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Pest categorisation of *Russellaspis pustulans*

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Abstract

The EFSA Panel on Plant Health performed a pest categorisation of *Russellaspis pustulans* (Hemiptera: Asterolecaniidae), the oleander pit scale, for the EU. *R. pustulans* occurs widely in tropical and subtropical areas of the world and is restricted to indoor plantings in cooler temperate regions. Within the EU, it has been reported in some literature from Cyprus, Italy and Malta though not confirmed by the NPPOs. *R. pustulans* is not listed in Commission Implementing Regulation (EU) 2019/2072. It is very polyphagous, feeding on plants in 69 families and exhibits a preference for fig (*Ficus carica*) and oleander (*Nerium oleander*). *R. pustulans* was observed completing up to three generations per year in Egypt, with peaks of presence in June, October and December. 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, cut branches and fruits provide potential pathways for entry into the EU. Climatic conditions in some parts of southern EU countries are favourable and host plants are available in those areas to support establishment. However, the magnitude of impact following introduction is uncertain. Phytosanitary measures are available to reduce the likelihood of entry and further spread. *R. pustulans* does meet the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest.

Keywords: Oleander pit scale, fig trees, Asterolecaniidae, pest risk, plant health, plant pest, quarantine

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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

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

1.3. Additional information

This pest categorisation was initiated following the commodity risk assessment of fig (*Ficus carica*) plants for planting from Israel performed by EFSA (EFSA PLH Panel, 2021), in which *R. pustulans* was identified as a relevant non-regulated EU pest which could potentially enter the EU on *F. carica*.

2. Data and methodologies

2.1. Data

2.1.1. Information on pest status from NPPOs

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

2.1.2. Literature search

A literature search on *Russellaspis pustulans* 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 Member States and the phytosanitary measures taken to eradicate or avoid their spread. The recording of interceptions switched from Europhyt to TRACES in May 2020.

GenBank was searched to determine whether it contained any nucleotide sequences for *R. pustulans* 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 *R. pustulans*, following guiding principles and steps presented in the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018), the EFSA guidance on the use of the weight of evidence approach in scientific assessments (EFSA Scientific Committee, 2017) and the International Standards for Phytosanitary Measures No. 11 (FAO, 2013).

The criteria to be considered when categorising a pest as a potential Union quarantine pest (QP) is given in Regulation (EU) 2016/2031 Article 3 and Annex I, Section 1 of the Regulation. Table 1 presents the Regulation (EU) 2016/2031 pest categorisation criteria on which the Panel bases its

conclusions. In judging whether a criterion is met the Panel uses its best professional judgement (EFSA Scientific Committee, 2017) by integrating a range of evidence from a variety of sources (as presented above in Section 2.1) to reach an informed conclusion as to whether or not a criterion is satisfied.

The Panel's conclusions are formulated respecting its remit and particularly with regard to the principle of separation between risk assessment and risk management (EFSA founding regulation (EU) No 178/2002); therefore, instead of determining whether the pest is likely to have an unacceptable impact, deemed to be a risk management decision, the Panel will present a summary of the observed impacts in the areas where the pest occurs, and make a judgement about potential likely impacts in the EU. Whilst the Panel may quote impacts reported from areas where the pest occurs in monetary terms, the Panel will seek to express potential EU impacts in terms of yield and quality losses and not in monetary terms, in agreement with the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018). Article 3 (d) of Regulation (EU) 2016/2031 refers to unacceptable social impact as a criterion for quarantine pest status. Assessing social impact is outside the remit of the Panel.

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

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

3. Pest categorisation

3.1. Identity and biology of the pest

3.1.1. Identity and taxonomy

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

Yes, the identity of the pest is established and *Russellaspis pustulans* (Cockerell) is the accepted name.

Russellaspis pustulans (Cockerell) is a scale insect within the order Hemiptera and family Asterolecaniidae. It is commonly known as oleander pit scale, akee fringed scale, fig pit scale or pustule scale. It was first described as *Asterodiaspis pustulans* by Cockerell in 1892 and subsequently underwent several taxonomic revisions. It comprises two subspecies: *Russellaspis pustulans principe* (Castel-Branco) and *Russellaspis pustulans pustulans* (Cockerell). However, *R. pustulans principe* is only recorded from São Tomé and Príncipe. Subspecies are rarely mentioned in the literature. It has the following synonyms: *Asterodiaspis pustulans, Asterolecanium pustulans, Planchonia pustulans, Asterolecanium pustulans sambuci, Asterolecanium pustulans seychellarum, Asterolecanium sambuci*

and *Asterolecanium morini*. The junior synonym *Asterolecanium pustulans* has been widely used in the literature and is still occasionally in use, for example, CABI (online).

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

Figure 1: *Russellaspis pustulans*: A, large infestation on oleander; B, old pitting and swollen stem, oleander; C, heavy infestation on apical twigs of olive; D, close up of adult female scale cover (approx. 1 mm in diameter) showing dense wax filaments on dorsum and margin; E, deep pits on oleander induced by the pit scale. All photos are from Gran Canaria, Canary Islands, Spain. However, there are no scientific publications reporting the presence of *R. pustulans* in the Canary Islands (Source: Chris Malumphy)

3.1.2. Biology of the pest

The biology of *R. pustulans* has been studied in detail in Egypt (Habib, 1943, 1953; El-Minshawy and El-Sawaf, 1971; Salama and Hamdy, 1974; Stumpf and Lambdin, 2006; Hassan et al., 2012; El-Amir et al., 2020). A summary is provided here. *R. pustulans* is parthenogenetic, males are not known, and it completes two to three generations each year, depending on environmental conditions and host plant species. Non-gravid females overwinter. The insect occurs between the 10°C winter isotherm and the 32°C summer isotherm, which, respectively, correspond to the lower developmental threshold and upper lethal temperature for eggs. On *N. oleander* females laid an average of 128 eggs each (range 66–192). However, an average of only 50–60 eggs actually hatched (Habib, 1943). El-Minshawy and El-Sawaf (1971) observed an average of 113 eggs per female on peach trees, 90 eggs per female on fig trees in winter and 194 eggs per female on fig trees in the summer. There are two nymphal instars. The average lifespan of a female is 80 days (range 73–87). The duration of the life cycle (from egg hatching to adult death) in summer ranged from 93 to 120 days, and in winter from 240 to 275 days.

[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).

Salama and Hamdy (1974) reported three generations each year (June, October and December) in Egypt and found the optimal temperature range for development to be 23–25.3°C, and relative humidity between 68% and 70%.

Feeding by the nymphs may induce shallow or deep pits at the feeding site. This pitting or galling varies with host species and is particularly noticeable on oleander (Figure 1). Similar galls induced by the pittosporum pit scale *Planchonia arabidis* Signoret, which is present in southern EU MS, result primarily from parenchyma multilayer tissue hyperplasia (Vovlas et al., 2013).

Table 2: Important features of the life history strategy of *Russellaspis pustulans*

Life stage	Phenology and relation to host	Other relevant information
Egg	Typically, females lay between 66 and 194 eggs, depending on host plant and generation.	The eggs are protected beneath the scale wax cover.
Larva/ Nymph	The nymphs are most abundant on the younger stems but also occur on the main trunk, branches, foliage and fruit. Feeding by the nymphs induces pitting or galling on some host plant species.	First-instar nymphs (known as 'crawlers') are mobile and disperse by walking to other parts of the same plant or are carried by the wind, phoresy (attached to other animals, including birds) or incidentally by machinery and agricultural workers, to other areas. Once a suitable feeding site is located, they insert their stylets to feed and remain anchored to the host.
Adult	See the notes for the nymphs. Non-gravid females overwinter.	This species is parthenogenetic. Adults are sessile.

