SCIENTIFIC OPINION

EFSA Journal

ADOPTED: 8 July 2021

doi: 10.2903/j.efsa.2021.6801

Pest categorisation of *Phenacoccus solenopsis*

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Abstract

The EFSA Panel on Plant Health performed a pest categorisation of *Phenacoccus solenopsis* (Hemiptera: Pseudococcidae) for the European Union (EU) territory. This species is not included in EU Commission Implementing Regulation 2019/2072. *P. solenopsis* is native to North America and has spread to all continents except Antarctica. It has recently been reported from Cyprus, Greece and Italy. This mealybug is a polyphagous pest, feeding on about 300 plant species. It usually feeds on aerial plant parts, especially new growth, but also occurs on roots, and is often associated with ants. It is an economically important pest of ornamentals, such as hibiscus and lantana, glasshouse vegetable crops, mainly bell pepper, tomato and eggplant, and field crops, such as cotton. Large populations cause die-back and reduction in yield. Adult and immature *P. solenopsis* could enter the EU with imported fresh fruit, vegetables and cut flowers, although the main pathway of introduction is likely to be plants for planting. Host availability and climate suitability indicate that most of the EU would be suitable for establishment. The main natural dispersal stage is the first instar, which crawls over the plant or may be dispersed further by wind and animals. All stages may be transported over longer distances in trade. Phytosanitary measures are available and should prevent further introductions and slow the spread within the EU. *P. solenopsis* is under official control in Cyprus and has recently been reported in Greece and Italy. Assuming that these reports reflect a limited distribution, and *P. solenopsis* shortly comes under official control, it would satisfy all the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest.

Keywords: cotton mealybug, solenopsis mealybug, pest risk, plant health, plant pest, quarantine

Requestor: European Commission

Question number: EFSA-Q-2021-00215

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Declarations of interest: The declarations of interest of all scientific experts active in EFSA's work are available at https://ess.efsa.europa.eu/doi/doiweb/doisearch.

Suggested citation: EFSA PLH Panel (EFSA Panel on Plant Health), Bragard C, Di Serio F, Gonthier P, Jaques Miret JA, Justesen AF, Magnusson CS, Milonas P, Navas-Cortes JA, Parnell S, Potting R, Reignault PL, Thulke H-H, Van der Werf W, Civera AV, Yuen J, Zappalà L, Gregoire J-C, Malumphy C, Campese C, Czwienczek E, Kertesz V, Maiorano A and MacLeod A, 2021. Scientific Opinion on the pest categorisation of *Phenacoccus solenopsis.* EFSA Journal 2021;19(8):6801, 36 pp. https://doi.org/10.2903/j.efsa.2021.6801

ISSN: 1831-4732

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

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1. Introduction

1.1. Background and Terms of Reference as provided by the requestor

1.1.1. Background

The new Plant Health Regulation (EU) 2016/2031, on the protective measures against pests of plants, is applying from 14 December 2019. Conditions are laid down in this legislation in order for pests to qualify for listing as Union quarantine pests, protected zone quarantine pests or Union regulated non-quarantine pests. The lists of the EU regulated pests together with the associated import or internal movement requirements of commodities are included in Commission Implementing Regulation (EU) 2019/2072. Additionally, as stipulated in the Commission Implementing Regulation 2018/2019, certain commodities are provisionally prohibited to enter in the EU (high risk plants, HRP). EFSA is performing the risk assessment of the dossiers submitted by exporting to the EU countries of the HRP commodities, as stipulated in Commission Implementing Regulation 2018/2018. Furthermore, EFSA has evaluated a number of requests from exporting to the EU countries for derogations from specific EU import requirements.

In line with the principles of the new plant health law, the European Commission with the Member States are discussing monthly the reports of the interceptions and the outbreaks of pests notified by the Member States. Notifications of an imminent danger from pests that may fulfil the conditions for inclusion in the list of the Union quarantine pest are included. Furthermore, EFSA has been performing horizon scanning of media and literature.

As a follow-up of the above-mentioned activities (reporting of interceptions and outbreaks, HRP, derogation requests and horizon scanning), a number of pests of concern have been identified. EFSA is requested to provide scientific opinions for these pests, in view of their potential inclusion by the risk manager in the lists of Commission Implementing Regulation (EU) 2019/2072 and the inclusion of specific import requirements for relevant host commodities, when deemed necessary by the risk manager.

1.1.2. Terms of Reference

EFSA is requested, pursuant to Article 29(1) of Regulation (EC) No 178/2002, to provide scientific opinions in the field of plant health.

EFSA is requested to deliver 53 pest categorisations for the pests listed in Annex 1A, 1B, 1D and 1E (for more details see mandate M-2021-00027 on the Open.EFSA portal). Additionally, EFSA is requested to perform pest categorisations for the pests so far not regulated in the EU, identified as pests potentially associated with a commodity in the commodity risk assessments of the HRP dossiers (Annex 1C; for more details see mandate M-2021-00027 on the Open.EFSA portal). Such pest categorisations are needed in the case where there are not available risk assessments for the EU.

When the pests of Annex 1A are qualifying as potential Union quarantine pests, EFSA should proceed to phase 2 risk assessment. The opinions should address entry pathways, spread, establishment, impact and include a risk reduction options analysis.

Additionally, EFSA is requested to develop further the quantitative methodology currently followed for risk assessment, in order to have the possibility to deliver an express risk assessment methodology. Such methodological development should take into account the EFSA Plant Health Panel Guidance on quantitative pest risk assessment and the experience obtained during its implementation for the Union candidate priority pests and for the likelihood of pest freedom at entry for the commodity risk assessment of High Risk Plants.

1.2. Interpretation of the Terms of Reference

Phenacoccus solenopsis is one of a number of pests listed in Annex 1 to the Terms of Reference (ToR) (Section 1.1.2) to be subject to pest categorisation to determine whether it fulfils the criteria of a regulated pest for the area of the EU excluding Ceuta, Melilla and the outermost regions of Member States referred to in Article 355(1) of the Treaty on the Functioning of the European Union (TFEU), other than Madeira and the Azores, and so inform European Commission decision-making as to its appropriateness for potential inclusion in the lists of pests of Commission Implementing Regulation (EU) 2019/2072. If a pest fulfils the criteria to be potentially listed as a regulated pest, specific import

requirements for relevant host commodities will be identified; for pests already present in the EU additional risk reduction options to slow spread and facilitate eradication will be identified.

2. Data and methodologies

2.1. Data

2.1.1. Literature search

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

2.1.2. Database search

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

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

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

2.2. Methodologies

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

The criteria to be considered when categorising a pest as a Union quarantine pest (QP) is given in Regulation (EU) 2016/2031 Article 3 and Annex 1 to this 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 defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

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

3. Pest categorisation

3.1. Identity and biology of the pest

3.1.1. Identity and taxonomy

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

Yes, the identity of the species is established and *Phenacoccus solenopsis* Tinsley is the accepted name. Recent molecular data provides some evidence that *P. solenopsis* may comprise a cryptic species complex (Thomas and Ramamurthy, 2014; Ahmed et al., 2015), but this requires further research and has not been proven.

Phenacoccus solenopsis is an insect within the Order Hemiptera and Family Pseudococcidae. It is commonly known as the cotton or solenopsis mealybug.

Phenacoccus solenopsis Tinsley (Figure 1), was initially described in 1898 from specimens collected in Mesilla Park, New Mexico, USA, in October 1892, from the roots and stems of *Boerhavia spicata* (Nyctaginaceae) and *Kallstroemia californica (*Zygophyllaceae*),* within nests of the fire ant *Solenopsis geminata* Fabricius (Hymenoptera: Formicidae), hence the specific epithet (Tinsley, 1898a). In the same year, Tinsley (1898b) provided a description of the adult female collected on the roots of *Atriplex canescens (*Amaranthaceae). The species was subsequently described under the names *Phenacoccus cevalliae* Cockerell 1902 and *gossypiphilous* Abbas, Arif and Saeed 2005, which are considered junior synonyms (García Morales et al., 2016).

Hodgson et al. (2008) suggested that three nominal species, *P. solenopsis*, *P. solani* Ferris and *P. defectus* Ferris, may be environmentally induced variants of a single species. Subsequently, *P. defectus* was synonymised with *P. solani*, and most researchers now consider *P. solenopsis* and *P. solani,* to be valid species. They can usually be easily separated in life as adult female *P. solenopsis* have distinct dorsal dark markings (Figure 1), which are absent in *P. solani.*

Thomas and Ramamurthy (2014) studied the genetic diversity in populations of *P. solenopsis* using mitochondrial cytochrome oxidase 1 (mtCO-1) sequences. The phylogenetic tree they produced with available sequences in the NCBI GenBank from different geographic regions revealed a distinct

separation between Asian and American populations. A similar result was obtained by Ahmed et al. (2015). The latter obtained *P. solenopsis* mtCOI sequences from specimens collected across China and Pakistan, and compared them with already available mtCOI sequences from additional Asian and North American countries. Genetic analysis provided evidence that *P. solenopsis* should be classified into two groups, one of which is found only in the United States and the other found in Asia. The Asian group contained nine unique haplotypes, two of which have invaded and spread across China, Pakistan, India and Vietnam.

It appears that there are two distinct evolutionary lineages of *P. solenopsis*, but further evidence is necessary to draw any reliable conclusions on the existence of a *P. solenopsis* species complex.

The EPPO code[1] for this species is: PHENSO (EPPO, online).

Figure 1: *Phenacoccus solenopsis*: teneral adult female (left), showing characteristic dark patches on the dorsum; colony of mature females (right), the dorsal markings are obscured by waxy secretions © Chris Malumphy

3.1.2. Biology of the pest

The biology of *P. solenopsis* has been described by Hodgson et al. (2008), Fand and Suroshe (2015) and Vennila et al. (2010). The life cycle takes between 28 and 35 days, and it has 8–12 generations annually, the number depending on temperature and host quality. Hodgson et al. (2008) reported that reproduction was always sexual although facultative parthenogenesis was observed under laboratory conditions in India (Vennila et al., 2010). It overwinters as an adult female, on the bark, the stem and branches of woody plants. It seems that it may develop underground on roots of non-woody plants (Spodek et al., 2018). It has been reported to be capable of surviving temperatures ranging from 0°C to 45°C on Okra in India (Sharma, 2007). Table 2 summarises key features of the biology of each life stage.

P. solenopsis colonies are frequently attended by ants and the mutualism between the red imported fire ant *Solenopsis invicta* and the mealybug has been studied by Zhou et al. (2012). The mutualism facilitates population growth and fitness of both species and may help drive the invasion success of these species when introduced to new areas.

[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).

