *Colletotrichum* species (Von Arx, 1957; Sutton, 1980, 1992). However, it has been demonstrated that these characters are not reliable for species level identification because of their variability under different environmental factors, including culture media, light and temperature (Cai et al., 2009; Damm et al., 2012; Liu et al., 2016). In the last few years, the use of multi-gene phylogenetic analysis has significantly changed the taxonomy of the genus *Colletotrichum* (Cannon et al., 2012; Weir et al., 2012). So far, 11 *Colletotrichum* species complexes have been identified within the genus *Colletotrichum*.

Colletotrichum fructicola is a distinct fungal species belonging to the C. gloeosporioides complex, which represents a large group of plant pathogens affecting many different crops (Weir et al., 2012). Based on multi-gene phylogenetics, 22 species and one subspecies have been identified within the C. gloeosporioides complex (Weir et al., 2012). C. fructicola was originally reported as the causal agent of coffee berry disease on Coffea arabica in northern Thailand (Prihastuti et al., 2009) and as a leaf endophyte in Central America (Rojas et al., 2010). Since then, C. fructicola has been reported to cause anthracnose, bitter rot and leaf spotting diseases on a wide range of woody or herbaceous plants growing in tropical, subtropical and temperate climates worldwide (Damm et al., 2010; Cannon et al., 2012; Weir et al., 2012; Fu et al., 2019). The pathogen is morphologically and physiologically identical to other species of the C. gloeosporioides complex. Nevertheless, it can be reliably identified based on multilocus gene sequencing analysis.

C. fructicola is a fungus of the family Glomerellaceae. CABI Crop Protection Compendium (CABI, 2021) provides the following taxonomic identification for *C. fructicola*:

Preferred scientific name: *Colletotrichum fructicola* Prihast., L. Cai & K.D. Hyde
Phylum: Ascomycota
Subphylum: Pezizomycotina
Class: Sordariomycetes
Order: Phyllachorales
Family: Glomerellaceae
Genus: *Colletotrichum*
Species: *Colletotrichum fructicola*

Common names: anthracnose, bitter rot of apple, bitter rot of pear, Glomerella leaf spot
Synonyms: Colletotrichum ignotum Rojas, Rehner & Samuels; Glomerella cingulata var. minor Wollenw. (Prihastuti et al., 2009; Rojas et al., 2010; Weir et al., 2012).

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

3.1.2. Biology of the pest

Colletotrichum fructicola has a similar life cycle to that of other C*olletotrichum* species and may survive between crops during winter as mycelium and perithecia on plant debris, or on infected plants, while its survival on seeds remains questionable (Rajeendran et al., 2017; Hanin and Fitriasari, 2019). Humid, wet, rainy weather is necessary for infection to occur. These requirements in particular may limit the occurrence of the pathogen in driest areas whereas the pathogen may represent a serious problem under controlled environments where humidity is ensured (i.e. in the greenhouse) or during postharvest stages (CDFA, 2009).

During active growth in the plant tissues, the pathogen develops acervuli, which produce masses of mucilage-embedded conidia. These conidia are disseminated by rain splash, wind-driven rain, cultivation tools, equipment and fieldworkers onto healthy leaves, young fruit or blossoms (de Silva et al., 2017). Conidia germinate, penetrate host tissue by means of specialised hyphae (appressoria) and invade host tissue. Upon infection the pathogen continues to produce conidia throughout the season resulting in a polycyclic disease cycle.

The life cycle of *Colletotrichum* species includes both sexual/teleomorph and asexual/anamorph reproductive stages, which occur on the host plant or in plant debris (de Silva et al., 2017). Sexual fruiting structures (perithecia) are readily formed in *in vitro* culture. Environmental conditions favourable for the formation of perithecia induce the development and release and the aerial dispersal of ascospores, which infect plant tissues (Zhao et al., 2019). Senescence of the host tissue may induce the development of the sexual stage, from which the life cycle will restart (Figure 1; de Silva et al., 2017). Perithecia also represent survival structures, which help the pathogen to overwinter or survive periods in the absence of a susceptible host, especially since *C. fructicola* does not produce sclerotia (Prihastuti et al., 2009; Rojas et al., 2010; Weir et al., 2012).

No information specific for the potential of the pathogen to survive in soil (with or without plant debris) exists. Nevertheless, in general, *Colletotrichum* species seem not to survive for long periods in soil (Bergstrom and Nicholson, 1999; Ripoche et al., 2008), although there are notable exceptions (Dillard and Cobb, 1998; Freeman et al., 2002) and melanised microsclerotia have been observed in several species (e.g. *C. truncatum, C. sublineola, C. coccodes*) (Dillard and Cobb, 1998; Boyette et al., 2007; Sukno et al., 2008). Conidia of *C. acutatum* and C. *gloeosporioides* isolates from strawberry survive for up to 1 year in autoclaved soil, whereas their viability declined rapidly within a few days in untreated soils at 22% soil moisture (field capacity) (Freeman et al., 2002). The number of conidia of *C. gloeosporioides*, causal agent of water yam (*Dioscorea alata*) anthracnose in Guadeloupe, was higher in artificially inoculated residues on the soil surface than in residues buried at 0.1 m soil depth, which decomposed faster (Ripoche et al., 2008). Eastburn and Gubler (1990) reported that *C. acutatum* survived in buried strawberry tissue for 9 months, but soil population densities gradually

[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).

declined over an 11-month period. According to Feil et al. (2008), the number of *C. acutatum* conidia recovered from artificially inoculated strawberry stolons buried in soil was the highest at 5°C with a soil moisture level of 26.8%. Recovery of conidia decreased progressively over a 6-month period, with the decline being more pronounced at 10°C than at 5°C and at a higher soil moisture.

Colletotrichum species exhibit diverse host colonisation strategies ranging from very short up to long latent periods (Perfect et al., 1999). The penetration and colonisation process of *C. fructicola* has been thoroughly described by Shang et al. (2020) on apple (cv. Gala) leaves using both light and transmission electron microscopy. *C. fructicola* conidia form germ tubes 4 h post-inoculation (hpi) and melanised appressoria at 8 hpi. At 12 hpi, *C. fructicola* produces secondary conidia. After penetration, *C. fructicola* develops infection vesicles at 36 hpi. At 48 hpi, the primary hyphae of *C. fructicola* are produced from infection vesicles within host epidermal cells; the host epidermal cell plasma membrane remains intact, indicating a biotrophic association. Subsequently, secondary hyphae penetrate epidermal cells and destroy cell components, initiating the necrotrophic colonisation stage. *C. fructicola* also produces biotrophic subcuticular infection vesicles and hyphae. Together, these results demonstrate that *C. fructicola* colonises apple leaves in a haemibiotrophic manner, involving intracellular as well as subcuticular colonisation strategies (Shang et al., 2020).

On PDA culture medium, optimal radial colony growth of *C. fructicola* occurs between 25°C and 30°C. Colony growth is significantly reduced at 35°C, and growth is arrested at 40°C (Lu et al., 2018).

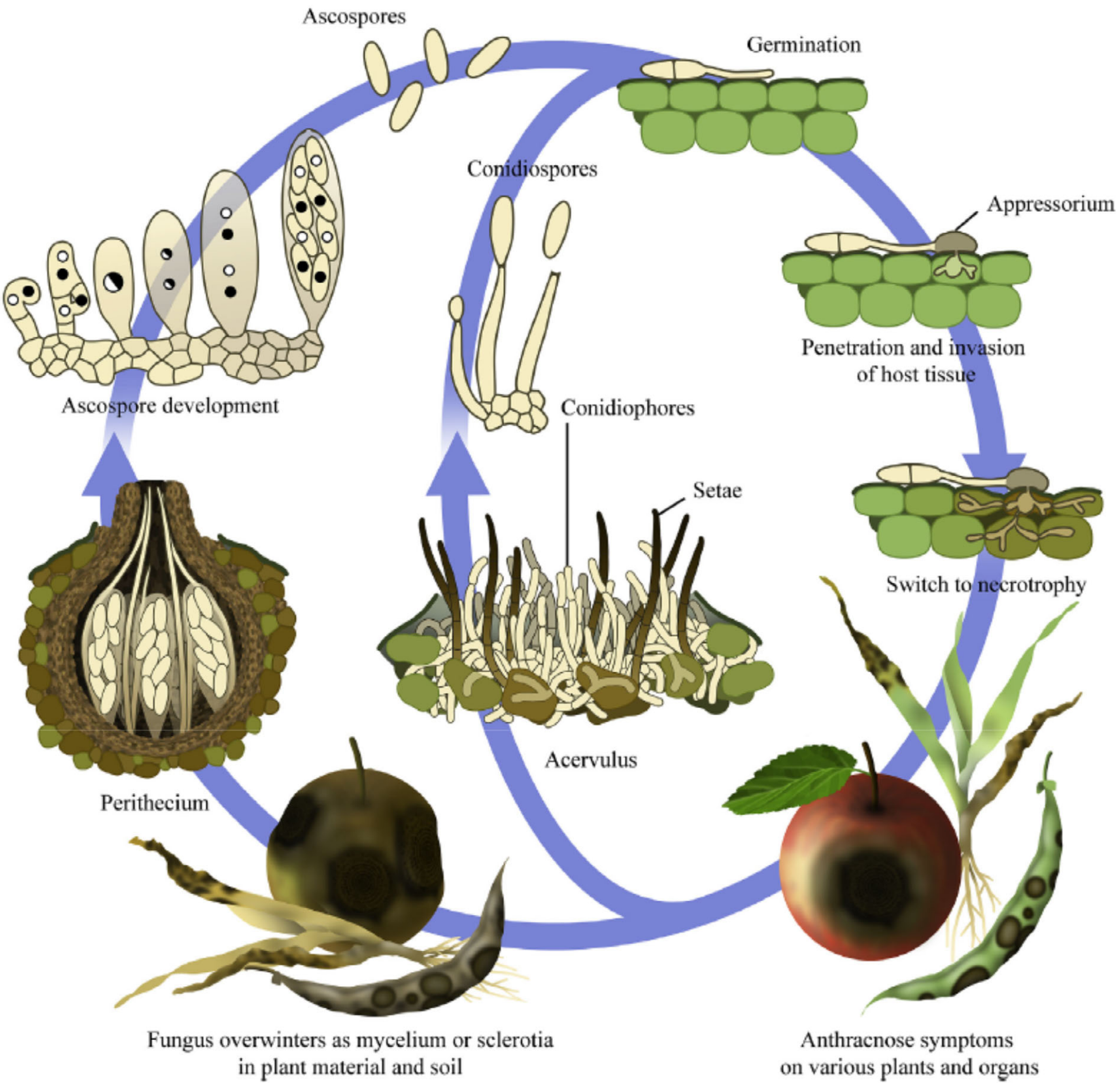

Figure 1: General life cycle of *Colletotrichum* species (from de Silva et al., 2017)