3.1.3. Host range/species affected

R. pustulans is a polyphagous pest, feeding on plants belonging to 69 families. Families that contain large numbers of host plants include Apocynaceae, Fabaceae, Malvaceae, Moraceae and Rosaceae. The main hosts of economic importance of *R. pustulans* are fig (*Ficus carica*), apple (*Malus domestica*), guava (*Psidium guajava*), mango (*Mangifera indica*), olive (*Olea europaea*), peach (*Prunus persica*), pear (*Pyrus communis*), plum (*Prunus domestica*), other fruit trees and ornamental plants, especially oleander (El-Salam and Mangoud, 2001; Malumphy, 2014; EFSA PLH Panel, 2021). Appendix A provides a comprehensive list of hosts.

3.1.4. Intraspecific diversity

Two subspecies are recognised: *Russellaspis pustulans principe* is restricted to São Tomé and Príncipe; *Russellaspis pustulans pustulans* is widespread in tropical and subtropical areas and appears to be more invasive.

3.1.5. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes. There are methods available for detection and morphological identification of *R. pustulans*.

Detection

Adult female scales and the galls, if present, are generally obvious enabling them to be detected by visual inspection (Figure 1).

Identification

The identification of *R. pustulans* requires microscopic examination of slide-mounted teneral adult females. A key to adult females and nymphs is provided by Russel (1941) and for species found in North and South America by Stumpf and Lambdin (2006). There are no nucleotide sequences for *R. pustulans* available on GenBank.

Symptoms

The pest infests mainly branches and stems, but also new twigs, leaves and fruits (Moursi et al., 2007). The species typically induces circular pits of different depths on the surface of the plant.

Although deep pits can be caused on stems and branches, generally no pits occur on leaves and fruits (Çalişkan et al., 2015; Moursi et al., 2007; Russell, 1941). The pits are usually more pronounced when the scales feed near the growing tips. When heavy infestations occur galls and deep pits are usually observed (Salama and Hamdy, 1974). However, depending on the host plant susceptibility and feeding location, there may be no pits. It also causes wilting of leaves and twigs, defoliation and dieback of branches, death of trees and yield loss (Abd El-Salam and Mangoud, 2001).

Description

The newly deposited egg is yellow in colour and gradually becomes darker before hatching. It is oval in shape and is about 0.23 mm long and 0.13 mm wide. After hatching, the first-instar nymph settles down and start secreting glassy wax filaments on the dorsal surface and around the body. The crawler grows slightly in size until it reaches about 0.43 mm long and 0.31 mm wide. Then, it casts its cuticle, antennae are greatly reduced and legs are lost. The second larval stage is easily recognised by its round shape and dark-brownish or greyish colour. It also grows in size and becomes yellow in colour (El-Minshawy and El-Sawaf, 1971). The adult scale cover or test is nearly round or oval, about 1 mm in diameter, nearly flat to convex in lateral view, translucent, showing the colour of the female body beneath. Dense white or pink wax filaments are present on the margin and dorsal areas of the cover, with dorsal filaments generally being longer than marginal ones. The female is round or oval, bright yellow, becoming brownish with age (Çalişkan et al., 2015). A detailed morphological description and illustration of an adult female is provided by Stumpf and Lambdin (2006).

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

R. pustulans is present in tropical and subtropical areas around the world, from the Americas, Africa, Europe to Asia and the Pacific (Figure 2, Appendix B). In cooler temperate areas, the pest can be found in indoor plantings (Malumphy, 2014). The scale was found in a greenhouse at a botanical garden in the UK in 1982 (Malumphy, 1996) but there have been no records since then and it is no longer present in the UK. A report of *R. pustulans* in Australia by Malumphy (2014) is erroneous. The occurrence in New York State dates from 1923 and the species' continued presence there is uncertain.

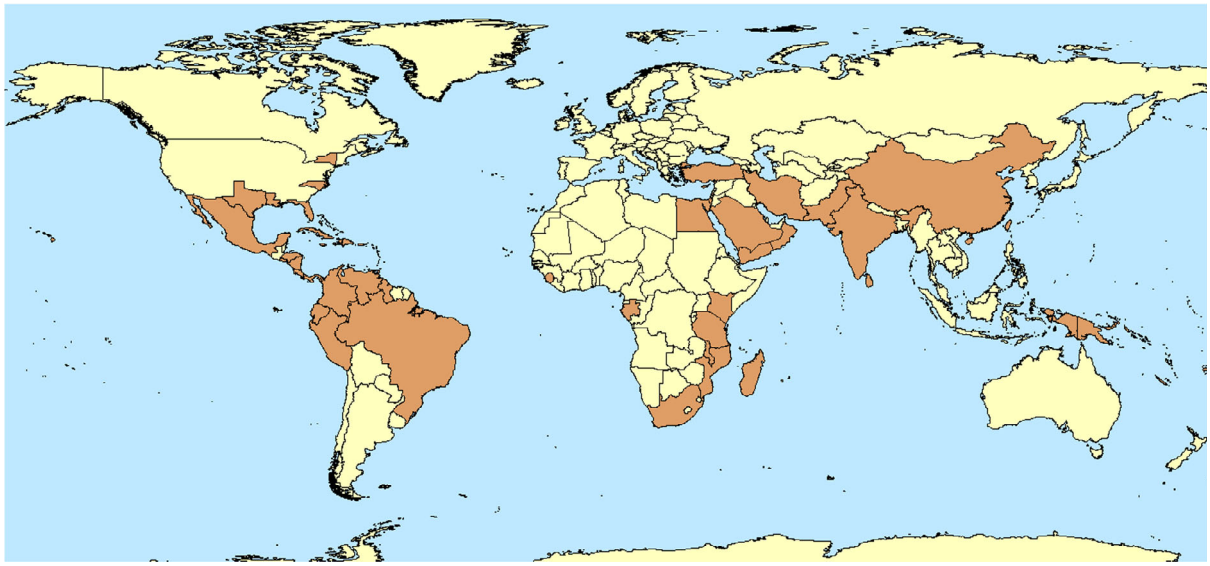

Figure 2: Global distribution of *Russellaspis pustulans* (Data Source: CABI (online) (accessed on 10.12.2021) and literature)

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.

R. pustulans has a restricted distribution in the EU. It has been reported in some literature from Cyprus, Italy and Malta, though not confirmed by the NPPOs. The pest occurs in Spain (Canary Islands, which for plant health purposes are outside the risk assessment area of the EU).

R. pustulans is reported in Cyprus (Şişman & Ülgentürk, 2010) but has not been confirmed by the NPPO. It has been present in the Canary Islands (Spain) for at least 30 years (C. Malumphy, personal communication, 2022). For plant health purposes, the Canary Islands are outside the risk assessment area of the EU.