Table 2: Important features of the life history strategy of *Phenacoccus solenopsis*

Life stage	Phenology and relation to host	Other relevant information
Egg	*P. solenopsis* has been reported to lay 150–600 eggs into an ovisac (Lu et al., 2008), whereas others report it is ovoviviparous (eggs hatch inside female) (Hodgson et al., 2008).	
Nymph	Mainly found on the young growth, including twigs, stems, leaves, flower buds and petioles. They are occasionally found on the roots of herbaceous plants and in ants' nests (Spodek et al., 2018). Females have three nymphal instars, and the males have four. The final two male nymph instars (called prepupa and pupa) do not feed.	First-instar nymphs (known as 'crawlers') are mobile and disperse by walking to other parts of the same plant or are carried on the wind or by other means (e.g. farm machinery, workers, animals) to other areas (Hodgson et al., 2008). Mealybug crawlers can live for approximately one day without feeding. When 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. Males have wings and females are wingless (neotenic and larviform).	Facultative parthenogenetic. Adult males have no functional mouthparts and are short-lived (a few hours to 3 days) during which time they disperse by flight, although they are weak flyers, and seek a female to mate with. Adult females can live for up to 3 months (Gerson and Aplebaum, online).

3.1.3. Host range and plants affected

P. solenopsis is highly polyphagous, feeding on approximately 300 plant species in 65 botanical families (listed in Appendix A). The plant families containing most hosts are Amaranthaceae, Asteraceae, Cucurbitaceae, Euphorbiaceae, Fabaceae, Lamiaceae, Malvaceae and Solanaceae. Hosts include many crops grown in the EU. However, Spodek et al. (2018) reported that some of the woody plants affected by the pest, including citrus (*Citrus* spp.), almond (*Prunus dulcis*) and grape vine (*Vitis vinifera*), are not suitable for the reproduction of *P. solenopsis* in Israel. *P. solenopsis* breeds on herbaceous plants in citrus groves and vineyards. These preferred hosts desiccate during the hot summer, and the mealybugs tend to migrate on to nearby stems of the crop plant, forming conspicuous aggregates on branches and in the canopy, but also on wooden or metal posts. Mealybug development was not observed on citrus and grapevines (Spodek et al., 2018).

There is uncertainty regarding how many of the plant species listed in Appendix A can support a self-sustaining population of *P. solenopsis*.

3.1.4. Intraspecific diversity

Hodgson et al. (2008) and Thomas and Ramamurthy (2014) found *P. solenopsis* exhibited considerable environmentally induced morphological variation. Recent molecular data provides some evidence that *P. solenopsis* may comprise a cryptic species complex (Ahmed et al., 2015; Chen et al., 2012; Thomas and Ramamurthy, 2014), but this requires further research and has not been proven.

3.1.5. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes, *P. solenopsis* can be found during visual inspection of infested consignments of host plants; adult females, ovisacs and nymphs can be found on the surface of plant foliage, stems, flowers, and fruit, and occasionally roots.

Morphological keys and molecular methods are available to identify specimens to the species level.

P. solenopsis is gregarious and often forms conspicuous groups on new growth (shoots, buds, flowers, fruits) of their host plants (Figure 1). They may be found on all aerial parts of the plant and show a preference for the upper parts, especially young shoots or branches carrying fruitlets (Spodek et al., 2018). They also occasionally occur on the root-collar and roots of herbaceous plants.

Symptoms resulting from large populations of mealybugs cause general weakening, distortion, chlorosis, defoliation, dieback and death of susceptible plants (Malumphy et al., 2013). Plants become covered in sooty moulds that grow on the honeydew egested by the mealybugs.

The taxonomy of Pseudococcidae is based on the morphology of the adult female. Adult female *P. solenopsis* exhibit considerable morphological variation which is discussed in Section 3.1.4. Hodgson et al. (2008) provided detailed descriptions and illustrations of adult and nymphs of both sexes. Detailed descriptions of the adult female and identification keys are provided by McKenzie (1967) for California, Williams and Granara de Willink (1992) and Granara de Willink and Szumik (2007) for Central and South America, Hodgson et al. (2008) for Asia and Ferris (1950) for North America. Hodgson et al. (2008) also provides a key to separate all the different instars of *P. solenopsis*.

Summary descriptions of the female life stages are provided below:

- First instar nymph is yellowish, elliptical, 0.4 × 0.2 mm, with red eyes and well-developed legs.
- Second and third instar nymphs are yellowish, elliptical, about 0.75–1.00 mm and 1.00–1.73 mm long, respectively, with short marginal wax filaments.
- Adult female is yellowish, about 2–5 mm long and 2–4 mm wide, covered with a powdery white wax secretion, except for bare patches of dark grey cuticle, with three pairs of submarginal patches on the abdomen (these may appear to be one long streak) and one pair on the thorax (Figure 1). Paired segmental wax filaments extend from the margin around the body, with the terminal pair of filaments longest. An ovisac of fluffy, loose-textured wax strands is produced (McKenzie, 1967; Sartiami et al., 2016).

An online factsheet on *P. solenopsis* produced by Jackson and Mua (2019) provides photographs of the adults and feeding damage. Molecular diagnostic methods, based on the cytochrome c oxidase I sequence, are available to identify *P. solenopsis* with a number of accessions in Genbank.

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

P. solenopsis is native to North America and has spread to Central and South America, the Caribbean, Africa, Asia and Oceania (see Map 2). It has recently been introduced to Europe (see Section 3.2.2 below).

Appendix B provides national and subnational records of occurrence (EPPO, online).

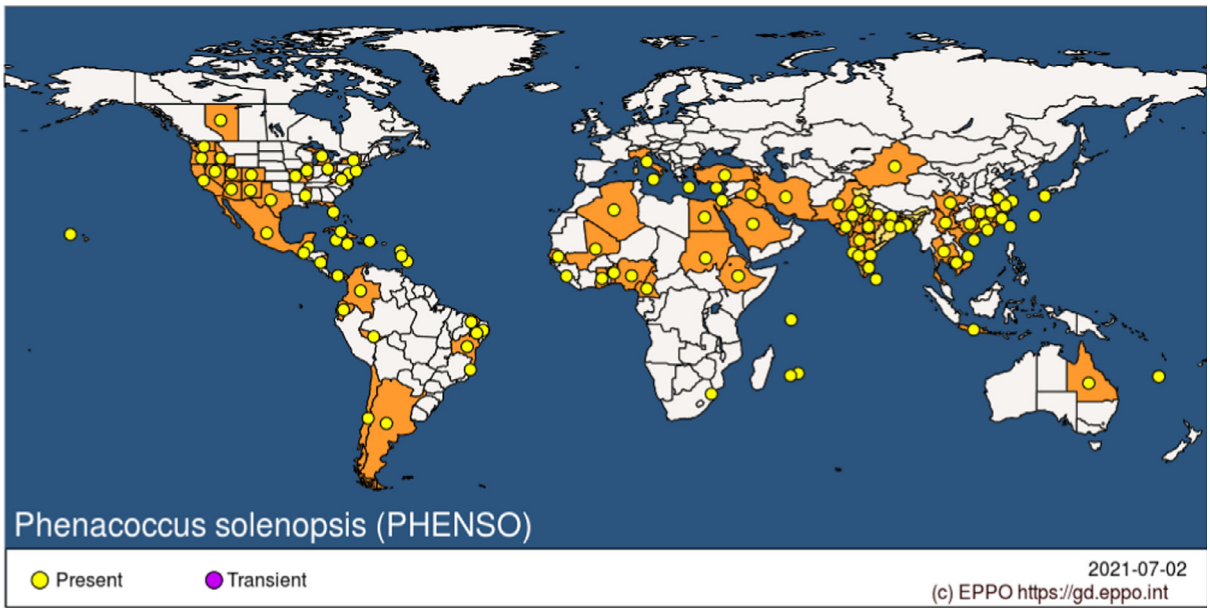

Figure 2: Global distribution of *Phenacoccus solenopsis* (Source: EPPO Global Database accessed on 2/7/2021)

3.2.2. Pest distribution in the EU

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

Yes, *P. solenopsis* is present in the EU and has a restricted distribution.

- Cyprus (EPPO, 2011).
- Greece. Present in Crete (pers. com. Milonas 2020 in EFSA PLH Panel, 2021a).
- Italy. Present in Lazio region and Sicily (Sannino et al., 2019).

In the Netherlands, EPPO (online) reported the pest as absent, intercepted only.

3.3. Regulatory status

3.3.1. Commission Implementing Regulation 2019/2072

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

It is under official control in Cyprus and has only recently been reported in Greece and Italy.

3.3.2. Hosts of *Phenacoccus solenopsis* that are prohibited from entering the Union from third countries

As specified in Annex VI of 2019/2072, some plants, which are also *P. solenopsis* host plants (see Appendix A), are prohibited from entering the EU as plants for planting (Table 3).

Table 3: List of plants, plant products and other objects that are *Phenacoccus solenopsis* 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 [. . .], *Prunus* L., *Pyrus* L. and *Rosa* L., other than dormant plants free from leaves, flowers and fruits	see 2019/2072 Annex VI for details	Third countries other than: specified European third countries (see 2019/2072 Annex VI for details)
9.	Plants for planting of [. . .], *Prunus* L. and *Pyrus* L. and their hybrids, [. . ..], other than seeds		Third countries, other than: specified European third countries, specified countries bordering the Mediterranean Sea, specified Eurasian countries, Australia, Canada, New Zealand, specified parts of Russia, United States other than Hawaii (see 2019/2072 Annex VI for details)
10.	Plants of *Vitis* L>, other than fruits		Third countries other than Switzerland
11.	Plants of *Citrus* L. [. . .] and their hybrids, other than fruits and seeds		All third countries
13.	Plants of *Phoenix* spp. other than fruit and seeds		Algeria, Morocco
14.	Plants for planting of the family Poaceae, other than plants of ornamental perennial grasses of the subfamilies Bambusoideae and Panicoideae and of the genera [. . .], other thanSeeds		Third countries, other than: specified European third countries, specified countries bordering the Mediterranean Sea (see 2019/2072 Annex VI for details)
15.	Tubers of *Solanum tuberosum* L.,seed potatoes		Third countries other than Switzerland

16.	Plants for planting of stolon- or tuber-forming species of *Solanum*L. or their hybrids, other than those tubers of *Solanum tuberosum*L. as specified in entry 15		Third countries other than Switzerland
17.	Tubers of species of *Solanum* L., and their hybrids, other thanthose specified in entries 15 and 16		Third countries other than:(a) Algeria, Egypt, Israel, Libya, Morocco, Syria, Switzerland, Tunisia and Turkey,or(b) those which fulfil the following provisions: (see 2019/2072 Annex VI for details)
18.	Plants for planting of Solanaceae other than seeds and the plantscovered by entries 15, 16 or 17		Third countries, other than: specified European third countries, specified countries bordering the Mediterranean Sea, specified Eurasian countries (see 2019/2072 Annex VI for details)
19.	Soil as such consisting in part of solid organic substances		Third countries other than Switzerland

Annex I of EU 2018/2019 lists high risk plants. Some of these plants are hosts of *P. solenopsis*, e.g. *Annona cherimola, Ficus carica*, *Nerium oleander* and *Prunus dulcis*.