3.1.3. Host range

As other members of the *C. gloeosporioides* complex, *C. fructicola* is polyphagous. Reported hosts include: *Camellia sinensis* (CDFA, 2009; Weir et al., 2012; Fuentes-Aragón et al., 2018); *Capsicum annuum* (Shoji et al., 2014); *Capsicum frutescens* (CDFA, 2009); *Carica papaya* (Saini et al., 2016); *Citrullus vulgaris* (CDFA, 2009); *Citrus* x *paradisi* (CDFA, 2009); *Citrus reticulata* (Huang et al., 2013); *Citrus sinensis* (Arzanlou et al., 2015); *Coffea arabica* (Prihastuti et al., 2009); *Cucumis melo* (CABI, 2019), *Dendrobium officinale* (Silva-Cabral et al., 2019; Ma et al., 2020a); *Dioscorea* sp. (CDFA, 2009; Weir et al., 2012; Fuentes-Aragón et al., 2018); *Diospyros kaki* (Carraro et al., 2019); *Ficus carica* (CDFA, 2009; Weir et al., 2012; Fuentes-Aragón et al., 2018); *Ficus edulis* (CDFA, 2009; Weir et al., 2012; Fuentes-Aragón et al., 2018); *Fortunella margarita* (Huang et al., 2013); *Fragaria* × *ananassa* (CDFA, 2009; Weir et al., 2012; Fuentes-Aragón et al., 2018); *Hylocerus undatus* (CABI, 2019); *Juglans regia* (Wang et al., 2018), *Limonium sinuatum* (CDFA, 2009; Weir et al., 2012; Fuentes-Aragón et al., 2018); *Lycopersicon esculentum* (CDFA, 2009); *Lycium chinense* (Paul et al., 2014); *Malus domestica* (Huang et al., 2013); *Mangifera indica* (CABI, 2019); *Musa acuminata* (CDFA, 2009); *Nerium oleander* (CDFA, 2009); *Nicotiana tabacum* (Wang et al., 2016); *Passiflora edulis* (CDFA, 2009); *Persea americana* (CDFA, 2009; Weir et al., 2012; Fuentes-Aragón et al., 2018); *Phaseolus lunatus* (Sousa et al., 2018); *Prunus persica* (Lee et al., 2020); *Pyrus bretschneideri* (Jiang et al., 2014); *Pyrus pyrifolia* (Zhang et al., 2015); *Theobroma cacao* (CDFA, 2009; Weir et al., 2012; Fuentes-Aragón et al., 2018); *Vitis vinifera* (Peng et al., 2013; Echeverrigaray et al., 2020).

Colletotrichum fructicola has also been reported on many other cultivated hosts (including ornamentals) worldwide (see Appendix A). Some weeds were reported as potential hosts of *C. fructicola*: the pathogen is able to form acervuli on the tissues of these plants once treated with an herbicide. Hence, infected weeds associated with strawberry cultivation were hypothesised to represent potential inoculum sources of *C. fructicola*, especially upon herbicide treatment (Hirayama et al., 2018). Interestingly, the pathogen has also been recently reported as causal agent of anthracnose on the invasive weed *Eichhornia crassipes* (Huang et al., 2021).

Nevertheless, the host range of the pathogen might be wider than that currently reported as, in the past, when molecular tools were not available, *Colletotrichum* isolates detected on other than the above-mentioned hosts and identified as *C. gloeosporioides sensu lato* based on morphology and pathogenicity, might have belonged to *C. fructicola*.

Given that *Colletotrichum* species are commonly found on many plant species as pathogens, endophytes and occasionally as saprobes, and that the accurate identification of *C. fructicola* and its discrimination from other closely related *Colletotrichum* species is only possible by using molecular tools, this Pest categorisation will focus on those hosts for which there is robust evidence in the literature that the pathogen was isolated and identified by both morphology and multilocus gene sequencing analysis, the Koch's postulates were fulfilled and the impacts on crop yield of the disease caused by *C. fructicola* were documented. Based on the above, the following hosts are considered as main hosts of *C. fructicola*:

- *Camellia sinensis*
- *Citrus reticulata*
- *Citrus sinensis*
- *Fragaria* × *ananassa*
- *Malus domestica*
- *Malus pumila*
- *Persea americana*
- *Prunus persica*
- *Pyrus bretschneideri*
- *Pyrus pyrifolia*

The complete list of the host plants of *C. fructicola* reported to date in the literature is included in Appendix A (last updated: 9 June 2021). However, uncertainty exists with respect to the actual host range of the pathogen.

3.1.4. Intraspecific diversity

The ability to differentiate sexual reproductive stages enhances the genomic plasticity and adaptation of *C. fructicola* to various and/or adverse environmental conditions, including the selection of fungicide-resistant populations. It is generally acknowledged that the risk of fungicide resistance development increases when sexual recombination occurs in the life cycle (FRAC, 2014). With this respect, isolates of *C. fructicola* from apple orchards in Japan were found to develop resistance to benomyl and QoI (quinone outside inhibitors) fungicides at a more rapid pace compared to other anamorphic species of the *Colletotrichum gloeosporioides* complex, such as *C. siamense* (Yokosawa et al., 2017). Out of 125 *Colletotrichum* isolates from strawberry and yam sampled from 2012 through 2016 in the Hubei Province (China), 56 were identified as *C. fructicola* and tested for resistance to carbendazim: the number of sensitive, moderately resistant and highly resistant isolates was 38, 3 and 15, respectively (Han et al., 2018).

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.

Plants infected by *C. fructicola* show symptoms of anthracose, which include dark brown stem and fruit spots, pre- and post-harvest fruit rot, spotting and wilting of leaves (Zhang et al., 2015; Guarnaccia et al., 2016; Carraro et al., 2019; Fu et al., 2019; Chung et al., 2020; Echeverrigaray et al., 2020; Fuentes-Aragón et al., 2020). However, these symptoms are similar to those caused by other *Colletotrichum* species. If fruiting structures (acervuli with conidia and/or perithecia with ascospores) are detected on the symptomatic plant tissues using a magnifying lens, they are also similar to those of other *Colletotrichum* species. Therefore, it is unlikely that the pathogen could be detected based on visual inspection only.

The pathogen can be readily isolated on culture media and description of its cultural and morphological characteristics is available in the literature (Prihastuti et al., 2009; Rojas et al., 2010; Weir et al., 2012). However, as some of these characteristics are similar to or overlap with those of other *Colletotrichum* species, and moreover, they vary under changing environmental conditions (Cai et al., 2009; Liu et al., 2016), the pathogen cannot be reliably identified based on morphology (Damm et al., 2010, 2012; Cannon et al., 2012; Weir et al., 2012). Molecular methods, such as multilocus gene (e.g. ITS, *tub2*, GS, *gapdh*, *cmdse*) sequencing analysis, are available in the literature (Zhu et al., 2015; Li et al., 2016a,b; Giblin et al., 2018; Grammen et al., 2019) and may be used in combination with morphology-based methods for the identification of *C. fructicola* (Guarnaccia et al., 2021). However, it is worth noting that ITS sequences do not separate *C. fructicola* from *C. aeschynomenes* and some *C. siamense* isolates. These taxa are best distinguished using GS or SOD2 genes (Weir et al., 2012). Using a comparative genomics approach, Gan et al. (2017) have developed a marker that can differentiate *C. fructicola*, *C. aenigma* and *C. siamense* within the *C. gloeosporioides* species complex based on polymerase chain reaction (PCR) amplicon size differences.

No EPPO Standard is available for the detection and identification of *C. fructicola*.

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

Colletotrichum fructicola is reported from Asia, Africa, America and Oceania (EPPO, 2016).

In Asia, the pathogen is reported from China (Jiang et al., 2014; Zhang et al., 2015; de Silva et al., 2019; Guarnaccia et al., 2021), Iran (Arzanlou et al., 2015), Japan (Shoji et al., 2014; Gan et al., 2016), Korea Republic (Paul et al., 2014; Lim et al., 2020), India (Sharma and Shenoy, 2013; Saini et al., 2016; de Silva et al., 2019), Taiwan (de Silva et al., 2019; Wu et al., 2020), Thailand (Weir et al., 2012; de Silva et al., 2019; Guarnaccia et al., 2021), Israel (Sharma et al., 2017) and Indonesia (Weir et al., 2012).

In Africa, *C. fructicola* is reported from Nigeria (Weir et al., 2012) and South Africa (Weir et al., 2012).

In America, the pathogen is reported from USA (Weir et al., 2012), Canada (Weir et al., 2012), Brazil (Lima et al., 2013; Lopes et al., 2021), Mexico (Fuentes-Aragón et al., 2018; Tovar-Pedraza et al., 2020), Uruguay (Casanova et al., 2017; Alaniz et al., 2019) and Panama (Weir et al., 2012).

In Oceania, *C. fructicola* is reported from Australia (Shivas et al., 2016; Giblin et al., 2018; Wang et al., 2021) and New Zealand (Weir et al., 2012; Hofer et al., 2021).

Details of the current distribution of the pathogen outside the EU are presented in Appendix B. No map on the global distribution of *C. fructicola* is available in the EPPO Global Database.

There is uncertainty with respect to the actual distribution of the pathogen outside the EU, as in the past, when molecular tools (i.e. multigene phylogenetic analysis) were not available, the pathogen might have been identified as *C. gloeosporioides* based on morphology and pathogenicity tests, which cannot reliably identify *Colletotrichum fructicola*.

3.2.2. Pest distribution in the EU

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

Yes, *C. fructicola* is reported to be present in the EU. The pest is not widely distributed within the EU with high uncertainty.

Colletotrichum fructicola is known to be present in the EU. More specifically, it has been reported from the following EU Member States:

- France (Nodet et al., 2019).
- Germany (Weir et al., 2012).
- Italy (Guarnaccia et al., 2016, 2021; Wenneker et al., 2021).

In France, the pathogen was detected in 2017 in four apple (*Malus pumila*) orchards in the Occitanie region (communes of Marsillargues, Saint-Just and Lunel-Viel of the Hérault Department and commune Campagne of the Gard Department; Dr P. Nodet, personal communication) exhibiting bitter rot symptoms on fruits (Nodet et al., 2019). Since then, no other reports on the presence of the pathogen in France exist in the available literature. In Germany, *C. fructicola* was found in 1936 to cause leaf spotting on a *Ficus edulis* plant grown in Berlin-Dahlem Botanical Garden. The pathogen was initially identified as *Glomerella cingulata* var. *minor.* In 2012, Weir et al. using multilocus gene sequencing analysis identified the isolate of the pathogen deposited in CBS (CBS 238.49) as *C. fructicola*. No other reports exist on the presence of the pathogen in Germany. Therefore, the Panel considers the pest as transient in Germany. In Italy, the pathogen was detected for the first time in 2013 causing fruit rot on 5- to 10-year-old avocado (*Persea americana*; cv Hass) trees grown in four orchards in Catania province (eastern Sicily) (Guarnaccia et al., 2016). In 2019, *C. fructicola* was reported to cause anthracnose on aromatic and ornamental plants grown in nurseries located in northern Italy (near Biella) (Guarnaccia et al., 2021). In the same year, the pathogen was reported to cause a severe outbreak of fruit rot in commercial 'Pink Lady' apple orchards in the region Emilia-Romagna (northern Italy) (Wenneker et al., 2021).

