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Pest categorisation of *Aulacaspis tubercularis*

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Abstract

The EFSA Panel on Plant Health performed a pest categorisation of *Aulacaspis tubercularis* (Hemiptera: Diaspididae), the white mango scale, for the EU. *A. tubercularis* is a tropical species that originates from Asia but is now established in several tropical and subtropical regions throughout the world. It also occurs within the EU and is established in Italy, Portugal and Spain. *A. tubercularis* is not listed in Commission Implementing Regulation (EU) 2019/2072. It is polyphagous, feeding on plants in more than 37 genera in 23 families and is most frequently reported on mango (*Mangifera indica*). Indeed, it is considered one of the key pests of mango crops around the world. No evidence was found indicating damage to crops other than mango. *A. tubercularis* is established in southern Spain (Andalusia) with four overlapping generations and two population peaks, one in summer and another in autumn. Andalusia is the main mango producing area of the EU and *A. tubercularis* can cause losses through downgrading of fruit. The main natural dispersal stage is the first instar, which crawls over the host plant or may be dispersed further by wind and animals. Plants for planting and fruits provide potential pathways for further entry and spread. Climatic conditions and availability of host plants in southern EU countries are conducive for establishment. Phytosanitary measures are available to reduce the likelihood of further entry and further spread. *A. tubercularis* satisfies the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest.

Keywords: mango scale insect, Hemiptera, pest risk, plant health, plant pest, Diaspididae, quarantine

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Table of contents

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

Aulacaspis tubercularis is one of a number of pests listed in Annex 1 to the Terms of Reference (ToR) to be subject to pest categorisation to determine whether it fulfils the criteria of a potential Union quarantine pest (QP) for the area of the EU excluding Ceuta, Melilla and the outermost regions of Member States (MS) referred to in Article 355(1) of the Treaty on the Functioning of the European Union (TFEU), other than Madeira and the Azores, and so inform EU decision making as to its appropriateness for potential inclusion in the lists of pests of Commission Implementing Regulation (EU) 2019/ 2072. If a pest fulfils the criteria to be potentially listed as a Union QP, risk reduction options will be identified.

2. Data and methodologies

2.1. Data

2.1.1. Information on pest status from NPPOs

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

2.1.2. Literature search

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

2.1.3. Database search

Pest information, on host(s) and distribution, was retrieved from the European and Mediterranean Plant Protection Organization (EPPO) Global Database (EPPO, online), the CABI databases and scientific literature databases as referred above in Section 2.1.1.

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

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

GenBank was searched to determine whether it contained any nucleotide sequences for *A. tubercularis* which could be used as reference material for molecular diagnosis. GenBank® (www.ncbi.nlm.nih.gov/genbank/) is a comprehensive publicly available database that as of August 2019 (release version 227) contained over 6.25 trillion base pairs from over 1.6 billion nucleotide sequences for 450,000 formally described species (Sayers et al., 2020).

2.2. Methodologies

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

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

The Panel's conclusions are formulated respecting its remit and particularly with regard to the principle of separation between risk assessment and risk management (EFSA founding regulation (EU)

No 178/2002); therefore, instead of determining whether the pest is likely to have an unacceptable impact, deemed to be a risk management decision, the Panel will present a summary of the observed impacts in the areas where the pest occurs, and make a judgement about potential likely impacts in the EU. While the Panel may quote impacts reported from areas where the pest occurs in monetary terms, the Panel will seek to express potential EU impacts in terms of yield and quality losses and not in monetary terms, in agreement with 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 QP status. Assessing social impact is outside the remit of the Panel.

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

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest (article 3)
Identity of the pest (Section 3.1)	Is the identity of the pest clearly defined, or has it been shown to produce consistent symptoms and to be transmissible?
Absence/ presence of the pest in the EU territory (Section 3.2)	Is the pest present in the EU territory? If present, is the pest in a limited part of the EU or is it scarce, irregular, isolated or present infrequently? If so, the pest is considered to be not widely distributed.
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	Is the pest able to enter into, become established in, and spread within, the EU territory? If yes, briefly list the pathways for entry and spread.
Potential for consequences in the EU territory (Section 3.5)	Would the pests' introduction have an economic or environmental impact on the EU territory?
Available measures (Section 3.6)	Are there measures available to prevent pest entry, establishment, spread or impacts?
Conclusion of pest categorisation (Section 4)	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential quarantine pest were met and (2) if not, which one(s) were not met.

3. Pest categorisation

3.1. Identity and biology of the pest

3.1.1. Identity and taxonomy

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

Yes, the identity of the pest is established and *Aulacaspis tubercularis* (Newstead) is the accepted name.

The mango scale, or white mango scale, *Aulacaspis tubercularis* (Newstead, 1906) is an insect species within the order Hemiptera, family Diaspididae. The species was described first by Newstead in 1906 as *Aulacaspis (Diaspis) tubercularis* from specimens collected on *Cinnamomum zeylanicum* in Java, Indonesia (García Morales et al., 2016). It was subsequently redescribed by Newstead in 1908 as *A. cinnamomi* from specimens collected on *C. zeylanicum* in Java and in 1911 as *Diaspis* (*Aulacaspis*) *cinnamomi* var. *mangiferae* (García Morales et al., 2016). Detailed morphological descriptions and illustrations of adults can be found in Takagi (1970, 2010) and of first and second female and male instars in Moharum (2012). The EPPO code (Griessinger and Roy, 2015; EPPO, 2019) for this species is AULSTU (EPPO, online).

3.1.2. Biology of the pest

A. tubercularis presents sexual dimorphism and its post embryonic development comprises of four male instars (nymph I, nymph II, prepupa and pupa) and two female instars (nymph I and nymph II) (Labuschagne, 1993; Del Pino et al., 2020). Crawlers and male adults are the only stages which can

move (Labuschagne, 1993). The crawlers are mobile and disperse over the host plant to find a suitable place to settle on. Once settled, they insert their stylets into the plant tissue and start feeding (Juarez-Hernandez et al., 2014). Female crawlers are randomly established on leaves, stems or on the fruits where they feed (Del Pino et al., 2020). They usually move away from their mother while male crawlers establish in groups of 10–80 individuals near the adult female (Gutierrez, 2003; Moharum, 2012). Of the hatched crawlers, about 80% are usually males (Otieno, 2021). In Egypt and Spain, it has three to four overlapping generations per year (Kwaiz, 2009; Nabil et al., 2012; Del Pino et al., 2021; Otieno, 2021), and in southern Spain it shows two population peaks, one in summer and another in autumn (Del Pino et al., 2021).

Important features of the life history strategy of *A. tubercularis* are summarised in Table 2.

Figure 1: *Aulacaspis tubercularis*: A, adult female scale cover, diameter 2.0 mm; B, scale cover removed to reveal body of adult female and purple eggs; C, immature male tests, length 0.6 mm; D, mango shoot exhibiting necrosis due to heavy infestation of scale in the Caribbean (Source: Chris Malumphy)

Table 2: Important features of the life history strategy of *Aulacaspis tubercularis*

Life stage	Phenology and relation to host	Other relevant information
Egg	Eggs are laid underneath the female scale and remain there until crawlers' hatch (Labuschagne, 1993). The number of eggs laid is influenced by host plant and temperature. On *Cucurbita moschata* the mean number of eggs laid per female was 82.45, 261.9 and 203.15 for winter (7 & 23°C), spring (13 & 26°C) and summer (18 & 29°C) simulated conditions, respectively (Labuschagne, 1993).	In winter (7 & 23°C), spring (13 & 26°C) and summer (18 & 29°C) simulated conditions, the duration of egg stage ranged from 10.3 to 15.6 days (Labuschagne, 1993). At 27°C and 81% Relative Humidity the egg stage lasts 8 days (Gutierrez, 2003).