Stumpf & Lambdin (2006) reported *R. pustulans* as present in Italy and Malta but without providing details on the source of this information. Mazzeo et al. (2014) reviewed the exotic scale insects in Italy and did not mention *R. pustulans*. Mifsud et al. (2014) produced a comprehensive checklist of the scale insects of Malta but explicitly stated that no Maltese specimens of *R. pustulans* had been seen. The reports of *R. pustulans* occurring in Italy and Malta are therefore questionable. The Maltese Plant Protection Directorate communicated that the current status of the pest in Malta is unknown. Similarly, the Italian NPPO stated that the presence of the pest in the country is not known by regional services.

3.3. Regulatory status

3.3.1. Commission Implementing Regulation 2019/2072

Russellaspis pustulans 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

Table 3: List of plants, plant products and other objects that are *Russellaspis pustulans* 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**
2.	Plants of [. . .] *Quercus* L., with leaves, other than fruit and seeds	ex 0602 10 90 ex 0602 20 20 ex 0602 20 80 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 99 ex 0604 20 90 ex 1404 90 00	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, Ukraine and the United Kingdom
8.	Plants for planting of [. . .] *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	Third countries other than: specific third countries (see 2019/2072 Annex VI for details)

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**
		ex 0602 90 47 ex 0602 90 48 ex 0602 90 50 ex 0602 90 70 ex 0602 90 91 ex 0602 90 99	
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: specific third countries (see 2019/2072 Annex VI for details)
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., [. . .] and their hybrids, other than fruits and seeds	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
18.	Plants for planting of Solanaceae other than seeds and the plants covered by entries 15, 16 or 17	ex 0602 90 30 ex 0602 90 45 ex 0602 90 46 ex 0602 90 48 ex 0602 90 50 ex 0602 90 70 ex 0602 90 91 ex 0602 90 99	Third countries other than: Albania, Algeria, Andorra, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Canary Islands, Egypt, Faeroe Islands, Georgia, Iceland, Israel, Jordan, Lebanon, Libya, Liechtenstein, Moldova, Monaco, Montenegro, Morocco, North Macedonia, Norway, Russia (only the following parts: Central Federal District (Tsentralny federalny okrug), Northwestern Federal District (Severo-Zapadny federalny okrug), Southern Federal District (Yuzhny federalny okrug), North Caucasian Federal District (Severo-Kavkazsky federalny okrug) and Volga Federal District (Privolzhsky federalny okrug)), San Marino, Serbia, Switzerland, Syria, Tunisia, Turkey, Ukraine and the United Kingdom

High Risk plant regulation 2018/2019 includes temporary prohibition of *Acacia*, *Albizia*, *Annona*, *Bauhinia*, *Caesalpinia*, *Cassia*, *Crataegus*, *Diospyros*, *Ficus carica*, *Jasminum*, *Malus*, *Nerium*, *Persea*, *Prunus, Quercus, Robinia* and *Salix,* which are hosts of *R. pustulans*, pending risk assessment.

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 plants for planting and fruits, although some host plants for planting are prohibited, closing some potential pathways (Table 3).

Comment on plants for planting as a pathway

Plants for planting, cut branches, cut foliage and fruits are the main potential pathways for entry of *R. pustulans* (Table 4).

Plants for planting, cut branches, cut foliage and fruits are the main potential pathways for entry of *R. pustulans* (Table 4).

Table 4: Potential pathways for *Russellaspis pustulans* into the EU 27

Pathways	Life stage	Relevant mitigations [e.g. prohibitions (Annex VI), special requirements (Annex VII) or phytosanitary certificates (Annex XI) within Implementing Regulation 2019/2072]
Plants for planting	Nymphs, adults	The import of some host plants of *R. pustulans* for planting from third countries is not allowed (Regulation 2019/2072, Annex VI), (Table 3) while there are many other hosts that can be imported to the EU with a phytosanitary certificate.
Cut branches, cut foliage and fruits	Nymphs, adults	A phytosanitary certificate is required to import fresh fruits, cut branches, cut foliage into the EU (2019/2072, Annex XI, Part A and B) unless exempt by being listed in 2019/2072 Annex XI, Part C. However, no specific requirements are set for *R. pustulans*. As not all, but only a proportion of imported consignments are liable to be physically inspected, this requirement does not preclude the entry of *R. pustulans*.

There is a derogation for *F. carica* (EU) 2020/1213) and for *Persea americana* ((EU) 2021/1936) plants coming from Israel. A commodity risk assessment for *F. carica* plants for planting from Israel, indicated with 95% certainty, that between 95.85% and 100% of imported plants would be free of *R. pustulans* (EFSA PLH Panel, 2021).

Table 5: EU 27 annual imports of fresh produce of main hosts from countries where *Russellaspis pustulans* is present (see Appendix B), 2016–2020 (in 100 kg) Source EUROSTAT accessed on 14/1/2022

Crop	HS code	2016	2017	2018	2019	2020
Apples	0808 10	172,168.39	257,956.04	281,930.12	143,755.57	120,871.61
Apricots	0809 10 00	53,858.53	46,519.43	68,502.49	48,880.34	104,477.48
Coconuts	0801	228,735.23	288,014.39	265,479.54	286,034.73	268,262.13
Eggplants	0709 30 00	74,574.02	93,386.48	100,900.39	90,105.63	109,185.45
Figs	0804 20 10	105,859.46	120,052.05	128,787.9	145,672.66	162,760.84
Mangos, guavas	0804 50 00	2,019,240.54	2,235,587.09	2,642,399.41	2,749,644.73	3,060,308.6
Peaches	0809 30 90	14,052.02	11,999.09	25,397.18	7,300	66,185.24
Pears	0808 30	116,415.7	130,887.3	185,407.06	147,761.46	213,213.56
Plums	0809 40 05	13,227.63	32,113.76	16,325.3	11,745.48	28,177.99
Sapodilla	0810 90 20	73,974.3	78,312.88	93,026.21	100,513.4	104,431.65

Notifications of interceptions of harmful organisms began to be compiled in Europhyt in May 1994 and in TRACES in May 2020. As at 08 February 2022, there were no records of interception of *R. pustulans* in the Europhyt and TRACES databases.

3.4.2. Establishment

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

Yes, *R. pustulans* is already reported from Cyprus, Italy and Malta.

Southern EU countries provide suitable environmental conditions (climate and hosts) for the establishment of *R. pustulans,* which is already reported from the above MSs.

It is unlikely that the insect could establish outdoors in central and northern EU countries, although it could occur in greenhouses and on indoor plantings in such areas.

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

R. pustulans is a polyphagous pest and feeds on plants belonging to 69 families (EFSA PLH, 2021). The main hosts of the pest cultivated in the EU 27 between 2016 and 2020 are shown in Table 6. Among others, figs, apples, plums, peaches, pears and olives are highly economically important in the EU.