Again, uncertainty exists with respect to the current distribution of *C. fructicola* in the EU, as in the past, when molecular tools (i.e. multigene phylogenetic analysis) were not available, the pathogen might have been identified in the past as *C. gloeosporioides* based on morphology and pathogenicity tests, which cannot reliably identify *Colletotrichum fructicola*.

3.3. Regulatory status

3.3.1. Commission Implementing Regulation 2019/2072

C. fructicola 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 of *Colletotrichum fructicola* that are prohibited from entering the Union from third countries

Table 2: List of plants, plant products and other objects that are *Colletotrichum fructicola* hosts whose introduction into the Union from certain third countries is prohibited Source Commission Implementing Regulation (EU) 2019/2072, Annex VI). Some of the hosts such as *Ficus carica*, *Malus, Nerium, Prunus, Juglans* and *Persea* are included in the Commission Implementing Regulation (EU) 2018/2019 on high risk plants.

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**
8.	Plants for planting of [. . .. . .], *Malus* Mill., *Prunus* L., *Pyrus* L. [. . .. .], other than dormant plants free from leaves, flowers and fruits	ex 0602 10 90 ex 0602 20 20 ex 0602 20 80 ex 0602 40 00 ex 0602 90 41 ex 0602 90 45 ex 0602 90 46 ex 0602 90 47 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, Andorra, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Canary Islands, Faeroe Islands, Georgia, Iceland, Liechtenstein, Moldova, Monaco, Montenegro, 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, Turkey and Ukraine
9.	Plants for planting of [. . .. .], *Malus* Mill., *Prunus* L. and *Pyrus* L. and their hybrids, and *Fragaria* L., other than seeds	ex 0602 10 90 ex 0602 20 20 ex 0602 90 30 ex 0602 90 41 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, Australia, Azerbaijan, Belarus, Bosnia and Herzegovina, Canada, Canary Islands, Egypt, Faeroe Islands, Georgia, Iceland, Israel, Jordan, Lebanon, Libya, Liechtenstein, Moldova, Monaco, Montenegro, Morocco, New Zealand, 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, Ukraine, and United States other than Hawaii
10.	Plants of *Vitis* L., other than fruits	0602 10 10 0602 20 10 ex 0604 20 90 ex 1404 90 00	Third countries other than Switzerland
11.	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruits and seeds	ex 0602 10 90 ex 0602 20 20 ex 0602 20 30 ex 0602 20 80 ex 0602 90 45 ex 0602 90 46 ex 0602 90 47 ex 0602 90 50 ex 0602 90 70 ex 0602 90 91 ex 0602 90 99 ex 0604 20 90 ex 1404 90 00	All third countries

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, *C. fructicola* could potentially enter the EU territory via the host plants for planting and the fresh fruit pathways.

Host plants for planting is the main pathway for the entry of the pathogen into the EU territory.

The PLH Panel identified the following main pathways for the entry of the pathogen into the EU territory:

1) host plants for planting, and
2) fresh fruit of host plants

originating in infested third countries (Table 4).

Albeit seeds are reported as one of the primary sources of inoculum for many *Colletotrichum* species, there is no evidence of *C. fructicola* being transmitted by seeds of its host plants.

No information specific for *C. fructicola* exists in the available literature on its survival in soil, but in general, *Colletotrichum* species appear to be poor competitors in soil (see Section 3.1.2). Therefore, uncertainty exists on the soil and other substrates associated or not with host plants for planting as a pathway of entry of the pathogen into the EU territory.

The pathogen is unlikely to enter the EU by natural means (rain, wind-driven rain, insects, etc.) because of the long distance between the infested third countries and the EU Member States. Although there are no quantitative data available, spores of the pathogen may be also present as contaminants on other substrates (e.g. non-host plants, other objects, etc.) imported into the EU. Nevertheless, this is considered a minor pathway for the entry of *C. fructicola* into the EU territory.

Given its biology, *C. fructicola* could potentially be transferred from the fruit pathway to host plants grown in the EU territory. However, the frequency of this transfer will depend on the volume and frequency of imported fruits, their final destination (e.g. retailers, packinghouses) and its proximity to the hosts and the management of fruit waste.

Table 3: Potential pathways for *Colletotrichum fructicola* into the EU 27

Pathways	Life stage	Relevant mitigations [e.g. prohibitions (Annex VI) or special requirements (Annex VII) within Implementing Regulation 2019/2072]
Plants for planting of *Malus* Mill., *Prunus* L. and *Pyrus* L., other than dormant plants free from leaves, flowers and fruits	Mycelium, acervuli with conidia, perithecia with ascospores	Annex VI (8.) bans the introduction of plants for planting of *Malus, Prunus* and *Pyrus* with leaves, flowers and fruits from certain third countries. None of the third countries from where the introduction of *Malus, Prunus* and *Pyrus* plants for planting with leaves, flowers and fruits is permitted has been reported to be infested by *C. fructicola* (see Section 3.3.1).
Plants for planting of *Malus* Mill., *Prunus* L. and *Pyrus* L. and their hybrids, and *Fragaria* L., other than seeds	Mycelium, acervuli with conidia, perithecia with ascospores	Annex VI (9.) bans the introduction of plants for planting of *Malus, Prunus, Pyrus* and *Fragaria* L. other than seeds from certain third countries. Of the third countries from where the introduction of *Malus, Prunus, Pyrus* and *Fragaria* L. plants for planting other than seeds, is not prohibited, the United States have been reported as infested by *C. fructicola* (see Section 3.3.1).
Plants for planting of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids	Mycelium, acervuli with conidia, perithecia with ascospores	Annex VI (11.) bans the introduction of plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruits and seeds from all third countries (see Section 3.3.1).

Pathways	Life stage	Relevant mitigations [e.g. prohibitions (Annex VI) or special requirements (Annex VII) within Implementing Regulation 2019/2072]
Plants of *Vitis* L., other than fruits	Mycelium, acervuli with conidia, perithecia with ascospores	Annex VI (10.) bans the introduction of plants of *Vitis* L., other than fruits from third countries other than Switzerland (see Section 3.3.1).
Fruits of *Diospyros* L., *Fragaria* L., *Malus* L., *Persea americana* Mill., *Prunus* L., *Pyrus* L., and *Vitis* L.	Mycelium, acervuli with conidia, perithecia with ascospores	Annex XI A (5) requires Phytosanitary Certificate for fruits (fresh or chilled) of *Diospyros* L., *Fragaria* L., *Malus* L., *Persea americana* Mill., *Prunus* L., *Pyrus* L., and *Vitis* L. originating in third countries other than Switzerland.
Fruits of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids	Mycelium, acervuli with conidia, perithecia with ascospores	Annex VII (57.) requires fruits of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids originating in third countries to be free from peduncles and leaves and the packaging shall bear an appropriate origin mark. Annex XI A (5) requires Phytosanitary Certificate for fruits (fresh or chilled) of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf. originating in third countries other than Switzerland.
Fruits of *Vitis* L.	Mycelium, acervuli with conidia, perithecia with ascospores	Annex XI A (5) requires Phytosanitary Certificate for grapes (fresh or chilled) originating in third countries other than Switzerland.

Table 4: EU 27 annual imports of fresh produce of main hosts from countries where *Colletotrichum fructicola* is present, 2016–2020 (in 1,000 kg) Source: Eurostat accessed on 11/06/2021

Commodity	HS code	2016	2017	2018	2019	2020
Citrus fruit, fresh or dried	0805	902,859	991,945	1,028,410	997,965	1,155,131
Fresh or dried avocados	080440	127,796	125,683	155,820	168,571	152,635
Fresh apples	080810	124,193	131,959	160,570	115,022	119,398
Fresh pears	080830	97,405	87,818	78,146	68,626	68,712
Fresh strawberries	081010	446	293	57	12	13
Fresh persimmons	081070	328	528	258	1,041	908
Fresh grapes	080610	209,599	248,583	242,833	254,796	236,271
Edible fruit or nut trees, shrubs and bushes	060220	2,209	2,170	939	958	1,427
Vegetable and strawberry plants	06029030	507	478	506	355	183
	Sum	1,465,342	1,589,456	1,667,539	1,607,345	1,734,678

Notifications of EU interceptions of harmful organisms began to be compiled in Europhyt in May 1994 and in TRACES in May 2020. No records of interceptions by EU Members States specific for *C. fructicola* exist in Europhyt (assessed on 1 June 2021). Nevertheless, until May–June 2020, there have been 21 interceptions of unidentified at species level *Colletotrichum.* No records of *C. fructicola* exist in TRACES database since May 2020 (assessed on 1 June 2021).

The California Department of Food and Agriculture (CDFA) reported that, during the period 2015–2016, *C. fructicola* was intercepted several times mainly in shipments of mango (*Mangifera indica*) and black sapote (*Diospyros nigra*) fruits, and *Dracaena* massangeana and Chinese evergreen (*Aglaonema* sp.) cuttings originated in Costa Rica, Puerto Rico and Florida and destined to private citizens or nurseries in the State of California (Chitambar, 2016).

3.4.2. Establishment

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

Yes. *Colletotrichum fructicola* has recently been reported to be present in Italy and France (Section 3.2), which indicates that the biotic (host availability) and abiotic (climate suitability) factors occurring in some parts of the EU territory are favourable for the establishment of the pathogen.

Climatic mapping is the principal method for identifying areas that could provide suitable conditions for the establishment of a pest taking key abiotic factors into account (Baker et al., 2000). Availability of hosts is considered in Section 3.4.2.1. Climatic factors are considered in Section 3.4.2.2.

3.4.2.1. EU distribution of main host plants

As noted above and shown in Appendix A, *C. fructicola* has a wide host range. Some of its main hosts are confined to the warmer southern Europe (e.g. citrus, avocado) whereas others (e.g. apples, pears, strawberries) are more widely distributed. Hosts are grown in commercial production (orchards, greenhouses) and in home gardens. Except for *Camellia sinensis* (tea), which is grown commercially in Europe only in the Azores Islands over a surface of 40 ha (Mazerolle et al., 2018), the harvested area of the main hosts of *C. fructicola* cultivated in the EU 27 in recent years is shown in Table 5. Appendix C provides production statistics for individual Member States.

Table 5: Harvested area of *Colletotrichum fructicola* main hosts in EU 27, 2016–2020 (1,000 ha). Source EUROSTAT (accessed 14/6/2021) https://ec.europa.eu/eurostat/databrowser/view/apro_cpsh1/default/table?lang=en

Crop	2016	2017	2018	2019	2020
Apples	506.48	505.55	507.24	491.35	473.66
Pears	115.76	114.84	114.84	111.84	108.83
Stone fruits	:	625.46	621.32	612.33	:
Citrus	519.01	502.84	508.99	512.53	487.08
Grapes	3,136.04	3,134.93	3,137.17	3,160.68	3,162.48
Avocado	12.24	12.72	13.22	15.52	17.27

':' data not available.