Life stage	Phenology and relation to host	Other relevant information
1st instar nymph	First instar nymphs are known as crawlers. The crawlers move to find a suitable place to settle on. After settling, fine threads of wax begin to exude from the body and this secretion continues until the insect is completely covered with white filaments (Moharum, 2012).	In winter (7 & 23°C), spring (13 & 26°C) and summer (18 & 29°C) simulated conditions female first instar stage lasts from 11.1 to 17.1 days (Labuschagne, 1993). At 27°C and 81% Relative Humidity first female and male instar last 10 and 9 days, respectively (Gutierrez, 2003).
2nd instar nymph	The second female instar secretes wax, forming a greyish, circular cover, 3–4 mm^2. The antennae are greatly reduced and her body becomes ovoid and translucent yellow (Del Pino et al., 2020). The second male instar develops inside a wax test (protective cover) with three dorsal longitudinal ridges (Del Pino et al., 2020).	In winter, spring and summer simulated conditions the duration of the second female instar ranged from 11.1 to 25.3 days (Labuschagne, 1993). At 27°C and 81% relative humidity the second female and male instars last 5 and 8 days, respectively (Gutierrez, 2003).
Prepupa and Pupa (only in males)	From prepupa to pupa, there is no change in the form of the male scale test (Del Pino et al., 2020).	The prepupa and pupa stages last 3 and 5 days, respectively (Gutierrez, 2003).
Adult	The female adult is larviform and lacks wings and legs (Gutierrez, 2003). It is covered with a nearly circular scale about 2 mm in diameter (Del Pino et al., 2020). The male adult has a single pair of wings, it is yellow to orange, 0.53 mm long, unable to feed and mates as soon as possible after emerging (Labuschange, 1993). Adult males typically die within 1-2 days.	Life cycle development occurs in 35 - 40 days in summer and 70 - 85 days in winter (Northern Territory Government of Australia, 2019). In Ecuador, the life cycle was reported to last approximately 52 days in females and 36 in males (Otieno, 2021). The total developmental period of one generation in winter, spring and summer simulated conditions was 68.9, 52.5 and 42.7 days, respectively (Labuschagne, 1993).

3.1.3. Host range/Species affected

A. tubercularis is polyphagous, feeding on plants in more than 37 genera in 23 families (Appendix A provides a full host list). Although it has a broad range of hosts, it is most frequently found on, and causes damage to mango trees (*Mangifera indica*). Large populations are often found on mango while other potential host species nearby are free from the scale. For example, although citrus and avocados are hosts of *A. tubercularis*, the pest has not been found on these crops in areas of southern Spain where these crops are grown in the vicinity of mangoes (Boyero et al., 2017).

3.1.4. Intraspecific diversity

No intraspecific diversity is reported for this species.

3.1.5. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes, visual detection is possible, and morphological and molecular identification methods are available.

Detection

Careful visual examination of plants and fruits is an effective way for the detection of *A. tubercularis*. Male crawlers settle in groups of 10–80, often near their mother and these groups are conspicuous due to the white scale covers (known as tests) they produce (Moharum, 2012). Moreover, the pink blemishes on the infested mango fruit and chlorotic patches on the foliage are easily detectable. Yellow sticky traps can also be used to determine the presence of the winged adult males although morphological species identification is not possible (Del Pino et al., 2021).

Identification

The identification of *A. tubercularis* requires microscopic examination of slide-mounted adult females and verification of the presence of key morphological characteristics as given by Takagi (2010).

Lo Verde et al. (2020) provide details to distinguish between congeneric species.

A key to identify adult females of 56 species of this genus recorded in China is provided by Wei et al. (2016) and a key to armoured scales on avocado is available by Evans et al. (2009).

Molecular techniques for species identification have also been developed (Fita et al., 2021). GenBank contains nucleotide sequences for *A. tubercularis*.

Symptoms

The main symptoms of *A. tubercularis* infestation on mango trees (Abo-Shanab, 2012; Nabil et al., 2012) are:

- Excessive leaf loss and malformation in young trees.
- Drying out of young twigs resulting in dieback.
- Poor blossoming.
- Infested (mango) fruits have conspicuous pink or pale blemishes around the feeding sites of the scales.
- Premature fruit dropping.
- Mature fruits are smaller and less juicy.
- Severe early-stage infestation retards growth of young nursery plants.

Description

- Eggs have an average length of 0.17 mm, oval and red-brown to purple (Labuschagne, 1993).
- First instar nymphs (crawlers) are deep bright brick red (Hodges and Hamon, 2016). They are flattened, elongate-oval, about 0.25 (male) and 0.28 (female) mm long with eyes, and well-developed legs and antennae (Moharum, 2012). The newly hatched nymphs are totally bare of any wax secretion. After settling, they begin to exude from the body fine threads of wax which appear cottony (Moharum, 2012).
- Second instar nymph female is broadly oval, rounded at the posterior end and approximately 0.43 mm long while the male is ovoid and about 0.38 mm long. Both have reduced antenna, but they do not have eyes and legs (Moharum, 2012).
- Adult females are about 1.14 mm in length, an elongate body with enlarged angular prosoma and distinct lateral tubercles, wingless, legless and yellow to purple brown (Del Pino et al., 2020). The female is covered with a nearly circular, flat, thin and often wrinkled, opaque greyish-white coloured scale, about 2 mm in diameter (Hodges and Hamon, 2016; Del Pino et al., 2020). Exuviae are marginal, and are yellowish-brown, with a median black ridge, forming a distinct dark median line.
- The male adult has one pair of wings, is yellow to orange, about 0.53 mm long (Labuschange, 1993), with well-developed legs and antennae (Del Pino et al., 2020).

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

A. tubercularis is a tropical species that originates from Asia but is now established in many tropical and subtropical regions throughout the world (Sayed, 2012, Belay and Nagassa, 2021). It has a wide distribution in several countries in Africa, Asia, Oceania, North America, South America and in the Caribbean; it has a restricted distribution in Europe (EPPO, online; CABI, online; García Morales et al., 2016) (Figure 2). For a detailed list of countries where *A. tubercularis* is present, see Appendix B.

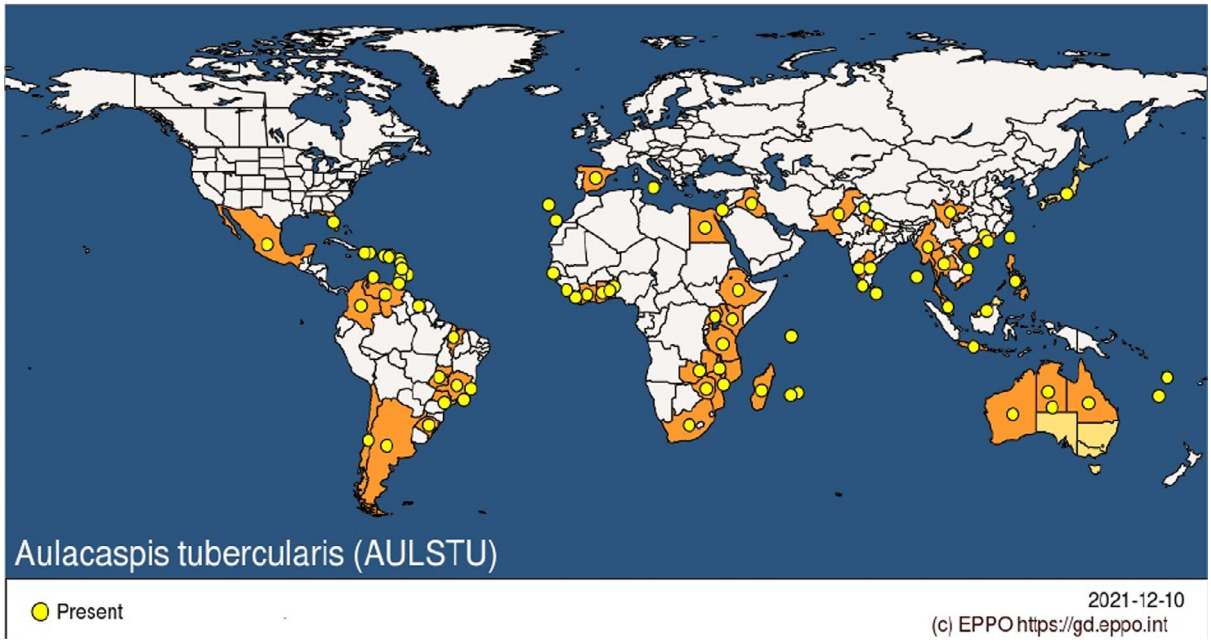

Figure 2: Global distribution of *Aulacaspis tubercularis* (Source: EPPO Global Database accessed on 10 December 2021)

3.2.2. Pest distribution in the EU

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

Yes, *A. tubercularis* has been recorded in Italy, Spain and Portugal.