Table 6: Crop area of main *Russellaspis pustulans* hosts in the EU 27 in 1,000 ha (Eurostat accessed on 14/1/2021)

Crop	2016	2017	2018	2019	2020
Apples	506.48	505.55	507.24	491.08	483.01
Apricots	72.52	72.23	72.57	73.22	76.12
Eggplants	42.96	41.47	42.49	41.21	42.3
Figs	23.74	24.63	24.99	25.59	27.20
Peaches	156.39	154.06	150.80	144.78	135.97
Pears	115.76	114.84	114.84	110.66	107.05
Plums	152.79	153.88	153.43	154.51	154.87
Olives	5,039.24	5,051.85	5,093.57	5,070.49	5,105.13

3.4.2.2. Climatic conditions affecting establishment

R. pustulans is a thermophilic insect and is distributed mainly in areas with tropical and subtropical climates in the Americas (including the Lesser Antilles), Africa, Europe, Asia, and the Pacific, and is restricted to indoor plantings in cooler temperate regions (Malumphy, 2014). Moreover, it has been reported in Cyprus (Şişman and Ülgentürk, 2010) and the Canary Islands (Spain) (C Malumphy, personal communication, 2022). Records in Italy and Malta are unreliable. 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 *R. pustulans* has been reported. Southern EU countries provide suitable climatic conditions for the establishment of *R. pustulans*. However, Köppen–Geiger climate zones do not capture the number of frost days, which may further inform judgments about where in the EU *R. pustulans* could establish. Appendix C shows the mean number of frost days each year on a global scale for the 30-year period 1988–2017, sourced from the Climatic Research Unit high resolution gridded data set CRU TS v. 4.03 at 0.5° resolution (https://crudata.uea.ac.uk/cru/data/hrg/)). A simple visual comparison of Figure 2 (global distribution of *R. pustulans*) and Appendix C indicates that *R. pustulans* occurs primarily in countries with few frost days (red colours in Appendix C). Appendix C indicates that the fewest frost days occur in southern Portugal, around the Mediterranean coast and islands in the Mediterranean; a much smaller area than suggested by Figure 3.

Habib (1943) noted that *R. pustulans* occurs between the 10°C winter isotherm, corresponding to the lower developmental threshold for eggs, and the 32°C summer isotherm, corresponding to the upper temperature for 100% mortality of eggs. Figure 4 shows the 10°C isotherm based on the winter (December, January, February) minimum temperature normals for the period 1991–2020, based on 25km grid weather data from the Joint Research Centre, indicating limits of establishment according to Habib (1943).

It is unlikely that *R. pustulans* could establish outdoors in central and northern EU countries, except for limited coastal areas. However, *R. pustulans* could occur more widely in greenhouses and on indoor plantings.

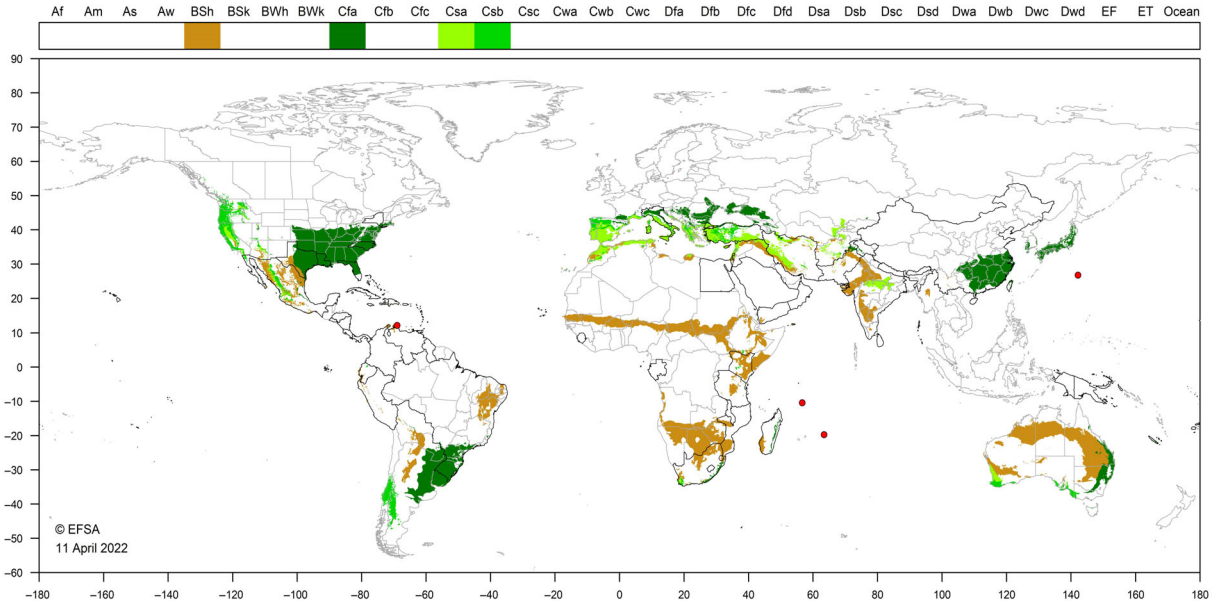

Figure 3: World distribution of Köppen–Geiger climate types that occur in the EU and which occur in countries where *Russellaspis pustulans* has been reported

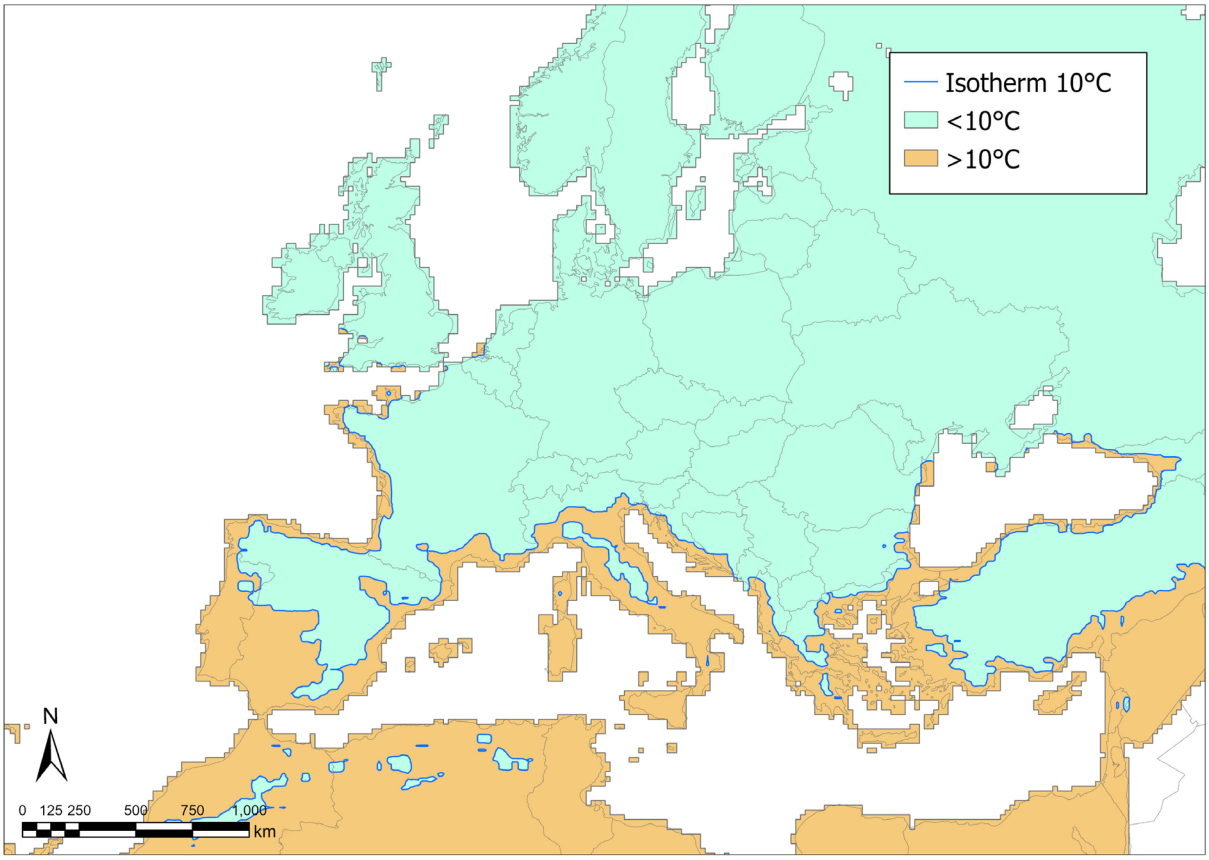

Figure 4: Winter 10°C isotherm based on the minimum temperature normals for the period 1991–2020

3.4.3. Spread

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

First instar nymphs are spread by crawling, wind, rainfall and on humans and animals. All stages may be moved over long distances by the trade of infested plant materials (plants for planting, twigs and fruits).