3.4.2.2. Climatic conditions affecting establishment

C. fructicola has been reported from all five continents. Limited data are available on the exact location of the areas of the current global distribution of *C. fructicola.* Nevertheless, based on the few data available, the climatic zones in parts of China, Iran, Brazil and Uruguay, where the pathogen is present, are comparable to climatic zones within the EU (Figure 2).

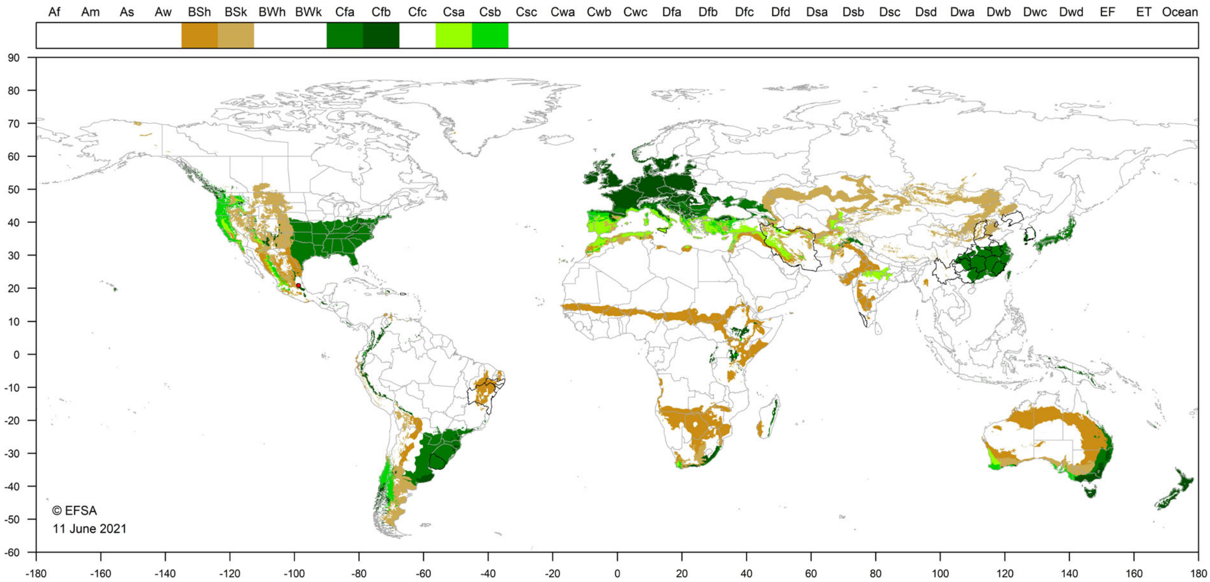

Figure 2: World distribution of Köppen–Geiger climate types that occur in the EU and in non-EU areas (America, Asia, Africa, Europe, Oceania) where *Colletotrichum fructicola* has been reported

The global Köppen–Geiger climate zones (Kottek et al., 2006) describe terrestrial climate in terms of average minimum winter temperatures and summer maxima, amount of precipitation and seasonality (rainfall pattern). *C. fructicola* occurs in several climate zones, such as Cfa, Csa, Csb, Bsh and Bsk. These climate zones also occur in the EU territory, where many hosts of the pathogen are grown. For example, in Italy, the presence of the pathogen has been reported from Csa and Csb (Catania, Sicily) and Cfa (Biella, Region of Piemonte) climatic zones (Guarnaccia et al., 2016).

Based on the above, it may be assumed that the climatic conditions occurring in some parts of the EU territory (mainly in southern EU Member States) are favourable for the establishment of *C. fructicola*. Given the limited data available on the exact locations of the current distribution of *C. fructicola* outside the EU, uncertainty exists on whether the pathogen could potentially establish at higher latitudes in the EU i.e. in areas belonging to other than the above-mentioned climate zones where hosts are also present. Nonetheless, the possibility of establishment of C. fructicola in protected crops (glasshouses) at higher latitudes in the EU, cannot be ruled out, given the conducive environmental conditions that occur in such environments and the extreme polyphagy of the pathogen.

3.4.3. Spread

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

Following establishment, *C. fructicola* could spread within the EU territory by natural and human-assisted means. Trading of host plants for planting is the main means of long-distance spread of the pathogen.

Following its introduction into the EU territory, *C. fructicola*, similarly to other *Colletotrichum* species, could potentially spread via natural and human-assisted means.

Spread by natural means. *Colletotrichum* species can spread locally mainly by water (rain, irrigation) droplets (Madden et al., 1996; Freeman et al., 2002; Mouen Bedimo et al., 2007; Penet et al., 2014). Wind-driven rain and insects may also contribute to the dispersal of *Colletotrichum* spp. spores (Gasparoto et al., 2017). In some pathosystems (e.g. *C. acutatum* and *C. gloeosporioides* affecting citrus), spread of the pathogen may also occur via the wind-disseminated ascospores (Silva-Junior et al., 2014).

Spread by human assistance. The pathogen can spread over long distances via the movement of infected host plants for planting (rootstocks, grafted plants, scions, etc.), including dormant plants, fresh fruits, contaminated agricultural machinery and tools, etc.

Uncertainty exists on the potential of the pathogen to spread via the seeds of its host plants and soil or other substrates, due to lack of evidence.

3.5. Impacts

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

Yes, the introduction of *C. fructicola* is likely to have yield and quality impacts on the EU territory.

The genus *Colletotrichum* includes important plant fungal pathogens affecting more than 30 plant genera by causing anthracnose and pre- and post-harvest fruit rots on several tropical, subtropical and temperate fruit crops, vegetables and ornamentals (Bailey and Jeger, 1992; Lima et al., 2011; Anderson et al., 2013; Guarnaccia et al., 2016; de Silva et al., 2017). *C. fructicola* is among the most aggressive species in the *C. gloeosporioides* complex and affects a wide range of plant species, among which economically important fruit and vegetable crops (e.g. apples, pears, peaches, strawberries) inciting anthracnose symptoms on fruits, flowers, twigs and leaves. Disease symptoms include dark brown stem and fruit spots, fruit rots, spotting and wilting of leaves and premature defoliation which result in yield and quality losses (Jiang et al., 2014; Velho et al., 2015; Zhang et al., 2015; Wang et al., 2016). Nevertheless, there is limited quantitative data available in the literature on the yield and/or quality losses caused by the pathogen in the area of its current distribution. Li et al. (2013) reported 60–90% losses in the fresh market of pear fruit (*P. bretschneideri*) in China as a result of *C. fructicola* infection. In Fujian province (China), the leaf black spot disease caused by *C. fructicola* on sandy pear (*P. pyrifolia*) affects 15–30% of the pear-growing areas causing more than 30 million kg in fruit loss each year (Zhang et al., 2015). In Brazil, commercial persimmon (*Diospyros kaki*) orchards affected by *C. fructicola* may experience 80% of anthracnose incidence resulting in comparable yield losses (Carraro et al., 2019). In Korea, *C. fructicola* was identified as the causal agent of anthracnose on strawberry (*Fragaria* × *ananassa*) with more than 30% of nurseries being affected by the disease (Nam et al., 2013). Gan et al. (2016) reported that anthracnose is the major problem in the Japanese strawberry cultivation industry and demonstrated that *C. fructicola* is the predominant causal agent. According to Chung et al. (2019), during the period 2010–2016, anthracnose disease of strawberry in Taiwan incited mainly by *C. fructicola* and *C. siamense* resulted in 30–40% and 20% loss of seedlings and transplanted plants, respectively.

As noted above, *C. fructicola* has been reported from Italy and France causing avocado stem-end rot and apple bitter rot (pre- and post-harvest), respectively (Guarnaccia et al., 2016; Nodet et al., 2019). Nevertheless, no quantitative data are available on the yield and/or quality losses caused by the pathogen on the respective crops.

Potential environmental consequences of the further introduction of *C. fructicola* into the EU territory may be associated with the additional fungicide treatments required for disease control. In addition, increasing the frequency of fungicide applications may interfere with the current integrated pest management (IPM) programmes that aim to reduce the use of chemical pesticides.

Based on the above, it is expected that further introduction of the pathogen into the EU territory would potentially cause yield and quality losses in parts of the risk assessment area. Nevertheless, it is not known if the agricultural practices and chemical control measures currently applied in the EU could potentially reduce the impact of the pest's introduction.

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

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

Yes. Although not specifically targeted against *C. fructicola*, existing phytosanitary measures (see Sections 3.3.1 and 3.3.2) mitigate the likelihood of the pathogen's entry into the EU territory. Potential additional measures also exist to further mitigate the risk of entry (see Section 3.6.1).

3.6.1. Identification of potential additional measures

Phytosanitary measures (prohibitions) are currently applied to some hosts of *C. fructicola*, although measures in Annex VII of Commission Implementing Regulation 2019/2072 do not specifically refer to this pest (see Section 3.3).

Potential additional control measures are listed in Table 6.

Table 6: Selected control measures (a full list is available in EFSA PLH Panel et al., 2018) for pest entry in relation to currently unregulated hosts and pathways

Special requirements summary (with hyperlink to information sheet if available)	Control measure summary in relation to *Colletotrichum fructicola*
Pest freedom	*Used to mitigate likelihood of infestation by specified pest at origin, hence to mitigate entry* Plant or plant products come from a country officially free from the pest, or from a pest-free area or from a pest-free place of production.
Managed growing conditions	*Used to mitigate likelihood of infestation at origin* Anthracnose diseases are generally most common among the tropical and subtropical countries. Hot and humid environmental conditions support the spread of these pathogens. Hence, the use of pathogen-free propagative material, proper field drainage, avoidance of unclean water for canopy irrigation, plant distancing, destroying infected parts of plants into small pieces for faster decomposition using limes, crop rotation and removal of any infected plant parts in the field represent effective strategies to manage *C. fructicola* at origin.
Growing plants in isolation	*Used to mitigate likelihood of infestation by specified pest in vicinity of growing site* The use of transplants raised from pathogen-free propagative material, as well as growing transplants in weed-free areas and away from other crops that are known host of *C. fructicola* may represent an effective control measure.
Certification of reproductive material (voluntary/official)	Plants should come from within an approved propagation scheme and be certified pest-free following laboratory testing.
Chemical treatments on crops including reproductive material	*Used to mitigate likelihood of infestation of pests susceptible to chemical treatments* Several effective fungicides are available to control *C. fructicola* and other anthracnose-causing species of *Colletotrichum*. Copper compounds, triazoles and strobilurins are effective in field treatment as well as when applied on reproductive material. The possibility of selection of fungicide resistant populations to triazoles and strobilurins has to be considered.
Roguing and pruning	*Used to mitigate likelihood of infestation by specified pest (usually a pathogen) at growing site where pest has limited dispersal* On some susceptible hosts, the infection by *C. fructicola* may occur from conidia or ascospores formed on infected plants or plant residues which can act as sources of inoculum. These propagules are dispersed from the infected organs and plant residues to newly established plant by rain splash, free water or high humidity. To reduce the sources of inoculum, pruning of the infected or damaged by the pathogen plant organs is highly recommended. Weed control may also represent an effective means to reduce inoculum sources and potential survival of the pathogen on alternative hosts.
Soil treatment	Used to mitigate likelihood of infestation of soil at origin Although no specific studies are available on *C. fructicola*, it is likely that the pathogen could potentially survive in infected plant residues in soil, similarly to other *Colletotrichum* species. Therefore, soil and substrate disinfection with chemical or physical (heat, soil solarisation) means represents a suitable option for control.
Inspections	*Used to mitigate likelihood of infestation by specified pest at origin* The symptoms caused by *C. fructicola* are similar to those caused by other *Colletotrichum* species. If signs (acervuli with conidia and/or perithecia with ascospores) are detected on the symptomatic plant tissues using a magnifying