Specifically, in the EU the pest is established in mango growing regions:

- in Italy (Sicily) (Pellizzari and Porcelli, 2014). The NPPO of Italy regard *A. tubercularis* as having restricted distribution in Italy.
- in Spain (Canary Islands and Andalusia) (Del Pino et al., 2021). The Canary Islands though are not part of the EU for plant health purposes. The NPPO of Spain regard *A. tubercularis* as being present on mango crops in Andalusia and the Canary Islands.
- in Portugal (Madeira Islands) (EPPO, online). The NPPO of Portugal regard *A. tubercularis* as being present on the island of Madeira and associated with mango. No official control measures are in place.

Note that when a pest is found in parts of its potential distribution and there are areas free from the pest that could suffer losses were the pest to spread or be introduced to such areas, the pest can be considered as not widely distributed (FAO, 2021 (ISPM No. 5, Supplement 1)). Hence, because *A. tubercularis* is not known to occur in Greece, where there is some mango production and impacts would be likely were *A. tubercularis* to be introduced there, *A. tuberclaris* can be regarded as being not widely distributed in the EU.

3.3. Regulatory status

3.3.1. Commission Implementing Regulation 2019/2072

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

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

According to the Commission Implementing Regulation (EU) 2019/2072, Annex VI, introduction of several *A. tubercularis* hosts into the EU from certain third countries is prohibited (Table 3).

Table 3: List of plants, plant products and other objects that are *Aulacaspis tubercularis* hosts whose introduction into the Union from certain third countries is prohibited (Source: Commission Implementing Regulation (EU) 2019/2072, Annex VI)

List of plants, plant products and other objects whose introduction into the Union from certain third countries is prohibited			
	Description	**CN Code**	**Third country, group of third countries or specific area of third country**
8.	Plants for planting of *Chaenomeles* Ldl., *Crataegus* L., *Cydonia* Mill., *Malus* Mill., *Prunus* L., *Pyrus* L. and *Rosa* 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 *Cydonia* Mill., *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.
11.	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruits and seed	ex 0602 10 90 ex 0602 20 20 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, the pest has already entered the EU territory. It could further enter the EU territory with fruits (mainly mangoes).

Comment on plants for planting as a pathway

The pest could further enter the EU territory with plants for planting (mainly mangoes) although some of the host plants from some third countries are prohibited (Table 4).

Plants for planting and fruits are the main potential pathways for entry of *A. tubercularis* (Table 4).

Table 4: Potential pathways for *Aulacaspis tubercularis* into the EU 27

Pathways Description (e.g. host/ intended use/ source)	**Life stage**	**Relevant mitigations [e.g. prohibitions (Annex VI) or special requirements (Annex VII) within Implementing Regulation 2019/2072]**
Plants for planting	Eggs, nymphs and adults	Plants for planting that are hosts of *A. tubercularis* and are prohibited to import from third countries (Regulation 2019/2072, Annex VI) are listed in Table 3. There is a temporary prohibition for High Risk plants (Regulation 2018/2019) some of which are *A. tubercularis* hosts i.e. *Acer*, *Acacia*, *Persea* and *Prunus*. Plants for planting from third countries require a phytosanitary certificate (Regulation 2019/2072, Annex XI, Part A).
Fruits	Eggs, nymphs and adults	Fruits from third countries require a phytosanitary certificate to import into the EU (2019/2072, Annex XI, Part A). According to Regulation 2019/2072, Annex XI, Part C fruits of *Cocos nucifera* do not require a phytosanitary certificate for their introduction into the Union territory.

The import of some host plants for planting of *A. tubercularis* from some third countries is not allowed (Implementing Regulation 2019/2072, Annex VI). There is a temporary prohibition for High Risk plants (Regulation 2018/2019) some of which are *A. tubercularis* hosts, i.e. *Acer, Acacia, Persea* and *Prunus*. All the other known host plants for planting can be imported to the EU with a phytosanitary certificate (Implementing Regulation 2019/2072, Annex XI, Part A).

Fruits that are imported in the EU must have a phytosanitary certificate. However, fruits of *Cocos nucifera* which are hosts of the pest do not require a phytosanitary certificate for their introduction into the EU (Implementing Regulation 2019/2072, Annex XI, Part C).

Annual imports of *A. tubercularis* hosts from countries where the pest is known to occur are provided in Appendix C.

Notifications of interceptions of harmful organisms began to be compiled in Europhyt in May 1994 and in TRACES in May 2020. As at 10/12/2021 (search date), there was one record of interception of *A. tubercularis* in the Europhyt and TRACES databases:

- in 2005 on *Mangifera indica* fruits imported from the Dominican Republic.

A. tubercularis was intercepted several times in England and Wales in the UK on imported fresh mango fruits prior to 1995 (Malumphy, 1996). Between 1996 and 2020, it was intercepted 162 times, mostly on mango fruit imported from Africa, Asia and the Caribbean. It was occasionally found on fruits of rambutan (*Nephelium lappaceum*), lychee (*Litchi chinensis*) and bitter melon (*Momordica charantia*) and once on cinnamon foliage (*Cinnamomum verum*).

3.4.2. Establishment

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

Yes, *A. tubercularis* is established in Italy, Portugal and Spain. In the EU countries of southern Europe, the climate is suitable and there are available hosts that can support establishment.

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, 2002). 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

A. tubercularis is a polyphagous pest. The main hosts of the pest cultivated in the EU between 2016 and 2020 are shown in Table 5. Citrus and stone fruits are highly economically important crops in the EU.

Table 5: Crop area of *Aulacaspis tubercularis* hosts in EU 27 in 1000 ha (Eurostat accessed on 9 December 2021)

Crop	2016	2017	2018	2019	2020
Citrus	519.01	502.84	508.99	512.83	519.98
Cucumbers	32.34	31.81	32.65	33.70	27.78
Stone fruits	No data	625.46	621.32	612.67	No data
Avocados	12.24	12.72	13.22	17.50	19.60

The crop area of mango, the main host, is limited to 5,700 ha in 2020 in Spain (Del Pino et al., 2021; MAPA, 2021) of which approximately 90% occurs in Andalusia and 10% in the Canary Islands (Hernández Delgado, 2016). There is production of 55 ha in Italy (Testa et al., 2018) and sporadic cultivation in southern Crete, Greece. The pest is already established in Sicily, Italy and in southern Spain (Andalusia). These areas are likely to represent over 95% of total EU mango production.

3.4.2.2. Climatic conditions affecting establishment

A. tubercularis is a thermophilic insect and is distributed mainly in areas with tropical and subtropical climates in Asia, Africa, Australia and the Americas. Moreover, it has also established in Southern Spain, Sicily (Italy) and Madeira Islands (Portugal). Figure 3 shows the World distribution of Köppen–Geiger climate types (Kottek et al., 2006) that occur in the EU and which occur in countries where *A. tubercularis* has been reported. Southern EU countries provide suitable climatic conditions for the establishment of *A. tubercularis* and it is already established in some of those areas, where mangoes are grown. It is unlikely that the insect could establish in the central and northern EU countries (Baufeld and Wilstermann, 2018) and if it did, the populations are likely to be small and have no impact. There is a possibility that *A. tubercularis* could occur in greenhouses and on indoor plantings in cooler areas.