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.

Comment on plants for planting as a pathway.

Yes, *P. solenopsis* has already entered the EU. It may further enter the EU territory with imported fresh fruit, vegetables, flowers and plants for planting.

Adult females and all immature stages of *P. solenopsis* may be transported with fresh fruit, vegetables, flowers, cotton linters and plants for planting, including bulbs, tubers, tuberous roots, corms, crowns and rhizomes. Adult males are less likely to be transported than the other stages, as they are winged and may fly off when disturbed during harvesting and processing for shipment. *P. solenopsis* is polyphagous and its hosts include many crop and ornamental plants imported into the EU from areas where the mealybug occurs (see Table 4 for a summary of potential pathways). No special requirements in Annex VII relate specifically to *P. solenopsis*. However, there are some prohibitions on high risk plants. Some of them are hosts of *P. solenopsis* (Section 3.3.2) Regarding plants for planting, commodity risk assessments specifically for *Ficus carica* plants imported from Israel and for *Nerium oleander* plants imported from Turkey identified *P. solenopsis* as a pest that could be transported (EFSA, 2021a,b).

Tables 5–11 show the imported weight (100 Kg) of specific commodities between 2015 and 2020 from regions where *P. solenopsis* is known to occur, and which provide potential pathways of introduction. Detailed data on the EU 27 imports of tomatoes from countries where the pest is present can be seen in Appendix C.

Soil and growing media and soil on machinery were not considered viable options.

Table 4: Potential pathways for *Phenacoccus solenopsis* into the EU 27. No special requirements in Annex VII relate to *P. solenopsis*

Pathways	Life stage	Relevant mitigations [e.g. prohibitions (Annex VI) or special requirements (Annex VII) within Implementing Regulation 2019/2072]
Tomato fruit, fresh and chilled	Adult female, immature	
Aubergine fruit, fresh or chilled	Adult female, immature	
Cotton linters	Adult female, immature	
Roots and tubers of manioc 'cassava', fresh or chilled	Adult female, immature	
Capsicum fruits, fresh or chilled	Adult female, immature	
Bulbs, tubers, tuberous roots, corms, crowns and rhizomes	Adult female, immature	For prohibitions, see Table 3
Live tree and other plants for planting	Adult female, immature	For prohibitions see Table 3
Cut flowers and ornamental foliage	Adult female, immature	
Leafy vegetables and herbs, fresh or chilled	Adult female, immature	

Table 5: Tomato fruit, fresh or chilled (CN code 0702), imported (kg) into the EU (27) from regions where *Phenacoccus solenopsis* is known to occur (Source Eurostat accessed on 13/5/2021)

Region	2016	2017	2018	2019	2020
Asia	728,476.61	1,017,542.27	1,082,435.27	1,006,835.33	1,256,132.98
Africa	101,016.13	76,333.51	101,068.88	97,158.46	84,005.18
North America	0.00	0.00	0.11	0.04	0.93
Central America	19,550.87	21,840.02	19,688.19	15,920.89	17,237.85
South America	2.03	27.60	0.00	2,828.76	236.09
Oceania	0.00	0.00	0.00	2.52	0.00
Total	849,045.64	1,115,743.40	1,203,192.45	1,122,746.00	1,357,613.03

Table 6: Aubergine fruit, fresh or chilled (CN code 070930), imported (kg) into the EU (27) from regions where *Phenacoccus solenopsis* is known to occur

Region	2016	2017	2018	2019	2020
Asia	66,485.69	85,828.24	88,563.24	77,201.19	100,309.80
Africa	3,928.68	3,771.83	2,094.41	2,346.75	2,711.81
North America	24.15	2,368.38	7,799.81	8,471.51	6,853.17
Central America	8,216.52	5,476.62	5,445.96	4,803.55	1,396.08
South America	0.00	0.30	0.00	4.65	1.53
Oceania	0.00	0.00	0.00	0.00	0.00
	78,655.04	97,445.37	103,903.42	92,827.65	111,272.39

Table 7: Bulbs, tubers, tuberous roots, corms, crowns and rhizomes (CN code 0601), imported (kg) into the EU (27) from regions where *Phenacoccus solenopsis* is known to occur

Bulbs, tubers, tuberous roots, corms, crowns and rhizomes,	2016	2017	2018	2019	2020
Asia	23,284.60	13,694.34	13,239.14	11,326.09	11,456.31
Africa	0.00	0.00	3.26	1.42	14.27
North America	10.48	5.48	7.18	409.89	6.97
Central America	0.97	0.45	0.35	0.00	0.00
South America	241.71	32.51	52.83	94.17	213.10
Oceania	0.18	0.67	0.26	0.05	0.00
	23,537.94	13,733.45	13,303.02	11,831.62	11,690.65

Table 8: Cotton linters (CN code 140420) imported (kg) into the EU (27) from regions where *Phenacoccus solenopsis* is known to occur

Cotton linters	2016	2017	2018	2019	2020
Asia	43,548.73	115,624.31	88,878.39	83,691.35	90,632.74
Africa	400.00	296.42	608.38	132.94	87.99
North America	56,181.45	32,472.85	16,629.25	7,933.06	19,150.08
Central America	0.00	0.00	0.00	0.00	0.00
South America	13,493.54	62,260.87	68,605.72	65,491.66	64,750.33
Oceania	0.00	0.00	0.00	0.00	0.00
	113,623.72	210,654.45	174,721.74	157,249.01	174,621.14

Table 9: Fresh, chilled, frozen or dried roots and tubers of manioc 'cassava' (CN code 071410), imported (kg) into the EU (27) from regions where *Phenacoccus solenopsis* is known to occur

	2016	2017	2018	2019	2020
Asia	14,984.63	11,192.93	20,188.01	47,612.53	69,083.05
Africa	8,004.89	13,055.09	17,750.91	20,433.65	45,015.23
North America	0.00	0.00	0.01	0.61	2.01
Central America	303.22	0.00	311.46	793.75	787.97
South America	2,685.43	3,200.44	2,648.93	7,792.67	7,636.22
Oceania	0.00	0.00	0.00	0.00	0.00
	25,978.17	27,448.46	40,899.32	76,633.21	122,524.48

Table 10: Fresh or chilled fruits of the genus *Capsicum* or *Pimenta* (CN code 070960), imported (kg) into the EU (27) from regions where *Phenacoccus solenopsis* is known to occur

Region	2016	2017	2018	2019	2020
Asia	882,016.17	849,417.36	1,003,658.42	841,294.12	993,485.36
Africa	14,751.34	19,484.00	14,928.88	8,037.57	6,759.77
North America	405.23	250.75	259.13	428.28	451.26
Central America	4,193.66	4,069.63	5,043.99	4,734.71	3,630.07
South America	124.57	48.43	69.57	46.99	17.77
Oceania	0.05	1.01	0.00	0.00	0.00
	901,491.02	873,271.18	1,023,959.99	854,541.67	1,004,344.23

Table 11: Live tree and other plants, bulbs and roots, cut flowers and ornamental foliage (CN code 06), imported (kg) into the EU (27) from regions where *Phenacoccus solenopsis* is known to occur

Region	2016	2017	2018	2019	2020
Asia	715,804.19	740,339.94	834,848.27	917,663.77	964,560.64
Africa	883,724.55	883,780.50	620,636.08	590,941.17	654,714.19
North America	286,490.71	254,708.77	227,613.35	216,327.76	175,542.89
Central America	637.48	188.66	891.65	6,520.69	5,308.10
South America	574,893.44	580,622.93	632,649.07	645,607.43	589,575.30
Oceania	7,817.69	7,823.61	10,441.77	7,365.74	7,029.60
	2,469,368.06	2,467,464.41	2,327,080.19	2,384,426.56	2,396,730.72

Notifications of interceptions of harmful organisms began to be compiled in Europhyt in 1994 and in TRACES in May 2020. As of 14 April 2021 there were 6 records of interceptions of *Phenacoccus solenopsis* in the Europhyt historical database (2001, 2002, 2004 and 2018 interceptions) on the following plants: *Manihot esculenta*, *Annona reticulata*, *Annona* sp. *Lantana camara*, Psidium guajava, *Ocimum basilicum*. This species was intercepted in the UK on multiple occasions during the last decade on fresh herbs and vegetables imported from Africa, the Middle East and Asia (Malumphy et al., 2013). The main trade pathways were *Ocimum basilicum* from Israel and Jordan, and *Solanum melongena* from Kenya.

3.4.2. Establishment

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

Yes, *P. solenopsis* has established in Cyprus and Italy, and was reported from Greece. Biotic factors such as host availability, and abiotic factors such as climate suitability suggest that large areas of the EU would be suitable for 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 3.4.2.1 and climatic factors in 3.4.2.2.

Although adult females and all immature stages of *P. solenopsis* may be transported with fresh fruit, vegetables, flowers and cotton linters, the likelihood of transfer to a suitable host following entry is low as the mealybugs have a relatively low natural dispersal potential. Plants for planting, including bulbs, tubers, tuberous roots, corms, crowns and rhizomes, present a much higher risk of establishment.

3.4.2.1. EU distribution of main host plants and plants affected

As noted above, and in Appendix A, *P. solenopsis* is polyphagous, feeding on a wide range of ornamentals, vegetable and fruit crops and cotton. Cultivated plants such as almond, basil, bell pepper, citrus, eggplant, grapevine, maize, olive, sage, sorghum and tomato, are grown in central and southern EU.

Table 12 shows the harvested area of key hosts and food plants cultivated in the EU 27 in recent years. Detailed production data of host plants in the EU 27 can be found in Appendix D.

Table 12: Harvested area of some *Phenacoccus solenopsis* hosts in EU 27, 2016–2020 (thousand ha). Source EUROSTAT (accessed on 15/5/2021)

Crop	Code	2016	2017	2018	2019	2020
Tomatoes	V3100	246.80	240.87	239.55	235.14	236.46
Eggplants	V3210	21.58	20.73	21.44	20.63	21.36
Peppers	V3600	57.59	57.47	56.27	59.68	59.66
Cotton fibre	I2300	301.34	326.12	345.64	361.78	350.07

3.4.2.2. Climatic conditions affecting establishment

P. solenopsis is most frequently reported from tropical and subtropical regions in the Americas, Middle East, Asia and Africa. However, it is reported to occur in India in areas which experience temperatures that range from 0°C to 45°C (Sharma, 2007). What is remarkable is that it has been found in the Canadian prairies in Alberta on the roots of *Artemisia frigida* and *Rosa arkansana* in the nests of six species of ant (Newton et al., 2011). Two of these ant species are very common throughout the EU: yellow meadow ant *Lasius flavus* and black garden ant *Lasius niger*. The significance of this finding is unclear. It may indicate that *P. solenopsis* could survive in ant's nests, feeding on plant roots, in northern temperate areas of the EU which experience sub-zero winters. It is likely to only occur at low population densities in such areas.