Special requirements summary (with hyperlink to information sheet if available)	Control measure summary in relation to *Colletotrichum fructicola*
	lens, they are also similar to those of other *Colletotrichum* species. Therefore, it is unlikely that the pathogen could be detected based on visual inspection only.
Chemical treatments on consignments or during processing	*Used to mitigate likelihood of infestation of pests susceptible to chemical treatments* Copper compounds, triazoles and strobilurins are effective as postharvest treatments against *C. fructicola*. Calcium chloride is reported to improve the shelf-life and quality of fruits that are known hosts of anthracnose pathogens. The possibility of selection of fungicide resistant populations should not be ruled out.
Physical treatments on consignments or during processing	*Used to mitigate likelihood of infestation of pests susceptible to physical treatments* Irradiation, mechanical cleaning (brushing, washing), sorting and grading, and removal of diseased plant parts could be adopted on consignment or during processing of susceptible host plants or fruit. In the packinghouse, proper sanitation practices (e.g. good drainage systems to channel out wastewater or sewage during on-farm fruit disinfection) should be built and regularly cleaned.
Heat and cold treatments	*Used to mitigate likelihood of infestation of pests susceptible to physical treatments* Hot water treatment at temperatures of 50–60°C for 5–60 min – depending on the host tolerance – may be applied to reduce the likelihood of infestation of *C. fructicola* in susceptible plants or plant organs. The combination of hot water and calcium chloride may increase the efficacy of the treatment. As a warmth-adapted microorganism, cold treatments could also mitigate infection of consignments by *C. fructicola*.
Controlled atmosphere	*Used to mitigate likelihood of infestation of pests susceptible to modified atmosphere (usually applied during transport) hence to mitigate entry* Modified and controlled atmosphere (CA and MA) packages using polymeric films with different permeability for O_2, CO_2, other gases and H_2O can be used to maintain relative humidity, reduce water loss and contamination in various fruit commodities.
Timing of planting and harvesting and timing of export to EU	Used to mitigate likelihood of entry of pests associated with particular phenological stages of host Not relevant for *C. fructicola*.
Cleaning and disinfection of facilities, tools and machinery	*Used to mitigate likelihood of entry or spread of soil-borne pests* Cleaning, disinfection and disinfestation (sanitation) of equipment and facilities (including premises, storage areas) are good cultural and handling practices employed in the production and marketing of any commodity and may contribute to mitigate likelihood of entry or spread of *C. fructicola*.
Conditions of transport	*Used to mitigate likelihood of entry of pests that could otherwise infest material post-production* When potentially infected/contaminated material has to be transported (including proper disposal of infested waste material), specific transport conditions (kind of packaging/protection, time of transport, transport mean) should be defined to prevent the pest from escaping (see Annex C Information sheet 1.15). These may include, albeit not exclusively: cold treatment and controlled atmosphere; physical protection; removal of leaves and peduncles from fruit commodities; sealed packaging.
Limits on soil	Used to mitigate likelihood of entry or spread via pests in soil No additional measures
Phytosanitary certificate and plant passport	*Used to attest which of the above requirements have been applied* Recommended for plant species known as hosts of *C. fructicola.*

Special requirements summary (with hyperlink to information sheet if available)	**Control measure summary in relation to *Colletotrichum fructicola***
Post-entry quarantine (PEQ) and other restrictions of movement in the importing country	*Plants in PEQ are held in conditions that prevent the escape of pests; they can be carefully inspected and tested to verify they are of sufficient plant health status to be released, or may be treated, re-exported or destroyed. Tests on plants are likely to include laboratory diagnostic assays and bioassays on indicator hosts to check whether the plant material is infected with particular pathogens* Recommended for plant species known as hosts of *C. fructicola*.

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

- Latently infected plants and plant products are unlikely to be detected by visual inspection.
- The similarity of symptoms and signs caused by *C. fructicola* with those of other *Colletotrichum* species makes impossible the detection of the pathogen based on symptomatology and morphology.
- The lack of rapid diagnostic methods based on serological or molecular approaches does not allow proper identification of the pathogen at entry. Thorough post-entry laboratory analyses may not be feasible for certain commodities as isolation in pure culture is needed prior to proceed with DNA extraction and molecular identification based on multigene sequencing.
- The polyphagy of the pathogen limits the possibility to set standard diagnostic protocols for all potential hosts.
- The genome plasticity and the possibility of sexual recombination in *C. fructicola* may favour the selection of fungicide-resistant populations, thereby limiting the efficacy of chemical control approaches.

3.7. Uncertainty

- Host range of the pathogen, particularly after the recent developments in the taxonomy of *Colletotrichum* species and the availability of molecular tools for the identification of *C. fructicola* and its discrimination from other close-related *Colletotrichum* species.
- Global distribution of the pathogen, including its distribution within the EU territory, particularly with respect to records where multilocus gene sequencing analysis was not used for the identification of the isolated *Colletotrichum* species.
- Seeds of host plants as potential pathway of entry into and means of spread within EU territory of *C. fructicola*, due to lack of evidence.
- *C. fructicola* could potentially be transferred from fruits to host plants grown in the EU territory. However, the frequency of this transfer was not assessed.
- Soil and other substrates associated or not with host plants for planting as a pathway of entry into and means of spread within the EU territory of *C. fructicola*.
- Uncertainty on the potential areas of establishment of the pathogen in the EU. *Colletotrichum fructicola* has been reported from several climate zones worldwide, such as Cfa, Csa, Csb, Bsh and Bsk. These climate zones are also present in the EU territory, especially in the southern Member States. Nevertheless, so far, there are no reports of the pathogen being established at higher latitudes in the EU, where hosts are also present.
- Whether the agricultural practices and chemical control measures currently applied in the EU could reduce the impact of pest introduction.

Nevertheless, because the pathogen is established in different locations in the EU, none of the above-mentioned uncertainties affects the conclusions of this pest categorisation.

4. Conclusions

Colletotrichum fructicola has been reported from a few locations in Italy and France. However, there is a high uncertainty on its actual distribution in the EU territory and worldwide because of the ongoing re-evaluation of the taxonomy of the genus *Colletotrichum* and the lack of systematic surveys. Therefore, the Panel cannot conclude with certainty on whether *C. fructicola* satisfies the criterium of being present but not widely distributed in the EU territory to be regarded as a potential Union quarantine pest unless systematic surveys are conducted and *Colletotrichum* isolates in culture collections are re-evaluated using multilocus gene sequencing analysis.

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)	Yes, the identity of the pathogen is well established; the pathogen has been shown to produce consistent symptoms and to be transmissible.	None
Absence/ presence of the pest in the EU (Section 3.2)	Yes, *C. fructicola* is reported to be present in the EU, namely in the following EU Member States: France, Germany and Italy.	Uncertainty exists with respect to the current distribution of *C. fructicola* in the EU, as in the past, when molecular tools were not available, the pathogen might have been identified as *C. gloeosporioides* based on morphology and pathogenicity tests, which cannot reliably identify the *Colletotrichum* species.
Regulatory status (Section 3.3)	*C. fructicola* is currently not regulated in the EU.	None
Pest potential for entry, establishment and spread in the EU (Section 3.4)	Yes, the pathogen is able to enter into, become established in, and spread within, the EU territory. The main pathways for the entry of the pathogen into, and spread within, the EU territory are: (i) host plants for planting, and (ii) fresh fruit of host plants originating in infested third countries. Spores of the pathogen may be also present as contaminants on other substrates (e.g. non-host plants, and other objects, etc.) imported into the EU, albeit this is considered a minor pathway for the entry of *C. fructicola* into the EU territory. Following establishment, *C. fructicola* could spread within the EU territory by natural and human-assisted means. Trading of host plants for planting is the main means of long-distance spread of the pathogen.	There is uncertainty about (i) the host range of the pathogen, particularly following the recent developments in the taxonomy of *Colletotrichum* species, (ii) seeds of host plants, and soil and other substrates associated or not with host plants for planting as potential pathways of entry into and spread within the EU territory of *C. fructicola,* (iii) the frequency of transfer of the pest from fruits to host plants grown in the EU territory and (IV) the ability of the pathogen to establish in EU areas belonging to other than Cfa, Csa, Csb, Bsh or Bsk climate zones where hosts are also present.
Potential for consequences in the EU (Section 3.5)	Yes, the introduction of *C. fructicola* is likely to have yield and quality impacts as well as environmental consequences in some parts of the EU territory.	Uncertainty exists on whether the agricultural practices and chemical control measures currently applied in the EU could reduce the impact of pest introduction.
Available measures (Section 3.6)	Yes. Although not specifically targeted against *C. fructicola*, existing phytosanitary measures mitigate the likelihood of the pathogen's entry into the EU territory. Potential additional measures also exist to further mitigate the risk of entry into, establishment within, or spread of the pathogen within the EU.	None
Conclusion (Section 4)	*C. fructicola* does not meet all criteria assessed by EFSA above for consideration as a Union quarantine pest since it is already present in the EU territory, albeit not widely distributed. *Colletotrichum fructicola* has recently been reported from a few locations in Italy and France.	High uncertainty exists about the actual distribution of *C. fructicola* in the EU territory.