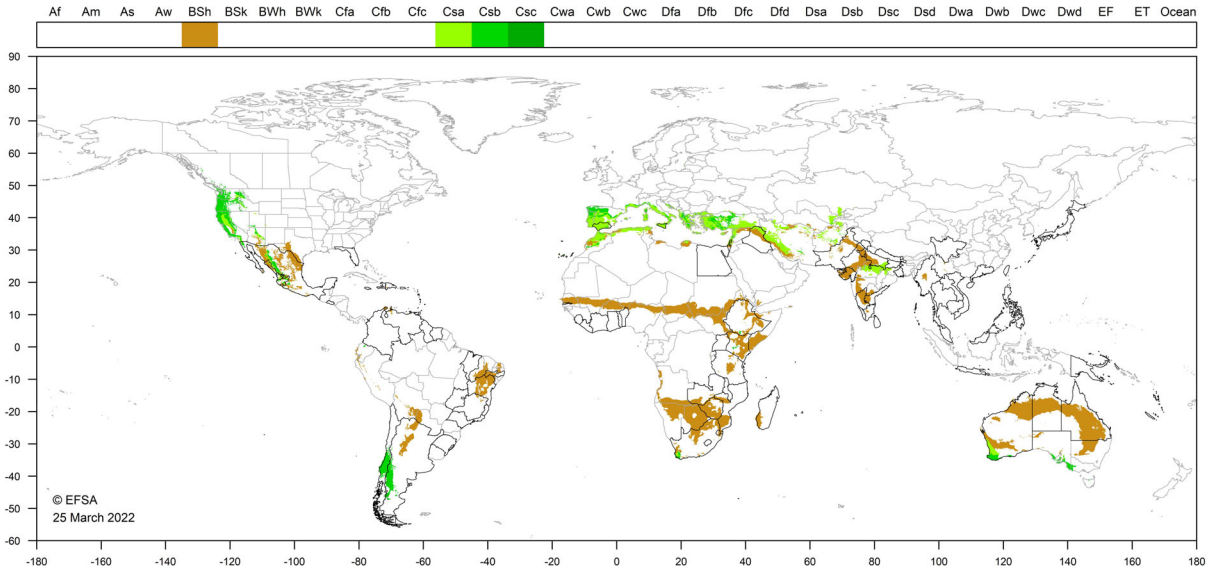

Figure 3: World distribution of Köppen–Geiger climate types that occur in the EU and which occur in countries where *Aulacaspis tubercularis* has been reported

3.4.3. Spread

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

Natural spread by the first instars crawling or being carried by wind, other animals, or machinery, will occur locally and relatively slowly. All stages may be moved over long distances by the trade of infested plant materials (plants for planting, fruits and unripe fruits with attached twigs).

The spread of *A. tubercularis* over short distances is possible by the crawling of the first instar nymphs. This is probably facilitated by the wind which may transport crawlers to neighbouring plants. The white mango scale can also move with the help of wind, birds and insects (Teshale et al., 2019). Long-distance dispersal of white mango scale is also possible if infested plant materials (plants for planting, twigs or fruits) are transported outside of the infested areas (Anjulo, 2009; Teshale et al., 2019).

3.5. Impacts

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

Yes, *A. tubercularis* is a key pest of mango in many mango producing areas of the world including Andalusia (Spain) and management intervention is required to reduce losses. Losses could also be expected in other mango producing areas of the EU. There is very little or no information available on the impact of this pest on other economically important hosts, such as citrus and avocado.

A. tubercularis is a serious pest on mango in Australia, East and West Africa, North and South America, and the Caribbean Islands (Nabil et al., 2012). It has become a devastating pest to mango fruit in western Ethiopia (Ofgaa and Emana, 2015) where it has emerged to be the second most important mango pest after anthracnose disease (Anjulo, 2019). It also causes significant damages on mango in South Africa, and it is one of the most destructive pests of mango trees in Egypt (Bakry and Abdel-Baky, 2020). However, in Kenya it is not considered an important pest (Ofgaa et al., 2014).

The pest injures the shoots, twigs, leaves, branches and fruits of mango by sucking plant sap with the mouthparts, causing deformation, defoliation, drying up of young twigs, dieback, poor blossoming, death of twigs possibly by the action of toxic saliva (Abo-Shanab, 2012; Nabil et al., 2012; Sayed, 2012). Heavily infested fruits drop prematurely, and mature fruits are smaller in size, less juicy, rotten and unfit for commercial use (Bakr et al., 2009; Abo-Shanab, 2012; Lo Verde et al., 2020). On mature fruits, pink or pale blemishes develop around the scale feeding sites decreasing their commercial value, especially for the international export markets (Labuschagne et al., 1995).

Bienvenido et al. (2020) state that in Spain *A. tubercularis* can cause up to 50% loss of mango value due to downgrading. The presence of four to five scales per fruit is enough to downgrade the fruit. Severe attacks can result in defoliation. Mango producers incur management costs through chemical treatments to minimise impacts. A substantial amount of mango production in Spain is organic and organic producers need to manage *A. tubercularis* accordingly.

3.6. Available measures and their limitations

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

Yes, although the existing phytosanitary measures identified in Section 3.3.2 do not specifically target *A. tubercularis*, they mitigate the likelihood of its entry into, establishment and spread within the EU.

3.6.1. Identification of potential additional measures

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

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

3.6.1.1. Additional potential risk reduction options

Potential additional control measures are listed in Table 6.

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

Control measure/Risk reduction option (Blue underline = Zenodo doc, Blue = WIP)	RRO summary	Risk element targeted (entry/establishment/spread/impact)
Growing plants in isolation	Plants could be grown in a dedicated facility such as an insect proof greenhouse.	Entry/Spread
Biological control and behavioural manipulation	The biological control of the species is feasible since there have been recorded 18 species of parasitoids and 50 species of predators of *A. tubercularis* (Del Pino et al., 2020). Generalist predators occur in the EU. *Encarsia citrina* Crawford (Hymenoptera: Aphelinidae) is one of the most common parasitoids of *A. tubercularis* worldwide and has been found in Andalusia (Del Pino et al., 2020).	Impact/Spread
Chemical treatments on crops including reproductive material	Used to mitigate likelihood of infestation of pests susceptible to chemical treatments. Many insecticides (organophosphates, pyrethroids and neonicotinoids) have been used successfully in reducing the *A. tubercularis* populations on mango trees (Kumari et al., 2014; Ayalew et al., 2015; Mendoza-Montero et al., 2017; Del Pino et al., 2020). However, the use of many of them has been banned in the EU and the application of these insecticides results in high mortality of pest's natural enemies. Good results have also been reported by the use of mineral oils (Abo-Shanab, 2012) and of propylene glycol monolaurate and mineral oil (Mendoza-Montero et al., 2017).	Entry/ Establishment/ Spread/Impact
Chemical treatments on consignments or during processing	Treatments can be applied to plants or to plant products after harvest, during process or packaging operations and storage. e.g. fumigation; spraying/dipping pesticides; surface disinfectants.	Entry/Spread

Control measure/Risk reduction option (Blue underline = Zenodo doc, Blue = WIP)	RRO summary	Risk element targeted (entry/ establishment/ spread/impact)
Physical treatments on consignments or during processing	Washing, brushing and other mechanical cleaning methods can be used to reduce the prevalence of the pest in the consignments to be exported or to be planted.	Entry/Spread
Cleaning and disinfection of facilities, tools and machinery	The physical and chemical cleaning and disinfection of facilities, tools, machinery, transport means, facilities and other accessories (e.g., boxes, pots, pallets, palox, supports, hand tools).	Entry/Spread
Heat and cold treatments	Controlled temperature treatments aimed to kill or inactivate pests without causing any unacceptable prejudice to the treated material itself.	Entry/Spread
Controlled atmosphere	Treatment of plants by storage in a modified atmosphere (including modified humidity, O_2, CO_2, temperature, pressure). Used to mitigate likelihood of infestation of pests susceptible to modified atmosphere (usually applied during transport) hence to mitigate entry. Controlled atmosphere storage can be used in commodities such as fresh and dried fruits.	Entry/Spread (via commodity)

3.6.1.2. Additional supporting measures

Potential additional supporting measures are listed in Table 7.