P. solenopsis can establish in southern and central Europe and there is uncertainty regarding establishment in Northern areas.

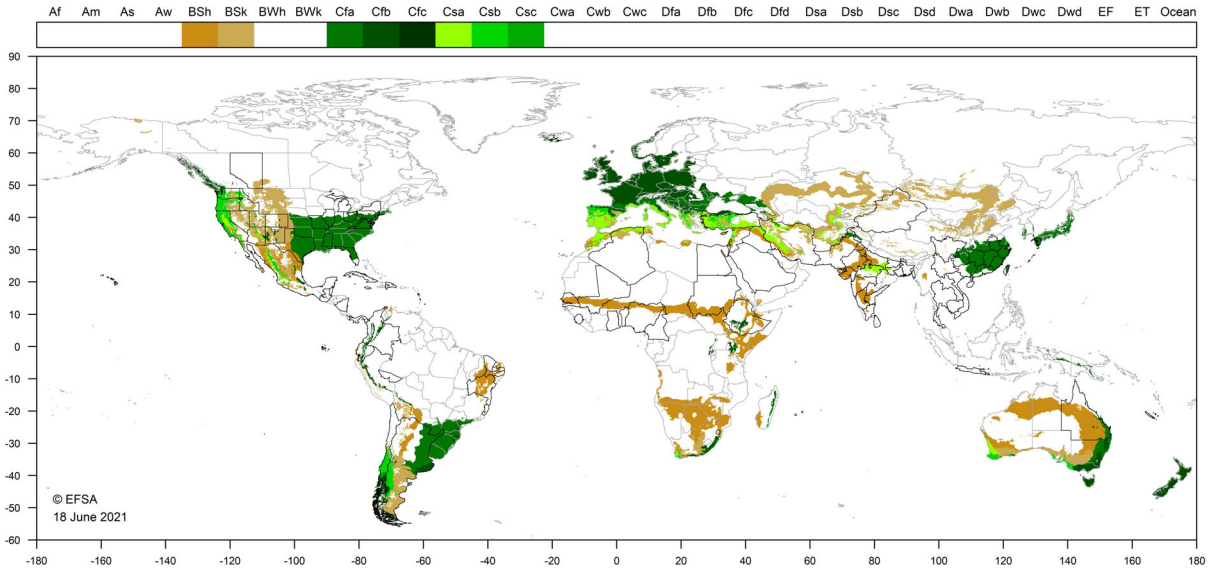

Figure 3: World distribution of eight Köppen–Geiger climate types that occur in the EU and which occur in countries where *Phenacoccus solenopsis* has been reported

3.4.3. Spread

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

P. solenopsis is a free-living organism that appears to be spreading and/or there have been multiple introductions within the EU. Natural spread by the first instars crawling or being carried by wind, other animals, or machinery, will occur locally and relatively slowly. In Israel, during dry periods it has been recorded migrating from herbaceous hosts, on which it breeds, to woody orchard plants and vineyards.

Comment on plants for planting as a mechanism of spread.

Adult females and immatures can be carried on plants for planting.

3.5. Impacts

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

Yes, adults and immatures are harmful to a range of plants and economic impacts are expected, particularly to glasshouse vegetable crops such as bell pepper, eggplants, and tomato, and field crops, such as cotton. Environmental impacts are also possible, as the mealybug can feed on a range of native herbaceous plants.

The main economic impact has been reported on cotton, with 30–60% yield losses in India and Pakistan (Fand and Suroshe, 2015). Infested cotton plants become stunted, growth appears to stop and most plants look dehydrated. In severe outbreaks, the bolls fail to open, and defoliation occurs (including the loss of flower buds, flowers and immature bolls) (Hodgson et al., 2008).

It is also an economic pest of tomato, eggplant and bell peppers grown in glasshouses in Israel, as *P. solenopsis* prefers to feed on the young shoots and branches carrying fruitlets (Spodek et al., 2018). On tomatoes the pest causes foliar yellowing, leaf wrinkling, puckering and severe damage, resulting in death (Ibrahim et al., 2015). Ornamental plants can lose value due to sooty moulds growing on honeydew egested by the mealybug.

In Cyprus, *P. solenopsis* was found mainly in private gardens on ornamental plants. It had a high impact to *Antirrhinum majus, Chrysanthemum, Hibiscus sinensis, Hibiscus syriacus, Lantana camara, Lycianthes rantonnetii, Myoporum laetum, Petunia, Pittosporum tobira, Osteospermum, Portulaca oleraceae* and a medium impact to *Abelmoschus esculentus, Gaillardia aristata, Leucophyllum frutescens, Solanum lycopersicum, Solanum melongena, Trachelospermum jasminoides* and *Vitis vinifera* (Malumphy et al., 2013).

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

Are there measures available to prevent the entry into the EU (and spread for pests already present) such that the risk becomes mitigated?

Yes, some hosts are already prohibited as plants for planting from third countries (see 3.3.2). Measures proposed by Israel for *Ficus carica* and Turkey for *Nerium oleander* plants for planting are evaluated in EFSA (2021a,b). Fresh produce imported into the EU require a phytosanitary certificate and a proportion of consignments are inspected. Additional options are available to reduce the likelihood of pest entry into the EU. Surveillance, detection, pesticide treatments, restricting plant movement are amongst measures to prevent spread.

3.6.1. Identification of potential additional measures

Phytosanitary measures (prohibitions) are currently applied to some host plants for planting (see 3.3.2). Further potential control measures on hosts that are imported are listed in Table 13. For *N. oleander* and *F. carica*, see EFSA (2021a,b).

Table 13: Selected control measures (a full list is available in EFSA PLH Panel, 2018) for pest entry and spread in relation to currently unregulated hosts and pathways

Special requirements summary with hyperlink (in blue) to information sheet if available	Potential control measures summary
Growing plants in isolation	Production in insect proof greenhouses or isolated fields could be considered because *P. solenopsis* has a low natural dispersal potential as adult females cannot fly; measures could be applied in vicinity of growing site.
Chemical treatments on crops including reproductive material	Used to mitigate likelihood of infestation of pests susceptible to chemical treatments. Sahito et al. (2011) provides a review of pesticides against *P. solenopsis*
Roguing and pruning	The mealybug shows a preference for new growth and pruning can reduce the population density.
Soil treatment	A soil drench will mitigate likelihood of infestation of soil at origin
Inspections	Has been detected during import inspections (Malumphy, 2005; Malumphy et al., 2013) Used to mitigate likelihood of infestation by specified pest at origin
Chemical treatments on consignments or during processing	Used to mitigate likelihood of infestation of pests susceptible to chemical treatments

Special requirements summary with hyperlink (in blue) to information sheet if available	Potential control measures summary
Physical treatments on consignments or during processing	Used to mitigate likelihood of infestation of pests susceptible to physical treatments
Heat and cold treatments	Although *P. solenopsis* is reported to have a wide temperature tolerance, treatments using temperatures outside tolerable limits could be used.
Controlled atmosphere	Used to mitigate likelihood of infestation of pests susceptible to modified atmosphere (usually applied during transport) hence to mitigate entry
Cleaning and disinfection of facilities, tools and machinery	Used to mitigate likelihood of entry or spread of soil borne pests
Limits on soil	*P. solenopsis* may occur on roots, especially of herbaceous plants Used to mitigate likelihood of entry or spread via pests in soil
Phytosanitary certificate and plant passport	Used to attest which of the above requirements have been applied

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

- *P. solenopsis* can feed on roots and is therefore difficult to detect and treat.
- *P. solenopsis* has mutualistic relations with ant colonies.
- *P. solenopsis* can feed on a wide range of hosts (approximately 300 species assigned to 65 families) although they seem unlikely to be able to sustain populations on some of the woody hosts.
- Limited effectiveness of control measures: Although both contact and systemic insecticides are available, they have not always been effective against *P. solenopsis* in Cyprus, and populations increase rapidly in the summer months (Malumphy et al., 2013). The congeneric South American bougainvillea mealybug *Phenacoccus peruvianus* was first detected in Europe in Spain in 1999, and in two decades became widespread in the Mediterranean.

3.7. Uncertainty

There is uncertainty regarding the abiotic requirements, area of potential establishment in the EU, rate of natural spread, frequency of root feeding and occurrence in ants' nests, level of impact to outdoor crops, environmental impacts and the effectiveness of mitigation measures.

If entering on fresh produce, there are uncertainties over the pest's ability to transfer to a suitable host following arrival in the EU. Uncertainties affecting establishment, which are common to other pests that enter, also include allee effects (effects causing reduced survival of new colonies with a small number of individuals (Tobin et al., 2011)).

Population densities of *P. solenopsis* have recently declined in Israel due to parasitism by *Aenasius arizonensis* (Girault) (Hymenoptera, Encyrtidae), which has reduced the impact (Spodek et al., 2018). *A. arizonensis* is present in Israel and Turkey but has not been recorded in the EU. There is uncertainty regarding the level of predation and parasitism by natural enemies of *P. solenopsis* already present in the EU, and whether *A. arizonensis* will spread naturally into the EU.

4. Conclusions

P. solenopsis is a highly polyphagous North American mealybug that has spread to all continents except Antarctica. It has recently been reported in the EU where it has a limited distribution. It is under official control in Cyprus and has recently been reported in Greece and Italy. Assuming that these reports reflect a limited distribution, and *P. solenopsis* shortly comes under official control, it would satisfy all the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest (Table 14).

Table 14: 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 species is established and *Phenacoccus solenopsis* Tinsley is the accepted name.	Recent molecular data provides some evidence that *P. solenopsis* may comprise a cryptic species complex.
Absence/presence of the pest in the EU (Section 3.2)	*Phenacoccus solenopsis* is present in the EU where it has a restricted distribution (Cyprus, Greece and Italy)	It is likely to be under-recorded due to difficulties with detection and identification.
Regulatory status (Section 3.3)	*P. solenopsis* is not regulated in the EU plant health regulations. It is under official control in Cyprus and has recently been reported in Greece and Italy.	Whether or not official action will be taken against *P. solenopsis* in all EU members where the pest occurs. It is unknown if it will become regulated in the near future.
Pest potential for entry, establishment and spread in the EU (Section 3.4)	Adult and immature *P. solenopsis* may enter the EU with imported fresh fruit, vegetables and flowers although the main pathway of introduction is likely to be plants for planting. Biotic factors (host availability) and abiotic factors (climate suitability) suggest that most of the EU would be suitable for establishment of *P. solenopsis*. The pest is a free-living organism and could spread within the EU, facilitated by movement of hosts.	
Potential for consequences in the EU (Section 3.5)	Adults and nymphs are harmful to a range of plants and economic and possibly environmental impacts would be expected if *P. solenopsis* spreads in the EU.	
Available measures (Section 3.6)	Some plants affected by *P. solenopsis* are already prohibited as plants for planting from third countries and produce imported into the EU require a phytosanitary certificate of which a proportion of consignments are inspected. Additional options are available to reduce the likelihood of pest entry into and spread within the EU.	
Conclusion (Section 4)	Assuming that the recent reports reflect a limited distribution, and *P. solenopsis* shortly comes under official control, it would satisfy all the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest.	It is unclear how effective any official action will be to eradicate or contain the pest.
Aspects of assessment to focus on/scenarios to address in future if appropriate:		

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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
TFEU	Treaty on the Functioning of the European Union
ToR	Terms of Reference

Glossary

Containment (of a pest)	Application of phytosanitary measures in and around an infested area to prevent spread of a pest (FAO, 2018).
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO, 2018).

Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled (FAO, 2018).
Eradication (of a pest)	Application of phytosanitary measures to eliminate a pest from an area (FAO, 2018).
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 2018).
Greenhouse	A walk-in, static, closed place of crop production with a usually translucent outer shell, which allows controlled exchange of material and energy with the surroundings and prevents release of plant protection products (PPPs) into the environment.
Impact (of a pest)	The impact of the pest on the crop output and quality and on the environment in the occupied spatial units.
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO, 2018).
Pathway	Any means that allows the entry or spread of a pest (FAO, 2018).
Phytosanitary measures	Any legislation, regulation or official procedure having the purpose to prevent the introduction or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO, 2018).
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO, 2018).
Risk reduction option (RRO)	A measure acting on pest introduction and/or pest spread and/or the magnitude of the biological impact of the pest should the pest be present. A RRO may become a phytosanitary measure, action or procedure according to the decision of the risk manager.
Spread (of a pest)	Expansion of the geographical distribution of a pest within an area (FAO, 2018).

Appendix A – *Phenacoccus solenopsis* host plants and plants affected

Source: EPPO Global Database (EPPO online) and García Morales et al. (2016).

Some of the woody host plants may not be suitable for a self-sustaining population of *P. solenopsis* (Spodek et al., 2018). Many of the 'wild weed hosts' listed below may also be cultivated as ornamentals.

Host status	Host name	Plant family	Common name	Reference[A]
Cultivated hosts	*Abelmoschus esculentus*	Malvaceae	Okra	EPPO
	Abelmoschus moschatus	Malvaceae	Musk okra	EPPO
	Anacardium occidentale	Anacardiaceae	Cashew	EPPO
	Ananas comosus	Bromeliaceae	Pineapple	Spodek et al. (2018)
	Annona muricata	Annonaceae	Soursop	EPPO
	Annona squamosa	Annonaceae	Sugar apple	EPPO
	Antirrhinum majus	Plantaginaceae	Snapdragon	Malumphy et al. (2013)
	Azadirachta indica	Meliaceae	Neem	García Morales et al. (2016)
	Beta vulgaris	Amaranthaceae	Beet	García Morales et al. (2016)
	Cajanus cajan	Fabaceae	Pigeon pea	**EPPO**
	Capsicum annuum	Solanaceae	Chilli, bell pepper	**EPPO**
	Capsicum frutescens	Solanaceae	Chilli pepper	Arif et al. (2009)
	Carica papaya	Caricaceae	Papaya	EPPO
	Chrysanthemum x morifolium	Asteraceae	Chrysanthemum	Arif et al. (2009)
	Chrysanthemum sp.	Asteraceae	Chrysanthemum	EPPO
	Cichorium intybus	Asteraceae	Chicory	Arif et al. (2009)
	Citrullus colocynthis	Cucurbitaceae	Bitter apple	Arif et al. (2009)
	Citrullus lanatus	Cucurbitaceae	Watermelon	EPPO
	Citrus aurantium	Rutaceae	Seville orange	Arif et al. (2009)
	Citrus limon	Rutaceae	Lemon	EPPO
	Citrus paradisi	Rutaceae	Grapefruit	Spodek et al. (2018)
	Citrus sinensis	Rutaceae	Orange	Arif et al. (2009)
	Cucumis melo	Cucurbitaceae	Musk melon	EPPO
	Cucumis sp.	Cucurbitaceae		García Morales et al. (2016)
	Cucurbita moschata	Cucurbitaceae	Pumpkin, butternut squash	EPPO
	Cucurbita sp.	Cucurbitaceae		García Morales et al. (2016)
	Cyamopsis tetragonoloba	Fabaceae	Cluster bean	EPPO
	Diospyros kaki	Ebenaceae	Japanese persimmon, kaki	Spodek et al. (2018)
	Eruca vesicaria	Brassicaceae	Garden rocket	Spodek et al. (2018)
	Euphorbia pulcherrima	Euphorbiaceae	Poinsettia	García Morales et al. (2016)
	Ficus carica	Moraceae	Common fig	Arif et al. (2009)
	Gaillardia aristata	Asteraceae	Common gaillardia	Malumphy et al. (2013)
	Gardenia jasminoides	Rubiaceae	Gardenia	Arif et al. (2009)
	Gossypium arboreum	Malvaceae	Tree cotton	Arif et al. (2009)
	Gossypium herbaceum	Malvaceae	Levant cotton	García Morales et al. (2016)
	Gossypium hirsutum	Malvaceae	Cotton	EPPO

Host status	Host name	Plant family	Common name	Reference[A]
	Gossypium sp.	Malvaceae		Fallahzadeh et al. (2014)
	Helianthus annuus	Asteraceae	Sunflower	EPPO
	Hibiscus cannabinus	Malvaceae	Mesta	EPPO
	Hibiscus rosa-sinensis	Malvaceae	Chinese hibiscus	EPPO
	Hibiscus sabdarifa	Malvaceae	Ambadi	EPPO
	Lactuca sativa	Asteraceae	Lettuce	Spodek et al. (2018)
	Lagenaria siceraria	Cucurbitaceae	Bottle gourd, calabash	EPPO
	Lagerstroemia indica	Lythraceae	Crape myrtle	Arif et al. (2009)
	Lantana camara	Verbenaceae	Common lantana	Arif et al. (2009)
	Leucophyllum candidum	Scrophulariaceae	Barometer bush	Spodek et al. (2018)
	Leucophyllum frutescens	Scrophulariaceae	Texas sage	Spodek et al. (2018)
	Luffa acutangula	Cucurbitaceae	Luffa, ridge gourd	EPPO
	Luffa aegyptiaca	Cucurbitaceae	Sponge gourd	EPPO
	Luffa sp.	Cucurbitaceae		Fallahzadeh et al. (2014)
	Lycianthes rantonnetii	Solanaceae	Blue potato bush	Spodek et al. (2018)
	Mangifera indica	Anacardiaceae	Mango	EPPO
	Manihot esculenta	Euphorbiaceae	Cassava	García Morales et al. (2016)
	Manilkara zapota (=*Achras zapota*)	Sapotaceae	Sapodilla, sapota	EPPO
	Mentha spicata	Lamiaceae	Spearmint	Arif et al. (2009)
	Momordica charantia	Cucurbitaceae	Bitter gourd	EPPO
	Morus alba	Moraceae	White mulberry	Arif et al. (2009)
	Myoporum laetum	Scrophulariaceae	Mousehole tree	Malumphy et al. (2013)
	Nerium oleander	Apocynaceae	Oleander	Arif et al. (2009)
	Nicotiana tabacum	Solanaceae	Tobacco	Arif et al. (2009)
	Ocimum basilicum	Lamiaceae	Basil	Arif et al. (2009)
	Olea europaea	Oleaceae	Olive	Spodek et al. (2018)
	Osteospermum	Asteraceae	African daisy	Malumphy et al. (2013)
	Passiflora edulis	Passifloraceae	Passion fruit	Spodek et al. (2018)
	Pelargonium	Geraniaceae		Spodek et al. (2018)
	Pennisetum glaucum	Poaceae	Pearl millet	García Morales et al. (2016)
	Petunia	Solanaceae	Petunia	Malumphy et al. (2013)
	Phoenix dactylifera	Arecaceae	Date palm	Arif et al. (2009)
	Piper betle	Piperaceae	Betel	Arif et al. (2009)
	Pittosporum tobira	Pittosporaceae	Mock orange	Malumphy et al. (2013)
	Portulaca oleracea	Portulacaceae	Common purlane	Malumphy et al. (2013)
	Psidium guajava	Myrtaceae	Guava	EPPO
	Plumeria rubra	Apocynaceae	Frangipani	Arif et al. (2009)
	Punica granatum	Lythraceae	Pomegranate	EPPO
	Prunus dulcis	Rosaceae	Almond	Spodek et al. (2018)
	Salvia officinalis	Lamiaceae	Sage	Arif et al. (2009)
	Sesamum indicum	Pedaliaceae	Sesame	EPPO
	Solanum lycopersicum	Solanaceae	Tomato	EPPO
	Solanum melongena	Solanaceae	Aubergine, brinjal, eggplant	EPPO
	Solanum tuberosum	Solanaceae	Potato	EPPO
	Sorghum bicolor	Poaceae	Sorghum, jowar	EPPO

Host status	Host name	Plant family	Common name	Reference[A]
	Spinacia oleracea	Amaranthaceae	Spinach	Spodek et al. (2018)
	Thymus vulgaris	Lamiaceae	Thyme	Spodek et al. (2018)
	Trachelospermum jasminoides	Apocynaceae	Star jasmine	Malumphy et al. (2013)
	Verbena officinalis	Verbenaceae	Common verbena	Arif et al. (2009)
	Vigna radiata	Fabaceae	Mung bean, green gram	EPPO
	Vitis sp.	Vitaceae	Grape vine	EPPO
	Vitis vinifera	Vitaceae	Grape vine	EPPO
	Zea mays	Poaceae	Maize	García Morales et al. (2016)
	Ziziphus mauritiana	Rhamnaceae	Jujube, ber	EPPO
Wild weed hosts	*Abutilon asiaticum*	Malvaceae	Country mallow	EPPO
	Abutilon fruticosum	Malvaceae	Texas Indian mallow	Fallahzadeh et al. (2014)
	Abutilon hirtum	Malvaceae	Indian mallow	Arif et al. (2009)
	Abutilon indicum	Malvaceae	Indian abutilon	Arif et al. (2009)
	Abutilon muticum	Malvaceae		Arif et al. (2009)
	Abutilon theophrasti	Malvaceae	Velvet plant	Arif et al. (2009)
	Acacia leucophloea	Fabaceae	White barked acacia	Arif et al. (2009)
	Acacia modesta	Fabaceae	Phulai	Arif et al. (2009)
	Acalypha wilkesiana	Euphorbiaceae	Copperleaf	Arif et al. (2009)
	Achillea	Asteraceae	Yarrow	Ben-Dov (1994)
	Achyranthes aspera	Amaranthaceae	Chaff-flower	Arif et al. (2009)
	Acrachne racemosa	Poaceae		García Morales et al. (2016)
	Adenium obesum	Apocynaceae	Desert rose	Spodek et al. (2018)
	Aerva javanica	Amaranthaceae	Kapok bush	Arif et al. (2009)
	Ageratina adenophora	Asteraceae	Crofton weed	García Morales et al. (2016)
	Ageratum conyzoides	Asteraceae	Billygoat-weed	Arif et al. (2009)
	Albizia lebbeck	Fabaceae	Lebbek	Arif et al. (2009)
	Alcea rosea	Malvaceae	Hollyhock	García Morales et al. (2016)
	Allamanda blanchetii	Apocynaceae	Purple allamanda	Spodek et al. (2018)
	Alternanthera ficoidea	Amaranthaceae	Joseph's coat	García Morales et al. (2016)
	Althaea	Malvaceae		García Morales et al. (2016)
	Alyogyne huegelii	Malvaceae	Lilac hibiscus	Spodek et al. (2018)
	Amaranthus hybridus	Amaranthaceae	Green amaranth	García Morales et al. (2016)
	Amaranthus retroflexus	Amaranthaceae	Red-root amaranth	Spodek et al. (2018)
	Amaranthus spinosus	Amaranthaceae	Spiny amaranth	García Morales et al. (2016)
	Amaranthus viridis	Amaranthaceae	Slender amaranth	García Morales et al. (2016)
	Ambrosia artemisiifolia	Asteraceae	Common ragweed	Ben-Dov (1994)
	Ambrosia tenuifolia	Asteraceae	Lacy ragweed	García Morales et al. (2016)
	Anagallis arvensis	Primulaceae	Scarlet pimpernel	Arif et al. (2009)