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Key uncertainties
	Nevertheless, the actual distribution of the pathogen in the EU and worldwide is likely to be wider than that currently reported because of the ongoing re-evaluation of *Colletotrichum* taxonomy and the lack of systematic surveys. Therefore, it cannot be concluded with certainty on whether *C. fructicola* satisfies the criterium of being present but not widely distributed in the EU territory to be regarded as a potential Union quarantine pest	
Aspects of assessment to focus on/ scenarios to address in future if appropriate:	The main knowledge gap concerns the lack of species-specific molecular diagnostic tool to readily identify *C. fructicola* in the past Given that all the data available in the literature have been explored, the Panel considers that systematic surveys should be carried out and *Colletotrichum* isolates in culture collections should be re-evaluated using appropriate pest identification methods (e.g. multilocus gene sequencing analysis) to define the current geographical distribution of *C. fructicola* in the EU territory	

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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.
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 – Colletotrichum fructicola host plants

Source: EPPO Global Database (EPPO online)

Host status	Host name	Plant family	Common name	Reference[A]
Cultivated hosts				
	Aglaonema sp.	Araceae	Chinese evergreen	CDFA (2009)
	Aesculus chinensis	Sapindaceae	Chinese horse chestnut	Sun et al. (2020)
	Amomum villosum	Zingiberaceae	Chinese spice	Song et al. (2019)
	Anacardium humile	Anacardiaceae	Monkey nut, dwarf cashew	Veloso et al. (2018)
	Anacardium occidentale	Anacardiaceae	Cashew	Veloso et al. (2018)
	Anacardium othonianum	Anacardiaceae	'Cerrado' cashew	Veloso et al. (2018)
	Annona spp.	Annonaceae	Cherimoya	Costa et al. (2017)
	Annona muricata	Annonaceae	Soursop, guanabana	Costa et al. (2019)
	Annona reticulata	Annonaceae	Custard apple	CDFA (2009)
	Annona squamosa	Annonaceae	Sugar apple	CDFA (2009)
	Anthurium andraeanum	Araceae	Anthurium, flamingo lily	Adikaram and Yakandawala (2020)
	Arachis hypogaea	Fabaceae	Peanut, groundnut	Rajeendran et al. (2017)
	Areca catechu	Arecaceae	Areca palm, betel palm	Cao et al. (2020)
	Artocarpus heterophyllus	Moraceae	Jackfruit	CDFA (2009)
	Aucuba japonica	Garryaceae	Aucuba	Li et al. (2016a,b)
	Camellia oleifera	Theaceae	Tea oil camellia	Li et al. (2016a,b)
	Camellia sinensis	Theaceae	Tea	Weir et al. (2012), Fuentes-Aragón et al. (2018), CDFA (2009)
	Capsicum annuum	Solanaceae	Pepper	Shoji et al. (2014)
	Capsicum frutescens	Solanaceae	Chilli pepper	CDFA (2009)
	Carica papaya	Caricaceae	Papaya	Saini et al. (2016)
	Cattleya sp.	Orchidaceae	Orchid	Silva-Cabral et al. (2019)
	Ceanothus thyrsiflorus	Rhamnaceae	Blue blossom ceanothus	Guarnaccia et al. (2021)
	Citrullus vulgaris	Cucurbitaceae	Watermelon	CDFA (2009)
	Citrus bergamia	Rutaceae	Bergamot orange	Peng et al. (2012)
	Citrus reticulata	Rutaceae	Mandarin orange	Huang et al. (2013)
	Citrus sinensis	Rutaceae	Sweet orange	Arzanlou et al. (2015)
	Citrus x paradisi	Rutaceae	Grapefruit	CDFA (2009)
	Coffea arabica	Rubiaceae	Coffee	Prihastuti et al. (2009)
	Corchorus capsularis	Malvaceae	White jute	Niu et al. (2016)
	Crinum asiaticum	Amaryllidaceae	Poison bulb (giant crinum lily (spider lily	Qing et al. (2020)
	Cucumis melo	Cucurbitaceae	Melon	CABI (2019)
	Cyclamen persicum	Primulaceae	Cyclamen	Guarnaccia et al. (2021)
	Cymbidium sp.	Orchidaceae	Orchid	CDFA (2009)

Host status	Host name	Plant family	Common name	Reference[A]
	Cymbopogon citratus	Poaceae	Lemon grass	Hyde et al. (2018)
	Dendrobium officinale	Orchidaceae	Orchid	Silva-Cabral et al. (2019), Ma et al. (2020a)
	Dimocarpus longan	Sapindaceae	Longan	Phoulivong et al. (2010)
	Dioscorea sp.	Dioscoreaceae	Yam	Weir et al. (2012), Fuentes-Aragón et al. (2018), CDFA (2009
	Diospyros kaki	Ebenaceae	Persimmon	Carraro et al. (2019)
	Diospyros nigra	Ebenaceae	Black sapote	CDFA (2009)
	Dracaena massangeana	Agavaceae	Cornstalk Dracaena	CDFA (2009)
	Epidendrum sp.	Orchidaceae	Orchid	CDFA (2009)
	Fatsia japonica	Araliaceae	Japanese aralia	Shi et al. (2017)
	Ficus carica	Moraceae	Common fig	CDFA (2009), Weir et al. (2012), Fuentes-Aragón et al. (2018)
	Ficus edulis	Moraceae	Fig	CDFA (2009), Weir et al. (2012), Fuentes-Aragón et al. (2018)
	Ficus habrophylla	Moraceae	Giant leaf fig	Farr and Rossman (2021)
	Ficus pumila	Moraceae	Creeping fig	EPPO GD
	Fortunella margarita	Rutaceae	Kumquat	Huang et al. (2013)
	Fragaria × *ananassa*	Rosaceae	Strawberry	CDFA (2009), Weir et al. (2012), Fuentes-Aragón et al. (2018)
	Gleditsia caspica	Fabaceae	Caspian locust	EPPO GD
	Hevea brasiliensis	Euphorbiaceae	Rubber tree	Liu et al. (2018)
	Hydrangea paniculata	Hydrangeaceae	Panicle hydrangea	Guarnaccia et al. (2021)
	Hylocerus undatus	Cactaceae	Dragon fruit, red pitaya	CABI (2019)
	Juglans regia	Juglandaceae	Common walnut	Wang et al. (2018)
	Licania tomentosa	Chrysobalanaceae	Oitizeiro	Lisboa et al. (2018)
	Limonium sinuatum	Plumbaginaceae	Wavyleaf sea lavender	CDFA (2009) Weir et al. (2012), Fuentes-Aragón et al. (2018)
	Liquidambar styraciflua	Altingiaceae	Sweet gum	Guarnaccia et al. (2021)
	Lobularia maritima	Brassicaceae	Alyssum	CDFA (2009)
	Lupinus angustifolius	Fabaceae	Blue lupine	CDFA (2009)
	Lycium chinense	Solanaceae	Goji berry	Paul et al. (2014)
	Lycopersicon esculentum	Solanaceae	Tomato	CDFA (2009)
	Malus domestica	Rosaceae	Apple	Huang et al. (2013)
	Malus pumila	Rosaceae	Paradise apple	Park et al. (2018) Nodet et al. (2019)
	Malus sylvestris	Rosaceae	Crab apple	CDFA (2009)
	Mangifera indica	Anacardiaceae	Mango	CABI (2019)
	Manihot esculenta	Euphorbiaceae	Cassava manioc	Bragança et al. (2016)
	Medicago polymorpha	Fabaceae	Burclover	CDFA (2009)
	Morus alba	Moraceae	White mulberry	Xue et al. (2019)

Host status	Host name	Plant family	Common name	Reference[A]
	Musa acuminata	Musaceae	Edible banana	CDFA (2009)
	Nephelium lappaceum	Sapindaceae	Ranbutan	Serrato-Diaz et al. (2017)
	Nerium oleander	Apocynaceae	Oleander	CDFA (2009)
	Nicotiana tabacum	Solanaceae	Tobacco	Wang et al. (2016)
	Nopalea cochenillifera	Cactaceae	Cochineal Nopal cactus	Conforto et al. (2017)
	Paris polyphylla	Melanthiaceae	Herb Paris	Zhou et al. (2020)
	Passiflora edulis	Passifloraceae	Passion fruit	CDFA (2009
	Persea americana	Lauraceae	Avocado	CDFA (2009), Weir et al. (2012), Fuentes-Aragón et al. (2018)
	Peucedanum praeruptorum	Apiaceae	Qian Hu	Ma et al. (2020b)
	Phalaenopsis sp.	Orchidaceae	Moth orchid	CDFA (2009)
	Phaseolus lunatus	Fabaceae	Lima bean	Sousa et al. (2018)
	Prunus persica	Rosaceae	Peach	Lee et al. (2020)
	Psydium guajava	Myrtaceae	Guava	CDFA (2009)
	Pyrus x *bretschneideri*	Rosaceae	Chinese white pear	Jiang et al. (2014)
	Pyrus pyrifolia	Rosaceae	Chinese pear, nashi	Zhang et al. (2015)
	Genipa americana	Rubiaceae	Genip tree	Rojas et al. (2010)
	Saccolabium sp.	Orchidaceae	Orchid	CDFA (2009)
	Salvia greggii	Lamiaceae	Autumn sage	Guarnaccia et al. (2019)
	Syzygium cumini	Myrtaceae	Malabar plum, Java plum	Hanin and Fitriasari (2019)
	Theobroma cacao	Malvaceae	Cacao	EPPO GD
	Vanda sp.	Orchidaceae	Orchid	CDFA (2009)
	Vitis labrusca	Vitaceae	Fox grape	Santos et al. (2018)
	Vitis vinifera	Vitaceae	Grapevine	Peng et al. (2013), Echeverrigaray et al. (2020)
Wild weed hosts				
	Amaranthus blitum	Amaracthaceae	Guernsey pigweed	Hirayama et al. (2018)
	Capsella bursa-pastoris	Brassicaceae	Shepherd's pursue	Hirayama et al. (2018)
	Cerastium glomeratum	Caryophyllaceae	Clammy chickweed	Hirayama et al. (2018)
	Cestrum parqui	Solanaceae	Green cestrum	CDFA (2009)
	Cyperus microiria	Cyperaceae	Asian flat sedge	Hirayama et al. (2018)
	Digitaria ciliaris	Poaceae	Southern crabgrass	Hirayama et al. (2018)
	Eichhornia crassipes	Pontederiaceae	Water hyacinth	Huang et al. (2021)
	Erigeron annuus	Asteraceae	Annual fleabane	Hirayama et al. (2018)
	Galinsoga ciliata	Asteraceae	Hairy galinsoga, quickweed	Hirayama et al. (2018)
	Matthiola incana	Brassicaceae	Common stock	CDFA (2009)
	Phormium tenax	Asphodelaceae	New Zealand flax	CDFA (2009)
	Platostoma palustre	Lamiaceae	Chinese mesona	Hsieh et al. (2020)
	Portulaca oleracea	Portulacaceae	Common purslane	CDFA (2009)
	Rubus glaucus	Rosaceae	Andean raspberry	Jayawardena et al. (2016)
	Sambucus ebulus	Adoxaceae	Dwarf elder	EPPO GD
	Solidago altissima	Asteraceae	Canada goldenrod	Hirayama et al. (2018)
	Sonchus oleraceus	Asteraceae	Common sowthistle	Hirayama et al. (2018)

Appendix B – Distribution of Colletotrichum fructicola

Distribution records based on EPPO Global Database (EPPO, online) and other literature.