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

Supporting measure	Summary	Risk element targeted (entry/ establishment/ spread/impact)
Inspection and trapping	Inspection is defined as the official visual examination of plants, plant products or other regulated articles to determine if pests are present or to determine compliance with phytosanitary regulations (ISPM 5). The effectiveness of sampling and subsequent inspection to detect pests may be enhanced by including trapping and luring techniques.	Establishment/ Spread
Laboratory testing	Examination, other than visual, to determine if pests are present using official diagnostic protocols. Diagnostic protocols describe the minimum requirements for reliable diagnosis of regulated pests.	Entry
Sampling	According to ISPM 31, it is usually not feasible to inspect entire consignments, so phytosanitary inspection is performed mainly on samples obtained from a consignment. It is noted that the sampling concepts presented in this standard may also apply to other phytosanitary procedures, notably selection of units for testing	Entry
Phytosanitary certificate and plant passport	An official paper document or its official electronic equivalent, consistent with the model certificates of the IPPC, attesting that a consignment meets phytosanitary import requirements (ISPM 5) a) export certificate (import) b) plant passport (EU internal trade)	Entry

Supporting measure	Summary	Risk element targeted (entry/ establishment/ spread/impact)
Certified and approved premises	Mandatory/voluntary certification/approval of premises is a process including a set of procedures and of actions implemented by producers, conditioners and traders contributing to ensure the phytosanitary compliance of consignments. It can be a part of a larger system maintained by the NPPO in order to guarantee the fulfilment of plant health requirements of plants and plant products intended for trade. Key property of certified or approved premises is the traceability of activities and tasks (and their components) inherent the pursued phytosanitary objective. Traceability aims to provide access to all trustful pieces of information that may help to prove the compliance of consignments with phytosanitary requirements of importing countries.	Entry
Surveillance	Surveillance to guarantee that plants and produce originate from a pest-free area could be an option.	Spread

3.6.1.3. Biological or technical factors limiting the effectiveness of measures

- Due to its small size, *A. tubercularis* may not be easily detected in cases where low populations occur.
- *A. tubercularis* is polyphagous, making the inspections of all consignments containing hosts from countries where the pest occurs difficult.
- Limited number of registered active substances for use in mango against *A. tubercularis*.
- The waxy scale covering and sessile nature of the later instar nymphs and adult female *A. tubercularis* reduces the efficacy from treatments with contact insecticides.

3.7. Uncertainty

The main sources of uncertainty regarding the establishment and impact potential of *A. tubercularis* within the EU include:

- The magnitude of potential economic impact on hosts other than mango, given that there are no records of *A. tubercularis* causing damage in any other crop apart from mango.

4. Conclusions

A. tubercularis satisfies all the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union QP (Table 8).

Table 8: The Panel's conclusions on the pest categorisation criteria defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Key uncertainties
Identity of the pest (Section 3.1)	The identity of the pest is established. Taxonomic keys based on morphology of female adults exist.	None
Absence/presence of the pest in the EU (Section 3.2)	The pest has a restricted distribution in the EU territory, it is present in southern Spain (Andalusia), southern Italy (Sicily) and Portugal (Madeira islands).	None
Pest potential for entry, establishment and spread in the EU (Section 3.4)	*Aulacaspis tubercularis* is able to enter into, become established, and spread within the EU territory. The main pathways are: – plants for planting (regulated, some of which are prohibited – fruits (regulated, except fruits of *Cocos nucifera*).	None

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Key uncertainties
Potential for consequences in the EU (Section 3.5)	*A. tubercularis* is a key pest of mango in Andalusia and management intervention is required to reduce losses. Losses could also be expected in other mango producing areas of the EU, where the pest is not present, such as Greece and the Azores.	None
Available measures (Section 3.6)	There are measures available to prevent the re-entry, establishment and spread of *A. tubercularis* within the EU. Risk reduction options include the inspections and physical treatments on consignments of fresh plant material from infested countries and the production of plants for import into the EU in pest free areas.	None
Conclusion (Section 4)	*A. tubercularis* satisfies all the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest	
Aspects of assessment to focus on/scenarios to address in future if appropriate:		

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Abbreviations

DG SANTÉ	Directorate General for Health and Food Safety
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, 2021)
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO, 2021)
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, 2021)
Eradication (of a pest)	Application of phytosanitary measures to eliminate a pest from an area (FAO, 2021)
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 2021)
Greenhouse	A walk-in, static, closed place of crop production with a usually translucent outer shell, which allows controlled exchange of material

	and energy with the surroundings and prevents release of plant protection products (PPPs) into the environment.
Hitchhiker	An organism sheltering or transported accidentally via inanimate pathways including with machinery, shipping containers and vehicles; such organisms are also known as contaminating pests or stowaways (Toy and Newfield, 2021).
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, 2021)
Pathway	Any means that allows the entry or spread of a pest (FAO, 2021)
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, 2021)
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, 2021)
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, 2021)

Appendix A – *Aulacaspis tubercularis* host plants/species affected

Host plants of *Aulacaspis tubercularis* based on García Morales et al. (2016) and Otieno (2021).

Host status	Host name	Plant family	Common name	Reference
Cultivated hosts	*Mangifera*	Anacardiaceae		García Morales et al. (2016)
	Mangifera indica	Anacardiaceae	Mango	García Morales et al. (2016)
	Cocos	Arecaceae		García Morales et al. (2016)
	Cocos nucifera	Arecaceae	Coconut	García Morales et al. (2016)
	Canarium	Burseraceae	Pacific almond, canarium nut, pili nut, Java almond, Kenari nut, galip nut, nangai, ngali.	García Morales et al. (2016)
	Calophyllum inophyllum	Calophyllaceae	Alexandrian laurel	García Morales et al. (2016)
	Cucumis	Cucurbitaceae	Melons, cucumbers, gherkins	García Morales et al. (2016)
	Cucurbita	Cucurbitaceae	Pumpkin	García Morales et al. (2016)
	Cucurbita pepo	Cucurbitaceae	Marrow	García Morales et al. (2016)
	Luffa	Cucurbitaceae	Chinese okra	García Morales et al. (2016)
	Acacia	Fabaceae	Wattle, acacia	García Morales et al. (2016)
	Acacia auriculiformis	Fabaceae	Northern black wattle, Australian babul, Australian wattle, coast wattle, ear leaf acacia, earpod black wattle, Papua wattle, Papuan wattle	García Morales et al. (2016)
	Acacia mangium	Fabaceae	Brown salwood, black wattle, broadleaf salwood, hickory wattle, mangium, Sabah salwood, sally wattle	García Morales et al. (2016)
	Dietes	Iridaceae	Wood iris, fortnight lily, African iris, Japanese iris, butterfly iris	García Morales et al. (2016)
	Dietes iridioides	Iridaceae	African iris, fortnight lily, morea iris	García Morales et al. (2016)
	Cinnamomum	Lauraceae		García Morales et al. (2016)
	Cinnamomum camphora	Lauraceae	Camphor, camphor tree, Japanese camphor, camphorwood, camphor laurel	García Morales et al. (2016)
	Cinnamomum cassia	Lauraceae	Chinese cassia, Chinese cinnamon	García Morales et al. (2016)
	Cinnamomum parthenoxylon	Lauraceae	Selasian wood, saffrol laurel, Martaban camphor wood	García Morales et al. (2016)
	Cinnamomum verum	Lauraceae	True cinnamon tree, ceylon cinnamon tree	García Morales et al. (2016)