Comment on plants for planting as a mechanism of spread

Plants for planting is one of the main pathways of spread of the pest over long distances.

The introduction of this pest to new territories over long distance is possible through the movement of infested plants for planting (e.g. fruit tree and ornamental nursery young plants), and trade of infested fruit, vegetables, cut flowers or other plant products. The USDA report that this species is commonly intercepted on imported fruit, particularly apple and mango (Miller et al., 2014).

3.5. Impacts

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

Yes, *R. pustulans* is harmful to fig, olive, apple, mango, guava, oleander and other crop and ornamental plants.

In addition to impacts on fig, the species is reported as a serious pest of apple in Egypt (El-Salam and Mangoud, 2001; Hassan et al., 2012), tea in Zhejiang, China (Cen, 1986), as well as of Sapodilla plum (*Achras sapota* L.) in Puerto Rico (Medina – Gaud et al., 1987). *R. pustulans pustulans* is a prohibited organism in Australia (Government of Western Australia, Department of Primary Industries and Regional Development, online).

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 3.3.2 do not specifically target *R. pustulans*, 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 7.

Table 7: 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
Use of resistant and tolerant plant species/ varieties	Resistant plants are used to restrict the growth and development of a specified pest and/or the damage they cause when compared to susceptible plant varieties under similar environmental conditions and pest pressure. It is important to distinguish resistant from tolerant species/varieties.	Entry/Establishment/Impact
Roguing and pruning	Used to remove infested plant parts and mitigate pest density.	Entry/Spread/Impact
Plants could be grown in a dedicated facility such as an insect proof greenhouse.	Plants could be grown in a dedicated facility such as an insect proof greenhouse.	Plants could be grown in a dedicated facility such as an insect proof greenhouse.
Biological control and behavioural manipulation	Several species of parasitoids and predators have been recorded on *R. pustulans* (Abd-Rabou & Evans, 2010; El Amir et al., 2020). They can contribute to contain pest populations.	Spread/Impact
Chemical treatments on crops including reproductive material	Pesticide sprays are generally effective against crawlers and less effective against the fixed stages of *R. pustulans* because of the wax covering of its body. Issues with pesticides resistance could arise. Azadirachtin, essential oils and mineral oil proved effective in controlling *R. pustulans* (Ismail et al., 2015).	Entry/Establishment/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
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, flowers and vegetables.	Entry/ Spread (via commodity)

3.6.1.2. Additional supporting measures

Potential additional supporting measures are listed in Table 8.

Table 8: 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
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, *R. pustulans* may not be easily detected in cases where low populations occur.
- The waxy scale covering and sessile nature of the later instar nymphs and adult female *R. pustulans* reduces the efficacy from treatments with contact insecticides.
- *R. pustulans* is polyphagous, making the inspections of all consignments containing hosts from countries where the pest occurs difficult.

3.7. Uncertainty

The main uncertainty regards the magnitude of impact of *R. pustulans* on crops and ornamental plants.

4. Conclusions

R. pustulans satisfies all the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest (Table 9).

Table 9: 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 and nymphs exist.	None
Absence/ presence of the pest in the EU (Section 3.2)	The pest has been reported in some literature from Cyprus, Italy and Malta, though not confirmed by the NPPOs.	None
Pest potential for entry, establishment and spread in the EU (Section 3.4)	*R. pustulans* is able to enter into, become established, and spread within the EU territory. The main pathways are: – plants for planting (regulated, some prohibited, some permitted) – fruits, vegetables and cut flowers (regulated, except fruits of *Cocos nucifera*).	None
Potential for consequences in the EU (Section 3.5)	Should *R. pustulans* be introduced into the EU, an economic impact would most likely follow.	Uncertainty about the magnitude of economic impact
Available measures (Section 3.6)	There are measures available to prevent the entry, establishment and spread of *R. pustulans* 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)	*R. pustulans* satisfies all the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest	None
Aspects of assessment to focus on/scenarios to address in future if appropriate:	Reports of significant damage including on apples and olives in Egypt are not seen in neighbouring countries where *R. pustulans* occurs. Further investigation to identify reasons why severe impacts occur in Egypt would inform likely magnitude of impacts in the EU.	

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Abbreviations

EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization
IPPC	International Plant Protection Convention
ISPM	International Standards for Phytosanitary Measures
MS	Member State
PLH	EFSA Panel on Plant Health
PZ	Protected Zone
TFEU	Treaty on the Functioning of the European Union
ToR	Terms of Reference

Glossary

Containment (of a pest)	Application of phytosanitary measures in and around an infested area to prevent spread of a pest (FAO, 2018)
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO, 2018)
Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled (FAO, 2018)
Eradication (of a pest)	Application of phytosanitary measures to eliminate a pest from an area (FAO, 2018)
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 2018)
Greenhouse	A walk-in, static, closed place of crop production with a usually translucent outer shell, which allows controlled exchange of material and energy with the surroundings and prevents release of plant protection products (PPPs) into the environment.
Hitchhiker	An organism sheltering or transported accidentally via inanimate pathways including with machinery, shipping containers and vehicles; such organisms are also known as contaminating pests or stowaways (Toy and Newfield, 2010).
Impact (of a pest)	The impact of the pest on the crop output and quality and on the environment in the occupied spatial units
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO, 2018)

Pathway	Any means that allows the entry or spread of a pest (FAO, 2018)
Phytosanitary measures	Any legislation, regulation or official procedure having the purpose to prevent the introduction or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO, 2018)
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO, 2018)
Risk reduction option (RRO)	A measure acting on pest introduction and/or pest spread and/or the magnitude of the biological impact of the pest should the pest be present. 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 – *Russellaspis pustulans* host plants/species affected

Source: CABI (online), García Morales et al. (2016) and other literature.