Region	Country	Sub-national (e.g. State)	Status
North America	Canada	Ontario	Present, no details
	Mexico	Oaxaca Molango de Escamilla	Present, no details
	USA	Florida, North Carolina, Georgia	Present, no details
Central America	Panama	Barro Colorado Monument	Present, no details
Caribbean	Puerto Rico	N/A	Present, no details
South America	Uruguay	San José	Present, no details
	Brazil	Rio Grande do Sul, Santa Catarina, Alagoas state (Maragogi, Estrela de Alagoas), State of Pernambuco, Bahia, São Paulo, Paraná	Present, no details
EU (27)	Italy	Catania, Sicily Biella, Piedmont	Present, no details
	France	Occitanie	Present, no details
	Germany	Berlin-Dahlem Botanical Garden	Present, no details
Other Europe			No records, presumed absent
Africa	Nigeria	Ibadan, Ilesha	Present, no details
	South Africa		Present, no details
Asia	China	Fujiian, Zhejiang, Jiangxi, Hunan, Anhui, Hubei, Jiangsu, Chonqing, Guangxi, Henan, Liaoning, Shanxi, Tianjin, Yunnan	Present, no details
	Iran	Mazandaran, Behshahr, Guilan, Talesh, Jomakooh, Kishonben, Astara	Present, no details
	Japan	Kyushu island, Chiba prefecture	Present, no details
	South Korea	Andong, Sangju, Gimcheon, Yechon,	Present, no details

Region	Country	Sub-national (e.g. State)	Status
		Yeongcheon, Cheongdo	
	India	Southern India	Present, no details
	Taiwan		Present, no details
	Thailand	Chiang Mai	Present, no details
	Israel Indonesia	Java, Bandung, Pangheotan	Present, no details Present, no details
Oceania	Australia	Queensland, New South Wales, Tamworth	Present, no details
	New Zealand	Mid-North New Zealand, Tauranga, Auckland, Sandringham, Northland	Present, no details

Appendix C – EU 27 annual imports of fresh produce of hosts from countries where *Colletotrichum fructicola* is present, 2016–2020 (in 100 kg)

Source: Eurostat accessed on 11/6/2021

		2016	2017	2018	2019	2020
Citrus fruit, fresh or dried	Australia	3,279.84	1,284.38	644.97	10645.40	2,733.47
	Brazil	864,863.09	903,432.95	900,907.24	822134.46	902,354.08
	Canada	0.00	2.35			
	China	827,840.57	1,084,857.27	1,024,163.15	1108595.22	1,098,689.87
	Indonesia	566.73	555.70	779.35	836.73	864.54
	Israel	799,118.49	969,403.62	824,601.66	812738.57	878,865.26
	India	246.80	1.00	449.63	88.51	254.95
	Iran	1,533.22	1218.52	1,208.01	2174.22	1,882.74
	Japan	352.58	417.44	270.73	319.24	162.50
	Mexico	570,402.80	553,818.66	58,9021.12	443743.54	349,626.22
	New Zealand	0.04	13.49	204.97	355.44	0.08
	Nigeria		0.00	0.03	0.10	200.00
	Panama		0.00			650.40
	South Africa	5,278,830.95	5,802,017.61	6,381,124.73	6196837.96	7,831,349.65
	South Korea	12.70	0.01		21.09	15.00
	Taiwan	157.49	0.00			0.01
	Thailand	426.42	1,283.13	659.74	624.93	194.87
	Uruguay	379,726.08	369,933.66	374,356.50	402778.68	334,616.70
	United States	301,229.06	231,210.47	185,706.99	177755.45	148,845.72
	Sum	9,028,586.86	9,919,450.26	10,284,098.82	9,979,649.54	11,551,306.06

		2016	2017	2018	2019	2020
Fresh or dried avocados	Australia		0.00		0.06	
	Brazil	44,357.36	71,040.50	68,697.61	78,673.73	48,183.82
	Canada		0.00			
	China	193.97	35.28		1.23	0.04
	Indonesia		0.00			
	Israel	301,123.91	424,267.97	370,378.23	437,318.01	345,663.40
	India	0.04	2.06	0.52	0.06	
	Iran		0.00			
	Japan		0.00			
	Mexico	503,687.52	445,611.06	463,741.28	767,878.48	716,200.13
	New Zealand	0.85	0.61			0.03
	Nigeria	1.06	3.15	3.18	0.51	
	Panama		0.00		474.24	
	South Africa	419,768.89	315,854.56	652,817.98	401,352.79	416,290.11
	South Korea		0.00			
	Taiwan		0.00			
	Thailand	3.68	9.76	9.66	9.06	3.39
	Uruguay		0.00			
	United States	8,819.53	1.19	2,546.86	0.02	4.66
	Sum	1,277,956.81	1,256,826.14	1,558,195.32	1,685,708.19	1,526,345.58

		2016	2017	2018	2019	2020
Fresh apples	Australia	1,048.66	4,926.09	9,159.46	8,311.03	3,638.72
	Brazil	154,768.58	249,520.21	242,632.64	139,015.43	92,900.91
	Canada	23.38	0.16			
	China	13,188.53	1,644.89	15,539.34	780.15	4,778.37
	Indonesia		0.00			
	Israel	2,225.55	1,037.58	936.63	1,813.20	755.03
	India	0.01	0.00			0.45
	Iran		0.00	2,945.28	0.38	676.65
	Japan	7.61	0.53	0.95		19.25
	Mexico		0.00			
	New Zealand	751,627.60	754,736.56	966,920.91	728,052.41	759,371.49
	Nigeria		0.76			
	Panama		0.00			436.80
	South Africa	298,162.64	252,068.96	334,615.90	258,077.03	329,087.60
	South Korea		0.00		4.17	
	Taiwan		0.00		2.97	
	Thailand		3.79			
	Uruguay	20,879.17	55,103.38	30,072.47	14,164.50	2,310.32
	United States	0.05	545.82	2,874.22		
	Sum	1,241,931.78	1,319,588.73	1,605,697.80	1,150,221.27	1,193,975.59

		2016	2017	2018	2019	2020
Fresh pears	Australia		0.00	1,224.72		
	Brazil	208.68	0.00	251.27	926.88	
	Canada		0.00			
	China	102,076.61	98,191.53	116,993.12	82,741.84	99,293.92
	Indonesia		0.00			
	Israel		664.59		569.20	219.49
	India		0.00			
	Iran		0.00	32.40		7.50
	Japan	2.50	0.02	0.45		
	Mexico		0.00			
	New Zealand	2,460.49	1,847.30	2,519.51	754.67	1,377.03
	Nigeria		0.00	1.00		0.36
	Panama	41.60	0.00			
	South Africa	865,862.63	759,193.32	655,428.91	590,939.08	583,340.54
	South Korea	789.33	1,036.40	666.02	819.04	628.26
	Taiwan		0.00			
	Thailand		0.00			
	Uruguay	2,392.20	16,789.90	3,873.25	9,494.10	2,250.90
	United States	214.47	454.76	471.49	12.54	
	Sum	974,048.51	878,177.82	781,462.14	686,257.35	687,118.00

		2016	2017	2018	2019	2020
Fresh strawberries	Australia		0.00			
	Brazil		0.00			
	Canada		0.00			
	China	1,500.00	1,250.00			

		2016	2017	2018	2019	2020
	Indonesia		0.00			
	Israel	4.28	5.10			
	India		0.00			
	Iran		0.00			
	Japan	0.97	1.38	0.36	0.33	0.09
	Mexico	49.87	34.38	41.34	80.00	6.66
	New Zealand		0.00			
	Nigeria		0.00			
	Panama		0.00			
	South Africa	20.46	64.44	176.31	25.35	124.80
	South Korea	0.12	0.00			
	Taiwan		0.00			
	Thailand		0.00			
	Uruguay		0.00			
	United States	2,881.84	1,572.86	354.26	10.12	3.11
	Sum	4,457.54	2,928.16	572.27	115.80	134.66
Fresh persimmons	Australia					
	Brazil	33.63	315.72	337.60	974.78	428.63
	Canada					
	China	17.57		5.09		17.40
	Indonesia					
	Israel	2,404.45	3,231.29	1,158.64	181.58	3,211.13
	India					
	Iran					
	Japan		0.27	0.76	0.27	0.02
	Mexico					
	New Zealand					
	Nigeria					
	Panama					
	South Africa	823.16	817.79	206.08	7,857.42	4,974.49
	South Korea			0.05	0.80	
	Taiwan					
	Thailand			0.07		
	Uruguay		913.19	872.76	1,392.90	448.50
	United States					
	Sum	3,278.81	5,278.26	2,581.05	10,407.75	9,080.17
Fresh grapes	Australia	2.95	0.50			
	Brazil	194,152.79	249,279.81	271,987.56	196,465.22	228,092.92
	Canada		164.64		164.64	
	China	0.00	6.00	0.03		
	Indonesia		0.00			
	Israel	13,169.16	7,165.09	6,397.33	318.24	1,080.90
	India	640,933.67	827,467.67	722,802.04	950,910.96	733,881.71
	Iran		0.00	2,158.50	366.00	399.80
	Japan	4.84	1.19	1.17	1.15	20.67
	Mexico		358.96		186.71	184.62
	New Zealand		0.00			
	Nigeria		0.00			
	Panama	0.00	0.00			

		2016	2017	2018	2019	2020
	South Africa	1,246,017.02	1,392,515.89	1,420,569.43	1,397,681.57	1,397,982.74
	South Korea		2.88	4.32	0.09	
	Taiwan		0.00			
	Thailand	0.37	0.14	0.16		0.87
	Uruguay		0.00			
	United States	1,714.93	8,868.74	4,413.37	1,866.20	1,072.48
	Sum	2,095,995.73	2,485,831.51	2,428,333.91	2,547,960.78	2,362,716.71
Edible fruit or nut trees, shrubs and bushes	Australia	165.50	6.50	0.44		2.99
	Brazil		0.00			0.78
	Canada		470.24	8.41	0.01	
	China	152.70	552.35	404.63	642.61	305.32
	Indonesia		0.00		0.01	1.34
	Israel	634.17	1,755.41	1,350.76	1,758.56	55.42
	India		4.00		0.22	
	Iran		0.00		8.17	
	Japan	66.57	133.75	0.95	41.26	0.55
	Mexico		2.44	0.42	5.52	0.63
	New Zealand	114.37	12.75	17.57	25.21	
	Nigeria		0.19			
	Panama		0.00			
	South Africa	0.35	0.13	112.01	30.48	456.51
	South Korea		0.00		163.76	
	Taiwan		0.10			
	Thailand		148.80		0.22	0.36
	Uruguay		0.00			
	United States	20,957.83	18,612.69	7,497.05	6,904.85	13,445.54
	Sum	22,091.49	21,699.35	9,392.24	9,580.88	14,269.44
Vegetable and strawberry plants	Australia			4.05		
	Brazil	0.16	1.01	393.78		0.85
	Canada		0.10		0.19	
	China	0.02		180.00	0.92	2.28
	Indonesia					
	Israel	213.07	9.27	34.04	17.44	17.61
	India	0.03	2.40	0.03	2.05	2.08
	Iran					7.15
	Japan				1.03	0.28
	Mexico	0.20				1.23
	New Zealand	0.16	0.01		1.35	0.31
	Nigeria					
	Panama					
	South Africa	5.89	58.73	2.00	17.88	5.94
	South Korea					
	Taiwan				0.30	
	Thailand			0.08		
	Uruguay					
	United States	4,848.40	4,711.58	4,447.01	3,506.85	1,794.38
	Sum	5,067.93	4,783.10	5,060.99	3,548.01	1,832.11