Host status	Host name	Plant family	Common name	Reference
	Laurus	Lauraceae	Laurel	García Morales et al. (2016)
	Laurus nobilis	Lauraceae	Bay tree, bay laurel, sweet bay, true laurel, Grecian laurel, laurel.	García Morales et al. (2016)
	Litsea	Lauraceae		García Morales et al. (2016)
	Litsea glutinosa	Lauraceae	Soft bollygum, bolly beech, Bollywood, bollygum, brown bollygum, brown Bollywood, sycamore, brown beech	García Morales et al. (2016)
	Persea	Lauraceae		García Morales et al. (2016)
	Persea americana	Lauraceae	Avocado, avocado pear, alligator pear, holly ghost pear	García Morales et al. (2016)
	Aglaia	Meliaceae		García Morales et al. (2016)
	Xylocarpus granatum	Meliaceae	Cannonball mangrove, cedar mangrove, puzzlenut tree	García Morales et al. (2016)
	Psidium	Myrtaceae	Guava	García Morales et al. (2016)
	Ternstroemia	Pentaphylacaceae		García Morales et al. (2016)
	Pittosporum	Pittosporaceae	Pittosporum, cheesewood	García Morales et al. (2016)
	Pittosporum glabratum	Pittosporaceae		García Morales et al. (2016)
	Bruguiera sexangula	Rhizophoraceae	Upriver orange mangrove	García Morales et al. (2016)
	Rhizophora apiculata	Rhizophoraceae	True mangrove	García Morales et al. (2016)
	Prunus	Rosaceae	Stone fruit	García Morales et al. (2016)
	Citrus	Rutaceae	Citrus	García Morales et al. (2016)
	Dimocarpus	Sapindaceae		García Morales et al. (2016)
	Dimocarpus longan	Sapindaceae	Longan tree	García Morales et al. (2016)
	Litchi	Sapindaceae		García Morales et al. (2016)
	Litchi chinensis	Sapindaceae	Lichi, leechee, lici, litchee, litchi nut, litchia, lychee	García Morales et al. (2016)
	Nephelium	Sapindaceae	rambutan	García Morales et al. (2016)
	Illicium cambodianum	Schisandraceae	Star anise, anisetree	García Morales et al. (2016)
	Zingiber officinale	Zingiberaceae	Ginger, common ginger, garden ginger, true ginger	García Morales et al. (2016)

Host status	Host name	Plant family	Common name	Reference
Wild weed hosts	*Desmos*	Annonaceae		García Morales et al. (2016)
	Acer kawakamii	Aceraceae	Kawakami maple	García Morales et al. (2016)
	Shorea laxa	Dipterocarpaceae	Yellow meranti	García Morales et al., 2016
	Polyosma	Escalloniaceae		García Morales et al., 2016
	Dietes prolongata	Iridaceae		Otiento et al., 2021
	Actinodaphne sphaerocarpa	Lauraceae		García Morales et al., 2016
	Cinnamomum ceylanicum	Lauraceae		Otieno (2021)
	Lindera	Lauraceae	Spicewood, spicebush, benjamin bush	García Morales et al. (2016)
	Lindera nacusua	Lauraceae		García Morales et al. (2016)
	Lindera pipericarpa	Lauraceae		García Morales et al. (2016)
	Lindera pulcherrima	Lauraceae		García Morales et al. (2016)
	Litsea monopetala	Lauraceae		García Morales et al. (2016)
	Litsea pungens	Lauraceae		García Morales et al. (2016)
	Machilus	Lauraceae		García Morales et al. (2016)
	Machilus wangchiana	Lauraceae		García Morales et al. (2016)
	Neolitsea lanuginosa	Lauraceae		García Morales et al. (2016)
	Phoebe	Lauraceae		García Morales et al. (2016)
	Gaiadendron	Loranthaceae		García Morales et al. (2016)
	Acer caudatifolium	Sapindaceae		García Morales et al. (2016)

Appendix B – Distribution of *Aulacaspis tubercularis*

Distribution records based on the EPPO Global Database (EPPO, online), CABI (online) and García Morales et al. (2016) and other references.

Region	Country	Sub-national (e.g. State)	Status	Reference
North America	Mexico		Present, restricted distribution	EPPO (online)
	Mexico	Jalisco	Present, no details	García Morales et al. (2016)
	Mexico	Colima	Present, no details	García Morales et al. (2016)
	Mexico	Sinaloa	Present, no details	García Morales et al. (2016)
	Mexico	Nayarit	Present, no details	García Morales et al. (2016)
	USA		Present, few occurrences	EPPO (online)
	USA	Florida	Present, no details	EPPO (online)
	Bermuda		Present, no details	García Morales et al. (2016)
Central America	El Salvador		Present, no details	CABI (online)
Caribbean	Antigua and Barbuda		Present, no details	EPPO (online)
	Aruba		Present, no details	EPPO (online)
	Barbados		Present, no details	EPPO (online)
	Dominican Republic		Present, no details	EPPO (online)
	Grenada		Present, no details	EPPO (online)
	Guadeloupe		Present, no details	EPPO (online)
	Haiti		Present, no details	EPPO (online)
	Jamaica		Present, no details	García Morales et al. (2016)
	Martinique		Present, no details	EPPO (online)
	Puerto Rico		Present, no details	EPPO (online)
	Saint Lucia		Present, no details	CABI (online)
	Trinidad and Tobago		Present, no details	EPPO (online)
	Virgin Islands (British)		Present, no details	EPPO (online)
	Virgin Islands (US)		Present, no details	EPPO (online)
South America	Chile		Present, no details	EPPO (online)
	Argentina		Present, restricted distribution	EPPO (online)
	Brazil		Present, no details	EPPO (online)
	Brazil	Espirito Santo	Present, no details	EPPO (online)
	Brazil	Goias	Present, no details	EPPO (online)
	Brazil	Maranhao	Present, no details	EPPO (online)
	Brazil	Minas Gerais	Present, no details	EPPO (online)
	Brazil	Rio de Janeiro	Present, no details	EPPO (online)
	Brazil	Rio Grande do Sul	Present, no details	EPPO (online)
	Brazil	Sao Paulo	Present, no details	EPPO (online)
	Brazil	Bahia	Present, no details	García Morales et al. (2016)
	Brazil	Pernambuco	Present, no details	García Morales et al. (2016)
	Colombia		Present, no details	EPPO (online)
	Guyana		Present, no details	García Morales et al. (2016)
	Suriname		Present, no details	EPPO (online)
	Venezuela		Present, no details	EPPO (online)

Region	Country	Sub-national (e.g. State)	Status	Reference
EU (27)	Italy		Present, few occurrences	EPPO (online)
	Italy	Sicilia	Present, few occurrences	EPPO (online)
	Portugal		Present, restricted distribution	EPPO (online)
	Portugal	Madeira	Present, no details	EPPO (online)
	Spain		Present, restricted distribution	EPPO (online)
	Spain	Canary Islands	Present, restricted distribution	EPPO (online)
	Spain	Andalusia	Present, restricted distribution	Del Pino et al., 2021
Africa	Benin		Present, no details	EPPO (online)
	Cote d'Ivoire		Present, no details	EPPO (online)
	Egypt		Present, no details	EPPO (online)
	Ethiopia		Present, no details	EPPO (online)
	Gambia		Present, no details	EPPO (online)
	Ghana		Present, no details	EPPO (online)
	Kenya		Present, no details	EPPO (online)
	Liberia		Present, no details	EPPO (online)
	Madagascar		Present, no details	EPPO (online)
	Malawi		Present, no details	EPPO (online)
	Mauritius		Present, no details	EPPO (online)
	Mozambique		Present, no details	EPPO (online)
	Reunion		Present, no details	EPPO (online)
	Seychelles		Present, no details	EPPO (online)
	Sierra Leone		Present, no details	EPPO (online)
	South Africa		Present, no details	EPPO (online)
	Tanzania		Present, no details	EPPO (online)
	Tanzania	Zanzibar Island	Present, no details	CABI (online)
	Togo		Present, no details	EPPO (online)
	Uganda		Present, no details	EPPO (online)
	Zambia		Present, no details	EPPO (online)
	Zimbabwe		Present, no details	EPPO (online)
Asia	China		Present, no details	EPPO (online)
	China	Guangdong	Present, no details	EPPO (online)
	China	Hainan	Present, no details	EPPO (online)
	China	Sichuan	Present, no details	EPPO (online)
	China	Hong Kong	Present, no details	EPPO (online)
	India		Present, no details	EPPO (online)
	India	Bihar	Present, no details	García Morales et al. 2016
	India	Andaman and Nicobar Islands	Present, no details	EPPO (online)
	India	Andhra Pradesh	Present, no details	EPPO (online)
	India	Himachal Pradesh	Present, no details	EPPO (online)
	India	Karnataka	Present, no details	EPPO (online)
	India	Kerala	Present, no details	EPPO (online)
	India	Uttar Pradesh	Present, no details	EPPO (online)