Host status	Host name	Plant family	Common name	Reference[A]
	Antirrhinum	Plantaginaceae		Spodek et al. (2018)
	Aphelandra squarrosa	Acanthaceae	Zebra plane	Arif et al. (2009)
	Artemisia frigida	Asteraceae	Arctic sage	Newton et al. (2011)
	Asparagus aethiopicus	Asparagaceae	Sprenger's asparagus	Arif et al. (2009)
	Asparagus setaceus	Asparagaceae	Lace fern	Arif et al. (2009)
	Asteriscus graveolens	Asteraceae	Canary Island daisy	Spodek et al. (2018)
	Atriplex canescens	Amaranthaceae	Chamiso	Tinsley (1898b)
	Bassia indica	Amaranthaceae	Indian bassia	Arif et al. (2009)
	Bauhinia purpurea	Fabaceae	Hawaiian orchid tree	Arif et al. (2009)
	Boerhavia repens	Nyctaginaceae	Anena	Arif et al. (2009)
	Boerhavia spicata	Nyctaginaceae	Creeping spiderling	Tinsley (1898b)
	Bombax ceiba	Malvaceae	Cotton tree	Arif et al. (2009)
	Bougainvillea glabra	Nyctaginaceae	Lesser bougainvillea	Arif et al. (2009)
	Brachychiton rupestris	Malvaceae	Narrow-leaved bottle tree	Spodek et al. (2018)
	Broussonetia papyrifera	Moraceae	Paper mulberry	Arif et al. (2009)
	Calendula officinalis	Asteraceae	Common marigold	Arif et al. (2009)
	Calotropis gigantea	Apocynaceae	Crown flower	García Morales et al. (2016)
	Calotropis procera	Apocynaceae	Apple of Sodom	Arif et al. (2009)
	Capparis decidua	Capparaceae	Karira	Arif et al. (2009)
	Cassia fistula	Fabaceae	Golden shower	Arif et al. (2009)
	Celosia argentea	Amaranthaceae	Plumed cockscomb	Arif et al. (2009)
	Centaurea cyanus	Asteraceae	Cornflower	Arif et al. (2009)
	Centaurea segetum	Asteraceae	Cornflower	García Morales et al. (2016)
	Cestrum diurnum	Solanaceae	Day-blooming jessamine	Arif et al. (2009)
	Cestrum nocturnum	Solanaceae	Night-blooming jessamine	Arif et al. (2009)
	Cevallia sinuata	Loasaceae	Stinging serpent	García Morales et al. (2016)
	Chenopodiastrum murale	Amaranthaceae	Nettle-leaved goosefoot	Arif et al. (2009)
	Chenopodium album	Amaranthaceae	White goosefoot or fat hen	Arif et al. (2009)
	Chenopodium leptophyllum	Amaranthaceae	Narrowleaf goosefoot	García Morales et al. (2016)
	Chromoleana odotata	Asteraceae	Siam weed	García Morales et al. (2016)
	Chrozophora tinctoria	Euphorbiaceae	Dyer's croton	Spodek et al. (2018)
	Cirsium arvense	Asteraceae	Creeping thistle	Arif et al. (2009)
	Cirsium lecontei	Asteraceae	Le Conte's thistle	Arif et al. (2009)
	Cleome viscosa	Cleomaceae	Asian spiderflower	Arif et al. (2009)
	Clerodendrum	Lamiaceae		Spodek et al. (2018))
	Codiaeum variegatum	Euphorbiaceae	Garden croton	García Morales et al. (2016)
	Coleus scutellarioides	Lamiaceae	Coleus	Arif et al. (2009)
	Combretum indicum	Combretaceae	Rangoon creeper	Arif et al. (2009)
	Convolvulus arvensis	Convolvulaceae	Field bindweed	Arif et al. (2009)

Host status	Host name	Plant family	Common name	Reference[A]
	Convolvulus prostratus	Convolvulaceae		Arif et al. (2009)
	Corchorus depressus	Malvaceae		Arif et al. (2009)
	Corchorus neocaledonicus	Malvaceae		García Morales et al. (2016)
	Corchorus trilocularis	Malvaceae		Arif et al. (2009)
	Cressa cretica	Convolvulaceae		Arif et al. (2009)
	Croton bonplandianus	Euphorbiaceae		Arif et al. (2009)
	Cucumis tetragona	Cucurbitaceae		Arif et al. (2009)
	Cupania americana	Sapindaceae		García Morales et al. (2016)
	Cuscuta reflexa	Convolvulaceae	Giant dodder	Arif et al. (2009)
	Cycas revoluta	Cycadaceae	Sago palm	García Morales et al. (2016)
	Cynodon dactylon	Poaceae	Bermuda grass	Arif et al. (2009)
	Cyperus rotundus	Cyperaceae	Purple nutsedge	Arif et al. (2009)
	Dalbergia sissoo	Fabaceae	North Indian rosewood	Arif et al. (2009)
	Datura metel	Solanaceae	Indian thornapple	Arif et al. (2009))
	Datura stramonium	Solanaceae	Thorn apple	García Morales et al. (2016)
	Daucus carota	Apiaceae	Wild carrot	Arif et al. (2009)
	Desmodium incanum	Fabaceae	Creeping beggarweed	García Morales et al. (2016 *Daucus carota*
	Digera muricata	Amaranthaceae	False amaranth	García Morales et al. (2016)
	Digera sp.	Amaranthaceae		Arif et al. (2009)
	Dimorphotheca ecklonis	Asteraceae	Cape marguerite	Spodek et al. (2018)
	Dodonaea viscosa	Sapindaceae	Akeake hop bush	Fallahzadeh et al. (2014)
	Duranta erecta	Verbenaceae	Golden dewdrop	Arif et al. (2009)
	Ecballium elaterium	Cucurbitaceae	Exploding cucumber	Spodek et al. (2018)
	Echinochloa colona	Poaceae	Jungle rice	Arif et al. (2009)
	Eclipta prostrata	Asteraceae	False daisy	García Morales et al. (2016))
	Elettaria cardamomum	Zingiberaceae	True *cardamom*	Arif et al. (2009)
	Eleusine indica	Poaceae	Indian goosegrass	Arif et al. (2009)
	Encelia farinosa	Asteraceae	Brittlebush	Ben-Dov (1994)
	Enceliopsis	Asteraceae		Ben-Dov (1994)
	Eragrostis minor	Poaceae	Little lovegrass	Arif et al. (2009)
	Erigeron bonariensis	Asteraceae	Flax-leaf fleabane	Arif et al. (2009)
	Erigeron canadensis	Asteraceae	Horseweed	Spodek et al. (201ckl
	Eriophyllum	Asteraceae	Woolly sunflower	Ben-Dov (1994)
	Eucalyptus camaldulensis	Myrtaceae	River red gum	Arif et al. (2009)
	Eupatorium perfoliatum	Asteraceae	Common boneset	García Morales et al. (2016)
	Euphorbia	Euphorbiaceae		García Morales et al. (2016)
	Euphorbia chamaesyce	Euphorbiaceae	Prostrate spurge	Spodek et al. (2018)
	Euphorbia cotinifolia	Euphorbiaceae	Caribbean copper plant	Arif et al. (2009)
	Euphorbia hirta	Euphorbiaceae	Asthma-plant	Arif et al. ((2009)
	Euphorbia maculata	Euphorbiaceae	Spotted spurge	Spodek et al. (2018)

Host status	Host name	Plant family	Common name	Reference[A]
	Euphorbia serpens	Euphorbiaceae	Matted sandmat	Spodek et al. (2018)
	Euphorbia prostrata	Euphorbiaceae	Prostrate spurge	Arif et al. (2009)
	Euphorbia trigona	Euphorbiaceae	African milk bush	García Morales et al. (2016)
	Euploca strigosa	Boraginaceae	Bristly heliotrope	Arif et al. (2009)
	Fagonia cretica	Zygophyllaceae	Virgin's Mantle	Arif et al. (2009)
	Ficus benghalensis	Moraceae	Bengal fig	Arif et al. (2009)
	Ficus lacor	Moraceae	Java fig	Arif et al. (2009)
	Ficus religiosa	Moraceae	Sacred fig	Fallahzadeh et al. ((2014)
	Ficus virens	Moraceae	Banyan	Arif et al. (2009)
	Grewia asiatica	Malvaceae	Phalsa	Arif et al. (2009)
	Hamelia patens	Rubiaceae	Firebush	Arif et al. (2009)
	Heliotropium europaeum	Boraginaceae	European heliotrope	Arif et al. (2009)
	Heliotropium strigosum	Boraginaceae		Arif et al. (2009)
	Heliotropium suaveolens	Boraginaceae	Fragrant heliotrope	Spodek et al. (2018)
	Hibiscus mutabilis	Malvaceae	Confederate rose	Arif et al. (2009)
	Hibiscus schizopitalus	Malvaceae	Japanese hibiscus	García Morales et al. (2016)
	Hibiscus syriacus	Malvaceae	Rose mallow	García Morales et al. (2016)
	Hibiscus tiliaceus	Malvaceae	Sea hibiscus	Spodek et al. (2018)
	Ipomoea cairica	Convolvulaceae	Mile-a-minute vine	Arif et al. (2009)
	Ipomoea tricolor	Convolvulaceae	Morning glory	Fallahzadeh et al. (2014))
	Iresine herbstii	Amaranthaceae	Bloodleaf	García Morales et al. (2016)
	Jacquemontia pentantha	Convolvulaceae	Skyblue cluster vine	Arif et al. (2009)
	Jasminum cuspidatum	Oleaceae	Pointed-leaf jasmine	Arif et al. (2009)
	Jasminum sambac	Oleaceae	Arabian jasmine	Arif et al. (2009)
	Jatropha integerrima	Euphorbiaceae	Spicy jatropha	García Morales et al. (2016)
	Kallstroemia californica	Zygophyllaceae	California caltrop	Arif et al. (2009)
	Kochia indica	Chenopodiaceae		García Morales et al. (2016)
	Lantana montevidensis	Verbenaceae	Trailing lantana	Spodek et al. (2018)
	Launaea nudicaulis	Asteraceae	Bhatal	García Morales et al. (2016)
	Lawsonia inermis	Lythraceae	Henna tree	Arif et al. (2009)
	Leichhardtia nigriflora	Apocynaceae		García Morales et al. (2016)
	Lepidium didymum	Brassicaceae	Lesser swine-cress	Arif et al. (2009)
	Lupinus	Fabaceae		García Morales et al. (2016)
	Maireana sedifolia	Amaranthaceae	Bluebush	Spodek et al. (2018)
	Malva parviflora	Malvaceae	Cheeseweed mallow	Arif et al. (2009)
	Malvastrum coromandelianum	Malvaceae	False mallow	EPPO
	Malvaviscus arboreus	Malvaceae	Wax mallow	Arif et al. (2009)