Host status	Host name	Plant family	Common name	Reference
Cultivated hosts	*Abelmoschus esculentus*	Malvaceae	Okra	García Morales et al. (2016)
	Abutilon	Malvaceae		García Morales et al. (2016)
	Acacia decurrens	Fabaceae	Black wattle	García Morales et al. (2016)
	Acacia farnesiana	Fabaceae	Casse flower	García Morales et al. (2016)
	Acacia nilotica	Fabaceae	Egyptian mimosa	García Morales et al. (2016)
	Aeglopsis chevalieri	Rutaceae		García Morales et al. (2016)
	Afraegle paniculata	Rutaceae		García Morales et al. (2016)
	Albizia lebbeck	Fabaceae	East Indian walnut	García Morales et al. (2016)
	Alternanthera	Amaranthaceae		García Morales et al. (2016)
	Annona squamosa	Annonaceae	Custard apple	García Morales et al. (2016)
	Artocarpus altilis	Moraceae	Breadfruit	García Morales et al. (2016)
	Bambusa	Poaceae		García Morales et al. (2016)
	Bauhinia tomentosa	Fabaceae	St Thomas tree	García Morales et al. (2016)
	Bignonia callistegioides	Araliaceae	Lavender trumpet vine	García Morales et al. (2016)
	Blighia sapida	Sapindaceae	Akee apple	CABI (online)
	Bougainvillea	Nyctaginaceae		García Morales et al. (2016)
	Boehmeria nivea	Urticaceae	China grass	García Morales et al. (2016)
	Bombax ceiba	Malvaceae	Cotton tree	García Morales et al. (2016)
	Brassica oleracea	Brassicaceae	Cabbage	García Morales et al. (2016)
	Bursera simaruba	Burseraceae	Gumbo limbo	García Morales et al. (2016)
	Caesalpinia	Fabaceae	Congo pea	García Morales et al. (2016)
	Calliandra	Fabaceae		García Morales et al. (2016)
	Callicarpa americana	Lamiaceae	American beauty berry	García Morales et al. (2016)
	Cajanus cajan	Fabaceae	Pigeon pea	CABI (online)
	Camellia sinensis	Theaceae	Tea	CABI (online)
	Capsicum frutescens	Solanaceae	Chilli pepper	García Morales et al. (2016)
	Carica papaya	Caricaceae	Papaya	García Morales et al. (2016)
	Carissa macrocarpa	Apocynaceae	Natal plum	García Morales et al. (2016)
	Carissa spinarum	Apocynaceae	Bush plum	García Morales et al. (2016)
	Casimiroa tetrameria	Rutaceae		García Morales et al. (2016)
	Cassia fistula	Fabaceae	Drumstick tree	García Morales et al. (2016)
	Castilloa	Moraceae		García Morales et al. (2016)
	Casuarina equisetifolia	Casuarinaceae	Australian pine	García Morales et al. (2016)
	Cecropia	Urticaceae		García Morales et al. (2016)
	Ceiba pentandra	Malvaceae	Kapok tree	García Morales et al. (2016)
	Celtis	Cannabaceae	Hackberries	García Morales et al. (2016)
	Cestrum nocturnum	Solanaceae	Night-blooming jessamine	García Morales et al. (2016)
	Chrysobalanus	Chrysobalanaceae		García Morales et al. (2016)

Host status	Host name	Plant family	Common name	Reference
	Chrysojasminum humile	Oleaceae	Italian jasmine	García Morales et al. (2016)
	Chrysophyllum	Sapotaceae		García Morales et al. (2016)
	Citrus	Rutaceae		García Morales et al. (2016)
	Clusia rosea	Clusiaceae	Autograph tree	García Morales et al. (2016)
	Clerodendrum	Lamiaceae		García Morales et al. (2016)
	Cleyera japonica	Pentaphylacaceae	Japanese cleyera	García Morales et al. (2016)
	Clitoria	Fabaceae		García Morales et al. (2016)
	Cocos nucifera	Arecaceae	Coconut	CABI (online)
	Coccoloba uvifera	Polygonaceae	Sea grape	García Morales et al. (2016)
	Coffea	Rubiaceae	Coffee	CABI (online)
	Cordia myxa	Boraginaceae	Assyrian plum	García Morales et al. (2016)
	Crataegus	Rosaceae		García Morales et al. (2016)
	Crotalaria	Fabaceae		García Morales et al. (2016)
	Croton	Euphorbiaceae		García Morales et al. (2016)
	Cupania juglandifolia	Sapindaceae		García Morales et al. (2016)
	Cuphea	Lythraceae		García Morales et al. (2016)
	Cydonia oblonga	Rosaceae	Quince	García Morales et al. (2016)
	Diospyros	Ebenaceae		García Morales et al. (2016)
	Dombeya	Malvaceae		García Morales et al. (2016)
	Dovyalis	Salicaceae		García Morales et al. (2016)
	Duranta	Verbenaceae		García Morales et al. (2016)
	Elaeagnus	Elaeagnaceae		García Morales et al. (2016)
	Eranthemum	Acanthaceae		García Morales et al. (2016)
	Eriobotrya	Rosaceae		García Morales et al. (2016)
	Erythrina	Fabaceae		García Morales et al. (2016)
	Erythroxylum coca	Erythroxylaceae		García Morales et al. (2016)
	Eucalyptus	Myrtaceae		García Morales et al. (2016)
	Eugenia	Myrtaceae		García Morales et al. (2016)
	Euphorbia pulcherrima	Euphorbiaceae	Christmas flower	García Morales et al. (2016)
	Ficus aurea	Moraceae	Golden fig	García Morales et al. (2016)
	Ficus benjamina	Moraceae	Weeping fig	García Morales et al. (2016)
	Ficus carica	Moraceae	Common fig	García Morales et al. (2016)
	Ficus drupacea	Moraceae	Brown woolly fig	García Morales et al. (2016)
	Ficus elastica	Moraceae	Indian rubber plant	García Morales et al. (2016)
	Ficus lutea	Moraceae	Giant-leaved fig	García Morales et al. (2016)
	Ficus minahassae	Moraceae	Hagimit	García Morales et al. (2016)
	Ficus religiosa	Moraceae	Sacred fig	García Morales et al. (2016)
	Ficus sur	Moraceae	Cape fig	García Morales et al. (2016)
	Ficus sycomorus	Moraceae	Mulberry fig	García Morales et al. (2016)
	Ficus virens	Moraceae	Grey fig	García Morales et al. (2016)

Host status	Host name	Plant family	Common name	Reference
	Flacourtia indica	Salicaceae	Madagascar plum	García Morales et al. (2016)
	Foeniculum vulgare	Apiaceae	Fennel	Rivera Amita and Echeverría Sosa (2011)
	Gardenia	Rubiaceae		García Morales et al. (2016)
	Geranium	Geraniaceae		García Morales et al. (2016)
	Gossypium	Malvaceae		García Morales et al. (2016)
	Graptophyllum pictum	Acanthaceae	Caricature plant	García Morales et al. (2016)
	Grevillea robusta	Proteaceae	Silky oak	CABI (online)
	Guazuma ulmifolia	Malvaceae	West Indian elm	García Morales et al. (2016)
	Hedera helix	Araliaceae	Common ivy	García Morales et al. (2016)
	Heliotropium arborescens	Boraginaceae	Garden heliotrope	García Morales et al. (2016)
	Hevea brasiliensis	Euphorbiaceae	Brazilian rubber tree	García Morales et al. (2016)
	Hibiscus mutabilis	Malvaceae	Confederate rose	García Morales et al. (2016)
	Hibiscus rosa-sinensis	Malvaceae	China rose	García Morales et al. (2016)
	Ixora	Rubiaceae		García Morales et al. (2016)
	Jacaranda mimosifolia	Bignoniaceae	Blue jacaranda	García Morales et al. (2016)
	Jasminum sambac	Oleaceae	Arabian jasmine	García Morales et al. (2016)
	Justicia spicigera	Acanthaceae	Mexican indigo	García Morales et al. (2016)
	Kalanchoe	Crassulaceae		García Morales et al. (2016)
	Lagerstroemia	Lythraceae		García Morales et al. (2016)
	Lantana	Verbenaceae		García Morales et al. (2016)
	Leucaena leucocephala	Fabaceae	Leucaena	CABI (online)
	Magnolia	Magnoliaceae		García Morales et al. (2016)
	Malachra	Malvaceae		García Morales et al. (2016)
	Malus domestica	Rosaceae	Apple	Abd El-Salam & Mangoud (2001)
	Malus prunifolia	Rosaceae	Snow cap	García Morales et al. (2016)
	Mangifera indica	Anacardiaceae	Mango	CABI (online)
	Manihot	Euphorbiaceae		García Morales et al. (2016)
	Manilkara zapota	Sapotaceae	Sapodilla	CABI (online)
	Mentha x piperita	Lamiaceae	Pepermint	Rivera Amita and Echeverría Sosa (2011)
	Melia azedarach	Meliaceae	China berry	García Morales et al. (2016)
	Melocactus	Cactaceae	Turk's cap cactus	García Morales et al. (2016)
	Momordica balsamina	Cucurbitaceae	African cucumber	García Morales et al. (2016)
	Morinda citrifolia	Rubiaceae	Noni	García Morales et al. (2016)
	Morus alba	Moraceae	Silkworm mulberry	García Morales et al. (2016)
	Murraya exotica	Rutaceae	Orange jasmine	García Morales et al. (2016)
	Myrica cerifera	Myricaceae	Candleberry	García Morales et al. (2016)