Region	Country	Sub-national (e.g. State)	Status	Reference
	India	Gujarat	Present, no details	CABI (online)
	India	Haryana	Present, no details	CABI (online)
	India	Sikkim	Present, no details	García Morales et al. (2016)
	India	Tamil Nadu	Present, no details	García Morales et al. (2016)
	India	West Bengal	Present, no details	García Morales et al. (2016)
	Indonesia		Present, no details	EPPO (online)
	Indonesia	Java	Present, no details	EPPO (online)
	Indonesia	Borneo	Present, no details	CABI (online)
	Iraq		Present, no details	EPPO (online)
	Israel		Present, no details	EPPO (online)
	Japan		Present, no details	EPPO (online)
	Laos		Present, no details	CABI (online)
	Malaysia		Present, no details	EPPO (online)
	Malaysia	West	Present, no details	EPPO (online)
	Malaysia	Peninsular Malaysia	Present, no details	CABI (online)
	Malaysia	Sabah	Present, no details	CABI (online)
	Malaysia	Sarawak	Present, no details	CABI (online)
	Malaysia	Malaya	Present, no details	García Morales et al., 2016
	Myanmar		Present, no details	EPPO (online)
	Nepal		Present, no details	CABI (online)
	Pakistan		Present, no details	EPPO (online)
	Philippines		Present, no details	EPPO (online)
	Sri Lanka		Present, no details	EPPO (online)
	Taiwan		Present, no details	EPPO (online)
	Thailand		Present, no details	EPPO (online)
	Vietnam		Present, no details	EPPO (online)
	Andaman Islands		Present, no details	García Morales et al., 2016
Oceania	Australia		Present, no details	EPPO (online)
	Australia	Northern Territory	Present, no details	EPPO (online)
	Australia	Queensland	Present, no details	EPPO (online)
	Australia	Western Australia	Present, no details	EPPO (online)
	New Caledonia		Present, restricted distribution	EPPO (online)
	Papua New Guinea		Present, no details	CABI (online)
	Vanuatu		Present, no details	EPPO (online)

Appendix C – Import data

Table C.1: **Fresh or dried citrus (CN code: 0805)** imported in 100 kg into the EU (27) from regions where *Aulacaspis tubercularis* is known to occur (Source: Eurostat accessed on 10 December 2021)

Country	2016	2017	2018	2019	2020
Antigua and Barbuda				19.83	
Argentina	2,412,706.76	1,913,772.23	2,242,298.89	1,585,087.09	1,403,348.80
Australia	3,279.84	1,284.38	644.97	10,645.40	2,343.47
Brazil	864,863.09	903,432.95	900,907.24	822,134.46	902,583.06
China	827,840.57	1,084,857.27	1,024,163.15	1,108,595.22	1,098,689.98
Colombia	44,825.37	79,400.99	123,887.46	136,914.85	172,197.70
Dominican Republic	11,178.95	9,336.81	10,426.97	7,355.36	12,886.58
Egypt	1,931,586.64	2,246,998.88	2,643,272.02	2,206,932.71	2,850,745.77
Ghana	280.09	348.28	99.50		
Guyana					24.00
Haiti	207.41	176.53	72.10	31.00	248.29
India	246.80	1.00	449.63	88.51	254.95
Indonesia	566.73	555.70	779.35	836.73	864.54
Iraq		3.60	11.20	0.30	20.00
Israel	799,118.49	969,403.62	824,601.66	812,738.57	878,713.18
Japan	352.58	417.44	270.73	319.24	162.50
Jamaica	3,633.97	3,325.11	675.68	2,409.55	1,646.87
Kenya			8.80		34.56
Laos	51.94	2.10			20.23
Madagascar	2.70	26.42	11.62	7.16	22.16
Mauritius	213.74		14.00		7.35
Mexico	570,402.80	553,818.66	589,021.12	443,743.54	349,648.63
Malaysia	4.18	39.02	83.45	7.71	
Nepal		1,170.00			
Pakistan			2.45	0.59	
Philippines			0.20	7.71	0.10
El Salvador	36.83	35.77	4.76		
Thailand	426.42	1,283.13	659.74	624.93	194.87
Taiwan	157.49				
Tanzania	179.90	190.01	144.12	35.95	75.50
Venezuela	744.08	2,216.36	681.07		
South Africa	5,278,830.95	5,802,017.61	6,381,124.73	6,196,837.96	7,830,147.60
Zimbabwe	297,550.62	328,595.48	397,906.49	348,303.06	391,868.70
Uganda	3.99	4.16	6.81	7.35	11.88
United States	301,229.06	231,210.47	185,706.99	177,755.45	148,608.92

Table C.2: **Fresh or dried guavas. mangoes and mangosteens (CN code: 080450)** imported in 100 kg into the EU (27) from regions where *Aulacaspis tubercularis* is known to occur (Source: Eurostat accessed on 10 December 2021)

Country	2016	2017	2018	2019	2020
Antigua and Barbuda			193.61		
Argentina	14.40				
Australia	25.72	94.18	62.92		
Benin		26.40			226.79
Brazil	1,025,325.37	1,158,717.06	1,241,860.63	1,437,569.20	1,577,043.99
China	38.95	51.87	180.81	78.23	104.34
Colombia	2,321.38	2,553.75	3,139.67	6,833.02	4,131.75
Dominican Republic	96,728.22	85,119.28	105,553.46	118,508.00	110,481.33
Egypt	4,135.64	9,186.69	4,855.57	6,407.46	12,233.16
Ghana	8,896.27	9,114.51	106,72.35	11,138.06	30,296.55
Haiti			4.87		
India	5,989.34	8,148.87	9,470.36	9,315.51	7,347.61
Indonesia	1,981.20	2,004.36	2,926.64	2,386.27	1,406.94
Israel	143,726.08	140,551.30	108,353.48	121,875.16	98,143.59
Japan	0.66				0.01
Kenya	232.06	4.08	65.09	10.30	66.53
Laos	753.34	620.36	603.14	806.50	525.32
Madagascar	246.94	22.10	15.02	0.66	1.05
Malawi					648.00
Mexico	35,095.07	40,848.36	46,001.68	50,935.79	51,841.89
Malaysia	289.86	197.22	170.64	72.72	44.56
Myanmar (Burma)		0.28	1.47	1.00	
Mozambique			122.61	126.65	134.13
Pakistan	17,149.78	15,912.58	21,867.43	29,207.33	16,196.50
Philippines	1,028.05	519.88	795.56	368.97	128.10
Sierra Leone			4.99	55.06	
Thailand	6,460.81	7,401.80	6,911.89	6,743.91	5,260.84
Taiwan			3.48	17.34	0.92
Tanzania			0.50	1.14	
Venezuela	2,917.57	2,033.75	2,401.44	1,939.11	282.69
South Africa	8,550.13	13,015.45	9,739.99	12,116.95	8,656.28
Zambia		2.46			23.04
Uganda	257.30	452.71	360.01	662.25	389.56
United States	78,874.11	45,478.21	54,660.34	82,580.54	82,852.21

Table C.3: **Coconuts. Brazil nuts and cashew nuts. fresh or dried. whether or not shelled or peeled (CN code: 0801)** imported in 100 kg into the EU (27) from regions where *Aulacaspis tubercularis* is known to occur (Source: Eurostat accessed on 13 December 2021)