Host status	Host name	Plant family	Common name	Reference[A]
	Malvella sherardiana	Malvaceae		Spodek et al. (2018)
	Medicago orthoceras	Fabaceae		Arif et al. (2009)
	Medicago polymorpha	Fabaceae	California burclover	Arif et al. (2009)
	Melaleuca leucadendra	Myrtaceae	Weeping paperbark	Arif et al. (2009)
	Melia azedarach	Meliaceae	Chinaberry tree	Arif et al. (2009)
	Melilotus indicus	Fabaceae	Sweet clover	Arif et al. (2009)
	Mentha longifolia	Lamiaceae	Horse mint	Arif et al. (2009)
	Mentha piperita	Lamiaceae	Peppermint	Arif et al. (2009)
	Monoon longifolia	Annonaceae	False ashoka	García Morales et al. (2016)
	Nerium sp.	Apocynaceae	Oleander	Spodek et al. (2018)
	Nicotiana plumbaginifolia	Solanaceae	Tex-Mex tobacco	Arif et al. (2009)
	Orobanche	Orobanchaceae		García Morales et al. (2016)
	Oxalis corniculata	Oxalidaceae	Creeping woodsorrel	Arif et al. (2009)
	Parthenium hysterophorus	Asteraceae	Santa-Maria	Arif et al. (2009)
	Persicaria barbata	Polygonaceae	Joint weed	Arif et al. (2009)
	Persicaria glabra	Polygonaceae	Denseflower knotweed	Arif et al. (2009)
	Petunia integrifolia	Solanaceae	Violet petunia	Fallahzadeh et al. (2014)
	Phyllanthus niruri	Phyllanthaceae	Gale of the wind	Arif et al. (2009)
	Physalis alkekengi	Solanaceae	Bladder cherry	Arif et al. (2009)
	Physalis minima	Solanaceae	Wild cape gooseberry	García Morales et al. (2016)
	Pilea serpyllacea	Urticaceae	Artillery stoplight	García Morales et al. (2016)
	Platyschkuhria integrifolia	Asteraceae	Basindaisy	Arif et al. (2009)
	Coleus (= *Plectranthus*) *scutellarioides*	Lamiaceae	Coleus	Arif et al. (2009)
	Polyalthia longifolia	Annonaceae	False ashoka	Arif et al. (2009)
	Portulaca	Portulacaceae		García Morales et al. (2016)
	Portulaca grandiflora	Portulacaceae	Rose moss	Arif et al. (2009)
	Prosopis farcta	Fabaceae	Syrian mesquite	Spodek et al. (2018)
	Prosopis juliflora	Fabaceae	Long-thorn kiawe	García Morales et al. (2016)
	Pyrus	Rosaceae		García Morales et al. (2016)
	Ricinus communis	Euphorbiaceae	Castor bean	Arif et al. (2009)
	Rosa arkansana	Rosaceae	Prairie rose	Newton et al. (2011)
	Rosa cymosa	Rosaceae		Arif et al. ((2009)
	Ruellia elegans	Acanthaceae	Red ruellia	Spodek et al. (2018)
	Ruellia squarrosa	Acanthaceae	Water bluebell	Arif et al. (2009)
	Ruellia tuberosa	Acanthaceae	Fever root	García Morales et al. (2016)
	Rumex dentatus	Polygonaceae	Toothed dock	Arif et al. (2009)
	Salsola imbricata	Amaranthaceae		Arif et al. (2009)
	Salvadora oleoides	Salvadoraceae		Arif et al. (2009)
	Salvia sp.	Lamiaceae		Fallahzadeh et al. (2014)
	Scalesia atractyloides	Asteraceae		García Morales et al. (2016)

Host status	Host name	Plant family	Common name	Reference[A]
	Sesbania sesban	Fabaceae	Egyptian riverhemp	Arif et al. (2009)
	Sida acuta	Malvaceae	Common wireweed	García Morales et al. (2016)
	Sida urens	Malvaceae		García Morales et al. (2016)
	Solanum aethiopicum	Solanaceae	Bitter tomato	Arif et al. (2009)
	Solanum americanum	Solanaceae	American black nightshade	García Morales et al. (2016)
	Solanum mauritianum	Solanaceae	Earleaf nightshade	García Morales et al. (2016)
	Solanum muricatum	Solanaceae	Pepino dulce	García Morales et al. (2016)
	Solanum nigrum	Solanaceae	Black nightshade	Arif et al. (2009)
	Solanum ptychanthum	Solanaceae	West Indian *nightshade*	García Morales et al. (2016)
	Solanum villosum	Solanaceae	Hairy nightshade	Spodek et al. (2018)
	Solanum virginianum	Solanaceae	Yellow-fruit nightshade	Arif et al. (2009)
	Sonchus oleraceus	Asteraceae	Common sowthistle	Arif et al. (2009)
	Sorghum halepense	Poaceae	Johnson grass	Spodek et al. (2018)
	Suaeda fructicosa	Amaranthaceae		Arif et al. (2009)
	Tabernaemontana divaricata	Apocynaceae	Crape jasmine	Arif et al. (2009)
	Tagetes erecta	Asteraceae	Mexican marigold	García Morales et al. (2016)
	Tagetes patula	Asteraceae	French marigold	García Morales et al. (2016)
	Taraxacum campylodes	Asteraceae	Common dandelion	Arif et al. (2009)
	Tecoma alata	Bignoniaceae	Orange bells	Spodek et al. (2018)
	Tecoma stans	Bignoniaceae	Yellow trumpetbush	Arif et al. (2009)
	Tetragonia tetragonioides	Aizoaceae	New Zealand spinach	Spodek et al. (2018)
	Tinospora cordifolia	Menispermaceae	Heart-leaved moonseed	Arif et al. (2009)
	Tradescantia pallida	Commelinaceae	Purple heart	Arif et al. (2009)
	Trianthema portulacastrum	Aizoaceae	Desert horse purslane	Arif et al. (2009)
	Trianthema triquetra	Aizoaceae	Red spinach	Arif et al. (2009)
	Tribulus terrestris	Zygophyllaceae	Goat's-head	García Morales et al. (2016)
	Trichilia havanensis	Meliaceae	Bastard lime	García Morales et al. (2016)
	Medicago polyceratia	Fabaceae		Arif et al. (2009)
	Tripolium pannonicum	Asteraceae	Sea aster	García Morales et al. (2016)
	Vachellia nilotica	Fabaceae	Gum arabic tree	Fallahzadeh et al. (2014)
	Vitex agnus-castus	Lamiaceae	Chaste tree	Spodek et al. (2018)
	Volkameria inermis	Lamiaceae	Glory bower	García Morales et al. (2016)
	Withania somnifera	Solanaceae	Indian ginseng	Arif et al. (2009)
	Xanthium strumarium	Asteraceae	Rough cocklebur	Arif et al. (2009)
	Zamia furfuracea	Zamiaceae	Cardboard palm	Spodek et al. (2018)
	Zinnia violacea	Asteraceae	Youth-and-age	Fallahzadeh et al. (2014)

Appendix B – Distribution of *Phenacoccus solenopsis*

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

Region	Country	Sub-national (e.g. State)	Status
North America	Canada	Alberta	Present, no details
	Mexico	Veracruz	Present, no details
	USA	Arizona	Present, no details
		California	Present, no details
		District of Columbia	Present, no details
		Idaho	Present, no details
		Illinois	Present, no details
		Maryland	Present, no details
		Michigan	Present, no details
		Mississippi	Present, no details
		Nevada	Present, no details
		New Jersey	Present, no details
		New Mexico	Present, no details
		New York	Present, no details
		Ohio	Present, no details
		Texas	Present, no details
		Virginia	Present, no details
Central America	Belize		Present, no details
	Guatemala		Present, no details
	Panama		Present, no details
Caribbean	Cayman Islands		Present, no details
	Cuba		Present, no details
	Dominican Republic		Present, no details
	Guadeloupe		Present, no details
	Haiti		Present, no details
	Jamaica		Present, no details
	Martinique		Present, no details
	Saint Martin & St. Barthelemy		Present, no details
South America	Argentina	Cordoba	Present, no details
		Corrientes	Present, no details
		Entre Rios	Present, no details
	Brazil	Acre	Present, no details
		Bahia	Present, no details
		Ceara	Present, no details
		Espirito Santo	Present, no details
		Paraiba	Present, no details
		Pernambuco	Present, no details
	Chile		Present, no details
	Colombia		Present, no details
	Ecuador		Present, no details
EU (27)	Cyprus		Present, no details
	Greece		Present, restricted
	Italy		Present, restricted
Africa	Algeria		Present, no details
	Benin		Present, no details
	Cameroon		Present, no details

Region	Country	Sub-national (e.g. State)	Status
	Canary Islands (Spain)		Present, no details
	Egypt		Present, no details
	Ethiopia		Present, no details
	Mali		Present, no details
	Mauritius		Present, no details
	Nigeria		Present, no details
	Reunion		Present, no details
	Senegal		Present, no details
	Swaziland		Present, no details
Asia	China	Anhui	Present, no details
		Fujian	Present, no details
		Guangdong	Present, no details
		Guangxi	Present, no details
		Hainan	Present, no details
		Hubei	Present, no details
		Hunan	Present, no details
		Jiangsu	Present, no details
		Jiangxi	Present, no details
		Shanghai	Present, no details
		Sichuan	Present, no details
		Xinjiang Uygur	Present, no details
		Yunnan	Present, no details
	India	Andhra Pradesh	Present, no details
		Gujarat	Present, no details
		Haryana	Present, no details
		Karnataka	Present, no details
		Kerala	Present, no details
		Madhya Pradesh	Present, no details
		Maharashtra	Present, no details
		Punjab	Present, no details
		Rajasthan	Present, no details
		Tamil Nadu	Present, no details
		West Bengal	Present, no details
		Bali	Present, no details
		Irian Jaya	Present, no details
	Iran		Present, no details
	Iraq		Present, no details
	Israel		Present, widespread
	Japan	Kyushu	Present, no details
	Malaysia		Present, no details
	Pakistan		Present, no details
	Saudi Arabia		Present, restricted distribution
	Sri Lanka		Present, no details
	Taiwan		Present, widespread
	Thailand		Present, no details
	Turkey		Present, no details
	United Arab Emirates		Present, no details
	Vietnam		Present, no details