Host status	Host name	Plant family	Common name	Reference
	Myrsine guianensis	Primulaceae		García Morales et al. (2016)
	Myrtus	Myrtaceae		García Morales et al. (2016)
	Nerium oleander	Apocynaceae	Oleander	CABI (online)
	Ocimum basilicum	Lamiaceae	Basil	Rivera Amita and Echeverría Sosa (2011)
	Olea europaea	Oleaceae	Olive tree	EFSA PLH Panel (2021)
	Orthosiphon aristatus	Lamiaceae	Cat's mustache	Rivera Amita and Echeverría Sosa (2011)
	Papilionanthe teres	Orchidaceae		
	Passiflora edulis	Passifloraceae	Passion-fruit vine	García Morales et al. (2016)
	Passiflora quadrangularis	Passifloraceae	Barbadine	García Morales et al. (2016)
	Passiflora vitifolia	Passifloraceae	Crimson passionflower	García Morales et al. (2016)
	Pelargonium radula	Geraniaceae	Crowfoot geranium	García Morales et al. (2016)
	Peltophorum africanum	Fabaceae	African flame	García Morales et al. (2016)
	Pentas lanceolata	Rubiaceae	Egyptian star cluster	García Morales et al. (2016)
	Persea	Lauraceae		García Morales et al. (2016)
	Poranopsis paniculata	Convolvulaceae	Bridal bouquet	García Morales et al. (2016)
	Phoenix	Arecaceae		García Morales et al. (2016)
	Pinus	Pinaceae	Pines	CABI (online)
	Pithecellobium	Fabaceae		García Morales et al. (2016)
	Pittosporum	Pittosporaceae		García Morales et al. (2016)
	Plumbago	Plumbaginaceae		García Morales et al. (2016)
	Plumeria	Apocynaceae	Frangipani	García Morales et al. (2016)
	Prosopis	Fabaceae		García Morales et al. (2016)
	Prunus armeniaca	Rosaceae	Apricot	Abd El-Salam and Mangoud (2001)
	Prunus avium	Rosaceae	Wild cherry	García Morales et al. (2016)
	Prunus domestica	Rosaceae	Plum	García Morales et al. (2016)
	Prunus persica	Rosaceae	Peach	García Morales et al. (2016)
	Psidium guajava	Myrtaceae	Guava	Abd El-Salam and Mangoud (2001)
	Psychotria	Rubiaceae		García Morales et al. (2016)
	Pyrus communis	Rosaceae	Pear	García Morales et al. (2016)
	Pyrostegia	Bignoniaceae		García Morales et al. (2016)
	Quercus	Fabaceae		García Morales et al. (2016)
	Quisqualis indica	Combretaceae	Chinese honeysuckle	García Morales et al. (2016)
	Rhus copallinum	Anacardiaceae	Winged sumac	García Morales et al. (2016)
	Robinia pseudoacacia	Fabaceae	Locust tree	García Morales et al. (2016)
	Rosa	Rosaceae		García Morales et al. (2016)
	Russelia equisetiformis	Plantaginaceae	Coral plant	García Morales et al. (2016)
	Salix	Salicaceae		García Morales et al. (2016)
	Sambucus	Adoxaceae		García Morales et al. (2016)
	Sapium	Euphorbiaceae		García Morales et al. (2016)
	Schefflera morototoni	Araliaceae	Matchwood	García Morales et al. (2016)

Host status	Host name	Plant family	Common name	Reference
	Sedum	Crassulaceae		García Morales et al. (2016)
	Senna alata	Fabaceae	Candelabra bush	García Morales et al. (2016)
	Sesbania sesban	Fabaceae	Egyptian rattlepod	García Morales et al. (2016)
	Sida antillensis	Malvaceae		García Morales et al. (2016)
	Sideroxylon inerme	Sapotaceae	White milkwood	García Morales et al. (2016)
	Smilax	Smilacaceae		García Morales et al. (2016)
	Solanum melongena	Solanaceae	Aubergine	CABI (online)
	Stephanotis floribunda	Apocynaceae	Bridal wreath	García Morales et al. (2016)
	Sterculia	Malvaceae		García Morales et al. (2016)
	Strobilanthes	Lamiaceae		García Morales et al. (2016)
	Symphoricarpos	Caprifoliaceae		García Morales et al. (2016)
	Syzygium	Myrtaceae		García Morales et al. (2016)
	Tabernaemontana divaricata	Apocynaceae	Pinwheel flower	García Morales et al. (2016)
	Tagetes lucida	Asteraceae	Mexican marigold	CABI (online)
	Talinum	Talinaceae		García Morales et al. (2016)
	Talisia macrophylla	Sapindaceae		García Morales et al. (2016)
	Tamarindus indica	Fabaceae	Indian date	García Morales et al. (2016)
	Tecoma	Bignoniaceae		García Morales et al. (2016)
	Tephrosia sinapou	Fabaceae	Fish death tephrosia	García Morales et al. (2016)
	Ternstroemia stahlii	Pentaphylacaceae		García Morales et al. (2016)
	Theobroma cacao	Malvaceae	Cocoa	CABI (online)
	Thespesia grandiflora	Malvaceae	Maga	García Morales et al. (2016)
	Thespesia populnea	Malvaceae	Cork tree	García Morales et al. (2016)
	Tipuana tipu	Fabaceae	Pride of Bolivia	García Morales et al. (2016)
	Trachelospermum	Apocynaceae	Star Jasmine	García Morales et al. (2016)
	Trema	Cannabaceae		García Morales et al. (2016)
	Tournefortia pubescens	Boraginaceae	White-haired Tournefortia	García Morales et al. (2016)
	Vachellia nilotica	Fabaceae	Egyptian mimosa	García Morales et al. (2016)
	Viburnum tinus	Adoxaceae	Laurustinus	García Morales et al. (2016)
	Vitis vinifera	Vitaceae	Grapevine	García Morales et al. (2016)
	Xanthophyllum	Polygalaceae		García Morales et al. (2016)
	Zanthoxylum martinicense	Rutaceae	White prickly ash	García Morales et al. (2016)
	Ziziphus	Rhamnaceae		García Morales et al. (2016)
Wild weed hosts	*Asclepias*	Apocynaceae		García Morales et al. (2016)
	Acalypha indica	Euphorbiaceae	Indian copperleaf	García Morales et al. (2016)