Country	2016	2017	2018	2019	2020
Argentina	6,351.16	3.36			
Australia	326.68	161.34	3.97	3.09	0.02
Benin	3,230.85	2,034.22	2,584.36	8,774.77	11,418.80
Brazil	36,419.17	28,181.64	51,378.25	59,924.59	75,715.61
Chile	2,615.82	180.28	4,103.40	382.01	3,141.93
China	1,409.93	1,078.20	995.67	1,091.95	3,073.07
Colombia	449.85	4.91	480.00	0.62	
Dominican Republic	1,350.04	1,731.11	2,313.84	594.68	467.96
Egypt	4.20	3.23	2.77	14.96	0.84
Ghana	10,890.16	11,671.46	9,733.90	15,089.42	20,769.02
Gambia	31.67	14.00	21.52		
India	170,399.32	243,346.77	192,497.06	205,693.06	172,138.65
Iraq		0.02		10.11	23.16
Indonesia	255,797.58	287,011.09	302,686.51	259,519.02	238,720.48
Israel	2.40	12.32	4.95	2.36	11.16
Kenya	17.01	696.35	57.73	244.49	1,191.89
Laos		0.09	280.00	0.23	
Madagascar	615.99	624.94	783.06	426.35	524.37
Malaysia	5,507.22	8,394.49	4,041.78	2,329.06	4,411.77
Mauritius			8.15	1.76	0.02
Mexico	15.38	0.48	0.05	0.25	0.10
Mozambique	15,031.71	7,490.17	10,508.99	16,038.30	12,972.32
Myanmar			0.15		10.00
Pakistan	63.15	11.50	22.53	24.60	25.70
Philippines	368,573.57	419,893.07	419,609.28	398,109.92	395,721.76
Sierra Leone		120.00	0.21	0.10	
El Salvador	2.00	90.71		86.73	81.87
South Africa	1.24	103.64	0.50	0.79	205.46
Suriname	71.21		58.90	57.38	0.10
Thailand	79,261.58	78,956.34	68,012.09	59,013.35	35,161.47
Taiwan	14.36		3.40		
Tanzania	1,889.75	2,570.78	1,197.66	1,931.29	1,800.05
United States	2,447.78	1,994.95	1,377.75	511.55	845.48
Uganda		2.07	2.99	3.61	1.90
Venezuela	317.52				
Virgin Islands	635.04	158.76	635.04	158.76	
Viet Nam	761,279.37	798,319.82	818,389.73	967,893.87	1,177,974.48
Vanuatu	158.76				

Table C.4: **Fresh or dried avocados (CN code: 080440)** imported in 100 kg into the EU (27) from regions where *Aulacaspis tubercularis* is known to occur (Source: Eurostat accessed on 10 December 2021)

Country	2016	2017	2018	2019	2020
Argentina	950.00				
Brazil	44,357.36	71,040.50	68,697.61	78,673.73	48,183.83
China	193.97	35.28		1.23	0.04
Colombia	152,115.55	210,139.60	251,050.33	387,367.23	663,148.97
Dominican Republic	53,962.41	55,001.50	52,897.18	95,531.91	100,024.05
Egypt	211.20	5.35	4.58	79.92	363.95
Ethiopia	110.19	137.32	310.59	11.78	35.83
Ghana	18.48	134.58	22.64	40.45	21.88
India	0.04	2.06	0.52	0.06	
Israel	301,123.91	424,267.97	370,378.23	437,318.01	345,664.24
Kenya	228,426.16	243,947.31	404,593.87	346,231.90	435,308.72
Madagascar					0.96
Mauritius	124.44	36.13	42.27	24.28	15.23
Mexico	503,687.52	445,611.06	463,741.28	767,878.48	716,092.02
Malaysia			47.04		
Mozambique		559.80	1,294.13	7,134.23	8,014.81
Thailand	3.68	9.76	9.66	9.06	3.39
Tanzania	26,823.05	25,773.58	55,517.16	60,480.96	50,769.74
Venezuela	0.09	233.40	111.12	71.29	
South Africa	419,768.89	315,854.56	652,817.98	401,352.79	416,290.22
Zambia			53.68		
Zimbabwe	130,30.06	20,378.85	36,539.24	32,020.52	38,872.63
Uganda	1,912.57	2,195.25	2,233.81	3,364.25	3,575.70
United States	8,819.53	1.19	2,546.86	0.02	4.66

Table C.5: **Apricots, cherries, peaches incl. nectarines, plums and sloes, fresh (CN code: 0809)** imported in 100 kg into the EU (27) from regions where *Aulacaspis tubercularis* is known to occur (Source: Eurostat accessed on 10 December 2021)

Country	2016	2017	2018	2019	2020
Argentina	7,231.35	7,695.92	13,271.11	7,692.29	8,620.46
Australia	373.51	378.21	487.00	372.26	631.59
Brazil		183.53	356.14	22.65	40.40
China			0.90	3.24	
Colombia		230.90	211.68		24.00
Egypt	2,586.73	2,450.75	909.77	1,457.95	906.27
India			0.45		
Israel	632.55	419.54	91.11	46.42	3.80
Japan		0.86	1.00	2.82	
Mauritius				67.75	140.00
Mexico			212.00		
Malaysia					1.78
Pakistan	5.10	0.50	1.20	1.36	4.40
Thailand		7.34	0.85	0.28	32.98
South Africa	307,820.44	321,979.30	297,609.30	242,780.96	271,615.89
Zimbabwe	261.12	148.46	23.52	11.94	0.12
United States	453.30	4,303.88	1,741.06	923.44	216.12

Table C.6: **Fresh melons (excl. watermelons) (CN code: 080719)** imported in 100 kg into the EU (27) from regions where *Aulacaspis tubercularis* is known to occur (Source: Eurostat accessed on 10 December 2021)

Country	2016	2017	2018	2019	2020
Argentina			564.00		171.64
Brazil	1,502,128.30	1,656,430.83	1,709,558.65	1,625,992.77	1,648,465.15
China		4.00		158.00	
Colombia				218.76	27.56
Dominican Republic	4,438.77	4,377.46	3,156.55	2,242.51	1,041.49
Egypt	1,516.68	1,037.42	3,010.96	2,310.98	2,817.34
Ghana	4.20	1,799.76		0.85	9.88
India	0.01	158.00	0.75		0.52
Israel	6308.05	2812.40	119.77	244.39	29.52
Japan	4.12	0.36	9.37	3.21	12.88
Laos	0.38	0.47			
Mexico		23.91	27.85	2.25	5.86
Malaysia	1,443.99	1.63		0.60	
Pakistan	35.39	71.88	9.11	1.01	
Thailand	65.02	41.40	17.02	33.77	0.06
South Africa	23,473.14	51,784.68	17,080.91	27,547.46	13,724.83
Uganda	4.32	5.40	1.80		
United States	221.80	1.97	2.35		0.10

Table C.7: **Fresh or chilled pumpkins, squash and gourds '*Cucurbita* spp.' (CN code: 070993)** imported in 100 kg into the EU (27) from regions where *Aulacaspis tubercularis* is known to occur (Source: Eurostat accessed on 10 December 2021)

Country	2016	2017	2018	2019	2020
Argentina	35,650.38	41,755.68	39,686.56	27,438.57	48,953.86
Brazil	4,941.92	8,703.47	21,454.98	26,141.53	53,595.35
China	2,984.90	3,712.73	3,691.38	3,029.60	2,674.09
Colombia		87.80	247.00	749.98	
Dominican Republic	752.87	1,143.55	941.13	746.09	486.49
Egypt	9,250.66	18,183.52	27,167.43	17,111.09	27,553.57
Ghana	11.93	3.08	416.00	10.59	18.42
Grenada			8.82		
Haiti	14.50	26.00	27.02		
India	1,517.85	1,742.50	24,07.67	1,433.35	1,514.03
Israel	3,509.40	4,648.08	4,671.33	2,307.44	1,742.04
Japan	6.53	2.34	3.66	8.35	20.42
Jamaica					3.82
Kenya	242.52	478.20	234.60	69.41	387.74
Laos	0.72	1.04			0.17
Madagascar			312.65	5.16	20.60
Mauritius		0.50			
Mexico	5,964.65	4,573.80	5,977.44	2,262.99	6,575.05
Malaysia		40.30	8.67		
Nepal		1.20			
Pakistan	1,215.53	1,433.31	1,904.34	1,554.71	1,061.31
Thailand	35.79	35.81	33.67	242.76	30.14
Taiwan		60.00			

Country	2016	2017	2018	2019	2020
Tanzania	0.20			0.07	
South Africa	40,523.42	51,408.54	72,015.54	55,537.38	120,122.00
Zimbabwe	75.87	7.55			
Uganda	28.77	52.65	71.60	15.13	24.21
United States	2.64	4.80	0.94	10.94	9.48