Region	Country	Sub-national (e.g. State)	Status
Oceania	Australia	Queensland	Present, no details
	New Caledonia		Present, widespread
	Palau		Present, no details
	Papua New Guinea		Present, no details
	Samoa		Present, no details
	Wallis and Futuna Islands		Present, no details

Appendix C – EU 27 imports of tomatoes

		2016	2017	2018	2019	2020
Asia	Turkey	711,723.54	1,006,308.14	1,076,029.29	1,006,003.21	1,255,949.46
	Israel	16,739.21	10,861.22	6,392.59	782.65	138.00
	Iran	–	363.79	–	–	11.13
	Japan	13.75	8.98	13.31	45.67	34.37
	UAE	–	0.00	–	3.77	–
	Thailand	0.08	0.08	0.08	0.02	0.02
	Vietnam	0.03	0.06	–	–	–
	India	–	0.00	–	0.01	–
	China	–	0.00	–	–	–
	Malaysia	–	0.00	–	–	–
	Pakistan	–	0.00	–	–	–
	Saudi Arabia	–	0.00	–	–	–
	Sri Lanka	–	0.00	–	–	–
	Taiwan	–	0.00	–	–	–
	Sum	728,476.61	1,017,542.27	1,082,435.27	1,006,835.33	1,256,132.98
Africa	Senegal	91,850.25	62,281.26	85,804.22	77,820.16	74,513.76
	Egypt	9,135.43	14,023.94	15,102.55	18,876.68	9,491.42
	Algeria	30.45	27.56	161.85	461.62	–
	Cameroon	–	0.75	–	–	–
	Ethiopia	–	0.00	0.26	–	–
	Mauritius	–	0.00	–	–	–
	Nigeria	–	0.00	–	–	–
	Sum	101,016.13	76,333.51	101,068.88	97,158.46	84,005.18
South America	Colombia	–	0.00	–	2,828.76	236.09
	Brazil	–	27.60	–	–	–
	Chile	2.03	0.00	–	–	–
	Argentina	–	0.00	–	–	–
	Ecuador	–	0.00	–	–	–
	Sum	2.03	27.60	–	2,828.76	236.09
Oceania	Australia	–	0.00	–	2.52	–
	Sum	–	0.00	–	2.52	–
North America	Mexico	–	0	–	–	0.8
	USA	–	0	0.11	0.04	0.13
	Canada	–	0	–	–	–
	Sum	–	0	0.11	0.04	0.93
Central America	Dominican Republic	19,550.87	21,840.02	19,688.19	15,920.89	17,237.85
	Belize	–	0.00	–	–	–
	Cuba	–	0.00	–	–	–
	Guatemala	–	0.00	–	–	–
	Panama	–	0.00	–	–	–
	Sum	19,550.87	21,840.02	19,688.19	15,920.89	17,237.85

Appendix D – Crop production in EU 27

Crop production in EU 27 by each member state, between 2016 and 2020 (Eurostat data of area cultivation/harvested/production (1,000 ha), accessed on 15/5/2021)

Tomatoes (V3100)

Member state/Year	2016	2017	2018	2019	2020
Austria	0.18	0.18	0.20	0.20	0.20
Belgium	0.51	0.52	0.55	0.57	0.60
Bulgaria	4.20	5.01	4.52	5.15	3.09
Croatia	0.37	0.45	0.49	0.32	0.40
Cyprus	0.22	0.26	0.29	0.28	0.26
Czechia	0.34	0.24	0.30	0.16	0.26
Denmark	0.03	0.03	0.03	0.03	0.03
Estonia	0.01	0.00	0.00	0.00	0.01
Finland	0.11	0.11	0.10	0.09	0.10
France	5.65	5.75	5.74	5.66	5.82
Germany	0.34	0.37	0.40	0.39	0.38
Greece	14.01	13.32	16.02	15.01	14.51
Hungary	2.08	2.19	2.50	2.41	1.95
Ireland	0.01	0.01	0.01	0.01	0.01
Italy	96.78	92.67	97.17	91.41	99.78
Latvia	0.00	0.00	0.00	0.00	0.00
Lithuania	0.57	0.55	0.57	0.56	0.56
Luxembourg	0.00	0.00	0.00	0.00	0.00
Malta	0.00	0.00	0.00	0.00	0.00
Netherlands	1.78	1.79	1.79	1.80	1.87
Poland	12.42	12.64	13.11	13.50	13.60
Portugal	20.85	20.87	15.83	16.13	13.53
Romania	22.71	22.21	22.97	23.78	23.50
Slovakia	0.68	0.60	0.59	0.48	0.22
Slovenia	0.21	0.20	0.19	0.22	0.26
Spain	62.72	60.85	56.13	56.94	55.47
Sweden	0.04	0.04	0.04	0.04	0.05
European Union - 27 countries (from 2020)	246.80	240.87	239.55	235.14	236.46

Eggplants (V3210)

Member state/Year	2016	2017	2018	2019	2020
Austria	0.01	0.01	0.01	0.01	0.01
Belgium	0.02	0.02	0.02	0.02	0.00
Bulgaria	0.31	0.48	0.44	0.39	0.37
Croatia	0.00	0.00	0.00	0.00	0.00
Cyprus	0.04	0.03	0.03	0.02	0.02
Czechia	0.00	0.00	0.00	0.00	0.00
Denmark	0.00	0.00	0.00	0.00	0.00
Estonia	0.00	0.00	0.00	0.00	0.00
Finland	0.00	0.00	0.00	0.00	0.00
France	0.73	0.73	0.80	0.71	0.79
Germany	0.00	0.00	0.00	0.00	0.00
Greece	1.75	1.70	1.67	1.35	1.70
Hungary	0.05	0.05	0.05	0.04	0.04

Member state/Year	2016	2017	2018	2019	2020
Ireland	0.00	0.00	0.00	0.00	0.00
Italy	10.13	9.45	9.76	9.55	9.51
Latvia	0.00	0.00	0.00	0.00	0.00
Lithuania	0.00	0.00	0.00	0.00	0.00
Luxembourg	0.00	0.00	0.00	0.00	0.00
Malta	0.00	0.00	0.00	0.00	0.00
Netherlands	0.11	0.10	0.11	0.12	0.13
Poland	0.00	0.00	0.00	0.00	0.20
Portugal	0.10	0.14	0.11	0.11	0.10
Romania	4.56	4.42	4.80	4.81	4.76
Slovakia	0.00	0.01	0.01	0.00	0.01
Slovenia	0.02	0.02	0.02	0.03	0.03
Spain	3.75	3.58	3.62	3.47	3.70
Sweden	0.00	0.00	0.00	0.00	0.00
European Union - 27 countries (from 2020)	21.58	20.73	21.44	20.63	21.36

Peppers (V3600)

Member state/Year	2016	2017	2018	2019	2020
Austria	0.17	0.18	0.16	0.16	0.16
Belgium	0.10	0.10	0.09	0.10	0.10
Bulgaria	3.66	3.35	2.95	3.22	2.72
Croatia	1.35	1.02	1.02	0.56	0.69
Cyprus	0.04	0.03	0.04	0.03	0.04
Czechia	0.00	0.00	0.42	0.27	0.29
Denmark	0.00	0.00	0.00	0.00	0.00
Estonia	0.00	0.00	0.00	0.00	0.00
Finland	0.01	0.01	0.01	0.01	0.01
France	0.84	0.96	0.95	0.94	1.17
Germany	0.08	0.09	0.11	0.11	0.11
Greece	3.77	4.03	3.84	3.39	4.18
Hungary	2.79	2.57	1.91	1.85	1.62
Ireland	0.00	0.00	0.00	0.00	0.00
Italy	8.67	8.29	7.87	10.28	10.01
Latvia	0.00	0.00	0.00	0.00	0.00
Lithuania	0.00	0.00	0.00	0.00	0.00
Luxembourg	0.00	0.00	0.00	0.00	0.00
Malta	0.00	0.00	0.00	0.00	0.00
Netherlands	1.32	1.32	1.31	1.50	1.53
Poland	3.78	3.63	3.71	3.70	3.80
Portugal	0.97	1.21	0.93	0.93	1.09
Romania	9.93	9.71	9.96	10.78	10.01
Slovakia	0.32	0.31	0.27	0.22	0.17
Slovenia	0.17	0.16	0.16	0.20	0.23
Spain	19.62	20.50	20.58	21.43	21.75
Sweden	0.00	0.00	0.00	0.00	0.00
European Union - 27 countries (from 2020)	57.59	57.47	56.27	59.68	59.66

Cotton fibre (I2300)

Member state/Year	2016	2017	2018	2019	2020
Austria	0.00	0.00	0.00	0.00	0.00
Belgium	0.00	0.00	0.00	0.00	0.00
Bulgaria	4.49	4.81	3.16	3.46	3.00
Croatia	0.00	0.00	0.00	0.00	0.00
Cyprus	0.00	0.00	0.00	0.00	0.00
Czechia	0.00	0.00	0.00	0.00	0.00
Denmark	0.00	0.00	0.00	0.00	0.00
Estonia	0.00	0.00	0.00	0.00	0.00
Finland	0.00	0.00	0.00	0.00	0.00
France	0.00	0.00	0.00	0.00	0.00
Germany	0.00	0.00	0.00	0.00	0.00
Greece	236.04	258.33	277.36	292.17	285.37
Hungary	0.00	0.00	0.00	0.00	0.00
Ireland	0.00	0.00	0.00	0.00	0.00
Italy	0.00	0.00	0.00	0.00	0.00
Latvia	0.00	0.00	0.00	0.00	0.00
Lithuania	0.00	0.00	0.00	0.00	0.00
Luxembourg	0.00	0.00	0.00	0.00	0.00
Malta	0.00	0.00	0.00	0.00	0.00
Netherlands	0.00	0.00	0.00	0.00	0.00
Poland	0.00	0.00	0.00	0.00	0.00
Portugal	0.00	0.00	0.00	0.00	0.00
Romania	0.00	0.00	0.00	0.00	0.00
Slovakia	0.00	0.00	0.00	0.00	0.00
Slovenia	0.00	0.00	0.00	0.00	0.00
Spain	60.81	62.98	65.12	66.15	61.70
Sweden	0.00	0.00	0.00	0.00	0.00
European Union - 27 countries (from 2020)	301.34	326.12	345.64	361.78	350.07