Appendix D – EU 27 and member state cultivation/harvested/production area of Colletotrichum fructicola hosts (in 1,000 ha)

Source EUROSTAT (accessed 14/6/2021)

Apples	2016	2017	2018	2019	2020
EU 27	506.48	505.55	507.24	491.35	473.66
Belgium	6.49	6.16	5.99	5.79	5.48
Bulgaria	4.11	3.97	3.98	4.14	3.56
Czechia	7.49	7.35	7.25	7.32	7.19
Denmark	1.35	1.28	1.42	1.39	1.38
Germany	31.74	33.98	33.98	33.98	33.98
Estonia	0.51	0.48	0.60	0.57	0.62
Ireland	0.70	0.70	0.71	0.71	0.71
Greece	10.04	9.60	10.35	9.82	9.82
Spain	30.87	30.55	29.93	29.64	29.49
France	49.65	50.31	50.54	50.37	50.15
Croatia	5.89	4.84	4.73	4.95	4.37
Italy	56.16	57.26	57.44	55.00	36.14
Cyprus	0.53	0.37	0.37	0.37	0.38
Latvia	2.40	3.30	3.20	3.44	3.50
Lithuania	9.70	9.82	10.13	10.18	10.74
Luxembourg	0.26	0.27	0.27	0.27	0.27
Hungary	32.49	32.17	31.84	30.97	25.90
Malta	0.00	0.00	0.00	0.00	0.00
Netherlands	7.30	7.00	6.60	6.42	6.20
Austria	6.67	6.67	6.74	6.59	6.43
Poland	164.76	162.53	166.15	155.62	163.25
Portugal	14.98	14.79	14.58	14.58	14.58
Romania	55.53	55.60	53.94	52.74	53.40
Slovenia	2.42	2.36	2.33	2.27	2.18
Slovakia	2.31	2.18	2.14	2.06	1.80
Finland	0.62	0.63	0.63	0.65	0.67
Sweden	1.54	1.40	1.41	1.52	1.49

Pears	2016	2017	2018	2019	2020
EU 27	115.76	114.84	114.84	111.84	108.93
Belgium	9.69	10.02	10.15	10.37	10.66
Bulgaria	0.41	0.45	0.57	0.7	0.6
Czechia	0.74	0.71	0.75	0.8	0.83
Denmark	0.3	0.3	0.29	0.3	0.3
Germany	1.93	2.14	2.14	2.14	2.14
Estonia	0	0	0	0	0
Ireland	0	0	0	0	0
Greece	4.08	4.07	4.41	4.34	4.34
Spain	22.55	21.89	21.33	20.62	20.22
France	5.3	5.25	5.24	5.25	5.61
Croatia	0.93	0.71	0.8	0.86	0.72
Italy	32.29	31.73	31.34	28.71	25.75
Cyprus	0.07	0.07	0.06	0.06	0.06
Latvia	0.2	0.2	0.2	0.2	0.2

Pears	2016	2017	2018	2019	2020
Lithuania	0.8	0.82	0.82	0.82	0.85
Luxembourg	0.02	0.02	0.02	0.02	0.02
Hungary	2.87	2.9	2.84	2.81	2.6
Malta	0	0	0	0	0
Netherlands	9.4	9.7	10	10.09	10
Austria	0.46	0.46	0.49	0.5	0.54
Poland	7.49	7.26	7.3	7.22	7.39
Portugal	12.62	12.56	12.5	12.5	12.5
Romania	3.15	3.12	3.1	3.08	3.1
Slovenia	0.2	0.2	0.21	0.21	0.23
Slovakia	0.11	0.11	0.12	0.11	0.1
Finland	0.04	0.04	0.05	0.04	0.05
Sweden	0.12	0.12	0.11	0.1	0.13

Stone fruits	2016	2017	2018	2019	2020
EU 27	:	625.46	621.32	612.33	:
Belgium	1.35	1.43	1.17	1.18	1.16
Bulgaria	22.68	23.67	24.66	26.30	23.96
Czechia	5.61	5.34	5.42	5.53	5.55
Denmark	0.85	0.72	0.62	0.61	0.70
Germany	11.49	13.13	13.10	13.11	13.07
Estonia	0.00	0.00	0.00	0.00	:
Ireland	0.00	0.00	0.00	0.00	0.00
Greece	67.54	67.45	69.92	68.90	68.97
Spain	148.12	148.32	143.52	140.84	134.61
France	46.69	46.74	46.66	44.18	44.14
Croatia	9.54	9.13	8.36	8.46	8.19
Italy	129.90	125.34	122.99	119.50	117.84
Cyprus	1.29	1.13	1.09	1.13	1.12
Latvia	0.20	0.60	0.80	0.18	0.20
Lithuania	1.47	1.47	1.49	1.52	1.54
Luxembourg	0.04	0.04	0.04	0.04	0.04
Hungary	34.09	34.38	34.24	34.13	33.38
Malta	0.00	0.00	0.00	0.00	0.00
Netherlands	1.10	1.10	1.10	1.06	1.10
Austria	1.38	1.38	1.51	1.50	1.52
Poland	53.42	52.84	53.48	54.13	53.07
Portugal	12.75	12.76	12.46	12.46	12.46
Romania	75.24	76.58	76.64	75.49	77.09
Slovenia	0.59	0.59	0.59	0.60	0.60
Slovakia	:	1.26	1.40	1.43	1.26
Finland	0.00	0.00	0.00	0.00	0.00
Sweden	0.07	0.07	0.06	0.06	0.05

':' data not available.

Citrus fruits	2016	2017	2018	2019	2020
EU 27	519.01	502.84	508.99	512.53	487.08
Belgium	0.00	0.00	0.00	0.00	0.00

Citrus fruits	2016	2017	2018	2019	2020
Bulgaria	0.00	0.00	0.00	0.00	0.00
Czechia	0.00	0.00	0.00	0.00	0.00
Denmark	0.00	0.00	0.00	0.00	0.00
Germany	0.00	0.00	0.00	0.00	0.00
Estonia	0.00	0.00	0.00	0.00	0.00
Ireland	0.00	0.00	0.00	0.00	0.00
Greece	45.86	43.47	46.26	44.23	44.48
Spain	295.33	294.26	297.62	296.48	297.97
France	4.22	4.27	4.39	4.61	4.69
Croatia	2.19	2.06	1.97	2.20	2.04
Italy	147.65	135.36	134.64	140.74	113.80
Cyprus	3.41	2.92	3.05	3.20	3.04
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	0.00	0.00	0.00	0.00	0.00
Malta	0.00	0.00	0.00	0.00	0.00
Netherlands	0.00	0.00	0.00	0.00	0.00
Austria	0.00	0.00	0.00	0.00	0.00
Poland	0.00	0.00	0.00	0.00	0.00
Portugal	20.36	20.51	21.07	21.07	21.07
Romania	0.00	0.00	0.00	0.00	0.00
Slovenia	0.00	0.00	0.00	0.00	0.00
Slovakia	0.00	0.00	0.00	0.00	0.00
Finland	0.00	0.00	0.00	0.00	0.00
Sweden	0.00	0.00	0.00	0.00	0.00

Grapes	2016	2017	2018	2019	2020
EU 27	3,136.04	3,134.93	3,137.17	3,160.68	3,162.48
Belgium	0.24	0.24	0.30	0.38	0.49
Bulgaria	36.55	34.11	34.11	30.05	28.81
Czechia	15.80	15.81	15.94	16.08	16.14
Denmark	0.00	0.00	0.00	0.00	0.00
Germany	:	:	:	:	:
Estonia	0.00	0.00	0.00	0.00	0.00
Ireland	0.00	0.00	0.00	0.00	0.00
Greece	98.09	101.75	100.34	101.85	101.85
Spain	935.11	937.76	939.92	936.89	931.96
France	751.69	750.46	750.62	755.47	758.86
Croatia	23.40	21.90	20.51	19.82	20.63
Italy	673.76	670.09	675.82	697.91	703.90
Cyprus	6.07	5.93	6.67	6.67	6.79
Latvia	0.00	0.00	0.00	0.00	0.00
Lithuania	0.00	0.00	0.00	0.00	0.00
Luxembourg	1.26	1.26	1.25	1.24	1.24
Hungary	68.12	67.08	66.06	64.92	62.90
Malta	0.68	0.68	0.42	0.42	0.42
Netherlands	0.14	0.16	0.17	0.16	0.17
Austria	46.49	48.05	48.65	48.72	48.06

Grapes	2016	2017	2018	2019	2020
Poland	0.62	0.67	0.73	0.74	0.76
Portugal	179.05	178.84	178.78	178.78	178.78
Romania	174.17	175.32	172.80	176.34	176.76
Slovenia	15.84	15.86	15.65	15.57	15.29
Slovakia	8.71	8.47	8.01	7.92	7.73
Finland	0.00	0.00	0.00	0.00	0.00
Sweden	0.05	0.04	0.05	0.05	0.06

':' data not available.

Avocados	2016	2017	2018	2019	2020
EU 27	12.24	12.72	13.22	15.52	17.27
Belgium	0.00	0.00	0.00	0.00	0.00
Bulgaria	0.00	0.00	0.00	0.00	0.00
Czechia	0.00	0.00	0.00	0.00	0.00
Denmark	0.00	0.00	0.00	0.00	0.00
Germany	0.00	0.00	0.00	0.00	0.00
Estonia	0.00	0.00	0.00	0.00	0.00
Ireland	0.00	0.00	0.00	0.00	0.00
Greece	0.48	0.60	0.72	1.08	1.08
Spain	11.44	11.81	12.16	14.10	15.85
France	0.23	0.23	0.24	0.24	0.24
Croatia	0.00	0.00	0.00	0.00	0.00
Italy	0.00	0.00	0.00	0.00	0.00
Cyprus	0.09	0.08	0.10	0.10	0.10
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	0.00	0.00	0.00	0.00	0.00
Malta	0.00	0.00	0.00	0.00	0.00
Netherlands	0.00	0.00	0.00	0.00	0.00
Austria	0.00	0.00	0.00	0.00	0.00
Poland	0.00	0.00	0.00	0.00	0.00
Portugal	0.00	0.00	0.00	0.00	0.00
Romania	0.00	0.00	0.00	0.00	0.00
Slovenia	0.00	0.00	0.00	0.00	0.00
Slovakia	0.00	0.00	0.00	0.00	0.00
Finland	0.00	0.00	0.00	0.00	0.00
Sweden	0.00	0.00	0.00	0.00	0.00