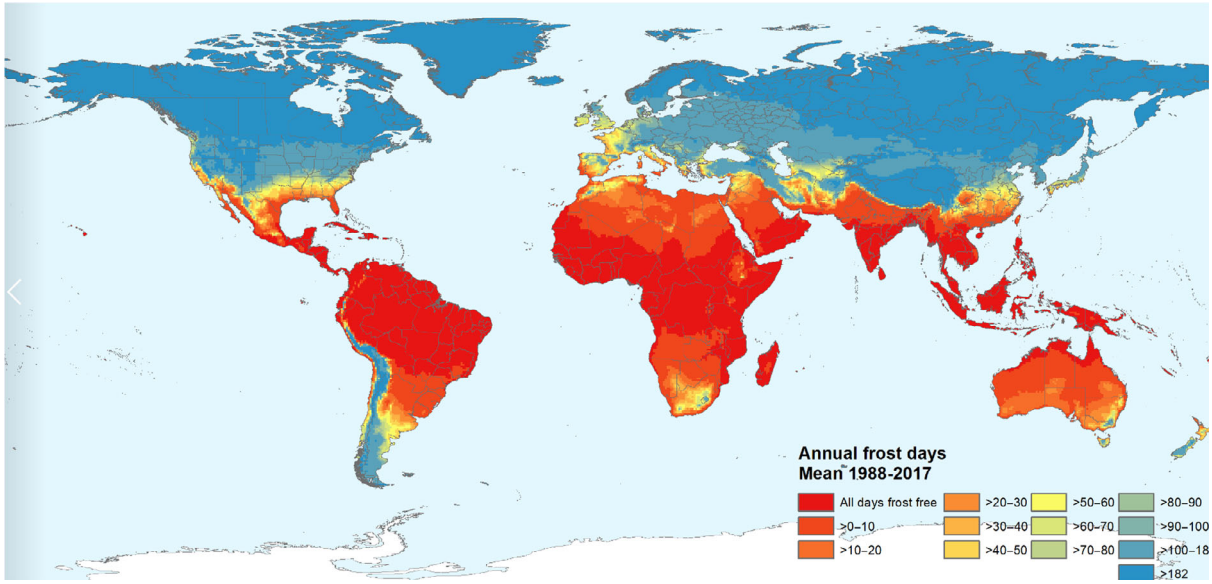
Appendix B – Distribution of *Russellaspis pustulans*

Distribution records based on CABI (online), García Morales et al (ScaleNet, online) and literature.

Region	Country	Sub-national (e.g. State)	Status	Reference
North America	Anguilla		Present	CABI (online)
	Antigua and Barbuda		Present	CABI (online)
	Bahamas		Present	CABI (online)
	Barbados		Present	CABI (online)
	Bermuda		Present	CABI (online)
	Costa Rica		Present	CABI (online)
	Cuba		Present	CABI (online)
	Curaçao		Present	CABI (online)
	Dominica		Present	CABI (online)
	Dominican Republic		Present	CABI (online)
	El Salvador		Present	CABI (online)
	Grenada		Present	CABI (online)
	Guadeloupe		Present	CABI (online)
	Haiti		Present	CABI (online)
	Honduras		Present	CABI (online)
	Jamaica		Present	CABI (online)
	Martinique		Present	García Morales et al. (2016)
	Mexico		Present	CABI (online)
	Montserrat		Present	CABI (online)
	Nicaragua		Present	CABI (online)
	Panama		Present	CABI (online)
	Puerto Rico		Present	CABI (online)
	Saint Croix		Present	García Morales et al. (2016)
	Saint Kitts and Nevis		Present	CABI (online)
	Saint Lucia		Present	CABI (online)
	Saint Vincent and the Grenadines		Present	CABI (online)
	Trinidad and Tobago		Present	CABI (online)
	U.S. Virgin Islands		Present	CABI (online)
	United States		Present	CABI (online)
	United States	Florida	Present	García Morales et al. (2016)
	United States	Louisiana	Present	García Morales et al. (2016)
	United States	New York	Present	García Morales et al. (2016)
	United States	North Carolina	Present	García Morales et al. (2016)
	United States	Texas	Present	García Morales et al. (2016)
	United States	Hawaii	Present	García Morales et al. (2016)
South America	Brazil		Present	CABI (online)
	Colombia		Present	CABI (online)
	Ecuador		Present	CABI (online)
	Guyana		Present	CABI (online)
	Peru		Present	CABI (online)
	Trinidad and Tobago		Present	García Morales et al. (2016)
	Venezuela		Present	CABI (online)
EU (27)	Cyprus		Present	CABI (online)

Region	Country	Sub-national (e.g. State)	Status	Reference
	Italy		Present	García Morales et al. (2016)
	Malta		Present	García Morales et al. (2016)
	Spain (Canary Islands)	Gran Canaria	Present	C Malumphy, personal communication, 2022
		Tenerife	Present	C Malumphy, personal communication, 2022
Africa	Cape Verde		Present	García Morales et al. (2016)
	Egypt		Present	CABI (online)
	Gabon		Present	García Morales et al. (2016)
	Kenya		Present	García Morales et al. (2016)
	Madagascar		Present	García Morales et al. (2016)
	Malawi		Present	García Morales et al. (2016)
	Mauritius	Agalega islands	Present	García Morales et al. (2016)
		Rodriques island	Present	García Morales et al. (2016)
	Mozambique		Present	Garcia Morales et al. (2016)
	São Tomé and Príncipe		Present	CABI (online)
	Seychelles		Present	García Morales et al. (2016)
	Sierra Leone		Present	García Morales et al. (2016)
	South Africa		Present	García Morales et al. (2016)
	Tanzania		Present	García Morales et al. (2016)
Asia	China		Present	CABI (online)
	India		Present	CABI (online)
	Indonesia	Irian Jaya (now Papua)	Present	García Morales et al. (2016)
	Iran		Present	García Morales et al. (2016)
	Israel		Present	Ben-Dov, 2012
	Japan	Bonin islands	Present	García Morales et al. (2016)
	Oman		Present	García Morales et al. (2016)
	Pakistan		Present	García Morales et al. (2016)
	Saudi Arabia		Present	García Morales et al. (2016)
	Sri Lanka		Present	García Morales et al. (2016)
	Taiwan		Present	CABI (online)
	Turkey		Present	CABI (online)
	Yemen		Present	García Morales et al. (2016)
Oceania	Fiji Islands		Present	García Morales et al. (2016)
	French Polynesia		Present	García Morales et al. (2016)
	Kiribati		Present	García Morales et al. (2016)
	New Caledonia		Present	García Morales et al. (2016)
	Papua New Guinea		Present	García Morales et al. (2016)
	Tuvalu		Present	García Morales et al. (2016)

Appendix C – Annual frost days



Source: Climatic Research Unit high resolution gridded data set CRU TS v. 4.03 at 0.5° resolution (https://crudata.uea.ac.uk/cru/data/hrg/).