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17-23273

Pest Risk Analysis for

Aleurotrachelus [Aleurothrixus] trachoides (Hemiptera: Aleyrodidae)

September 2017

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This risk assessment follows the EPPO Standard PM 5/5(1) *Decision-Support Scheme for an Express Pest Risk Analysis* (available at http://archives.eppo.int/EPPOStandards/pra.htm) and uses the terminology defined in ISPM 5 *Glossary of Phytosanitary Terms* (available at https://www.ippc.int/index.php). This document was first elaborated by an Expert Working Group and then reviewed by the Panel on Phytosanitary Measures and if relevant other EPPO bodies.

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Photos: *Aleurotrachelus trachoides*, Courtesy: Philippe RYCKEWAERT - CIRAD, Martinique (FR)

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After considering this PRA, it was decided not to add *Aleurotrachelus trachoides* to EPPO A1 Lists of pests recommended for regulation as quarantine pests.

Pest Risk Analysis for *Aleurotrachelus trachoides* (Hemiptera: Aleyrodidae)

This PRA follows EPPO Standard PM 5/5 *Decision-Support Scheme for an Express Pest Risk Analysis*. It is a follow-up of the EPPO Study on Pest Risks Associated with the Import of Tomato Fruit (EPPO, 2015). Four PRAs for tomato pests were performed in parallel, in a new procedure by which they were prepared in a shorter time and reviewed together by one Expert Working Group. This implies among others that the final PRAs contain more uncertainties, which could not be resolved in the framework of this new procedure.

PRA area: *EPPO region*
Prepared by: EWG on PRAs for tomato
Date: 2015-12-07/11 (the PRA was further reviewed and amended by other EPPO bodies, see below)

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Prior to the EWG, the PRA was reviewed and comments provided by: Jean-Claude Streito (INRA, France), Maurice Jansen (NPPO, The Netherlands), Colmar Serra (IDIAF, Dominican Republic).
All personal communications were obtained in November-December 2015.

Following the EWG, the PRA was further reviewed by Chris Malumphy (Defra, UK).
The following PRA core members also provided comments: Alan MacLeod (UK), Dirk Jan van der Gaag (The Netherlands), José Maria Guitian Castrillon (and colleagues; Spain), Robert Steffek (Austria), Silvija Pupelienė (and Henrikas Ostrauskas; Lithuania). The PRA was reviewed by the EPPO Panel on Phytosanitary Measures in November 2016-March 2017 and the Panel decided that this pest should not be recommended for regulation as a quarantine pest.

Summary of the Pest Risk Analysis for *A. trachoides* (Hemiptera: Aleyrodidae)			
PRA area: *EPPO region*			
Describe the endangered area: The endangered area is considered to be the southern part of the Mediterranean Basin (south of a line from southern Spain to southern Turkey) and southern Portugal, as well as indoors production of Solanaceae throughout the PRA area. There is a high uncertainty on the limits of the endangered area because of lack of data on the adaptability of the pest.			
Main conclusions *Overall assessment of risk:* ***A. trachoides* is considered to pose a low phytosanitary risk for the endangered area.** *A. trachoides* is a whitefly native to the neotropical region; it has spread to the Pacific, and there are recent findings in Africa. It is oligophagous, with a preference for Solanaceae. The life stages of *A. trachoides* are present mostly on leaves, and occasionally on other green parts. *A. trachoides* causes direct damage by feeding on plants and through the production of honeydew on leaves and fruits, which in turn favour the development of sooty moulds. Entry is considered possible on plants for planting, on fruit with green parts (incl. tomato), and on cut plant parts (cut flowers and branches, cut herbs, leafy vegetables). *A. trachoides* may cause outbreaks and transient populations under protected conditions (where it may cause damage even it is does not establish permanently). It is expected to have a moderate impact, and is not known as a virus vector. It may have impact especially on hot and sweet peppers, but also tomato and eggplant. Spread will mainly be with traded commodities rather than natural spread. *Phytosanitary Measures to reduce the probability of entry:* No phytosanitary measures are recommended as the risk is considered low			
Phytosanitary risk for the *endangered area* (*Individual ratings for likelihood of entry and establishment, and for magnitude of spread and impact are provided in the document*)	High ☐	**Moderate** ☐	**Low** ☒
Level of uncertainty of assessment *(see Q 17 for the justification of the rating. Individual ratings of uncertainty of entry, establishment, spread and impact are provided in the document)*	High ☐	**Moderate** ☒	Low ☐
Other recommendations:			

Stage 1. Initiation

Reason for performing the PRA:

Aleurotrachelus trachoides was identified during the EPPO Study on pests risks associated with the import of tomato fruit ('EPPO tomato study' hereafter; EPPO, 2015) and was later selected as a priority for PRA by the EPPO Panel on Phytosanitary Measures based on a number of criteria including its impact on tomato, biological criteria, consideration of entry and transfer from commodities to hosts at destination. *A. trachoides* is native to the Neotropical region; it has spread to the Pacific, and there are recent findings in Africa and Réunion Island. It is oligophagous, with a preference for Solanaceae.

PRA area: EPPO region (map at www.eppo.int).

Stage 2. Pest risk assessment

1. Taxonomy

Taxonomic classification. Order: Hemiptera; Family: Aleyrodidae; Subfamily: Aleyrodinae; Genus: *Aleurotrachelus* Quaintance & Baker, 1914; Species: *Aleurotrachelus trachoides* (Back, 1912).
Although the taxonomy is clear, identification to species is difficult (see Identification in Section 2).
Synonyms. *Aleyrodes trachoides* Back 1912: 151; *Aleurotrachelus trachoides* (Back) Quaintance & Baker 1914: 103 ; *Aleurotulus bodkini* Quaintance & Baker in Baker & Moles, 1923: 635-636.
Dubey and Sundararaj (2015) suggested that this species should be reclassified in the genus *Aleurothrixus*, as *Aleurothrixus trachoides*. However, as this change is not yet internationally agreed, the name *Aleurotrachelus trachoides* is used in this PRA.

Common names. solanum whitefly (Martin, 2005), privet whitefly (Hara, 2011), mosca blanca del pimiento (Armstrong and Cabrera, 2005), mosca blanca del ají (Barroso and Diaz, 2014), mosca blanca de la falda (Colonia Coral, 2013), mosca blanca de las Solanáceas (EcuRed, nd), aleurode des solanacées (Ryckewaert and Rhino, in press.

2. Pest overview

A. trachoides is a pest of Solanaceae and some other plant species (see Section 7).

Life cycle. Adults are small, 1-2 mm long, and are sap-sucking flying insects. Newly laid eggs are yellowish, and gradually turn orange-brown. They are oblong and glued to the leaf by a short peduncle. First stage nymphs are flat and oval, yellow, with 8 white spots and without white filaments. They are slightly mobile, and usually stay on the leaf on which they were laid on. The first instars usually settle to feed shortly after hatching. The second to fourth nymphal stages are also attached under the leaves, are yellowish and become gradually covered by cottony white filaments (Ryckewaert, 2011). The fourth nymphal stage consists of two substage-nymphae which feed and, after apolysis, a 'puparium'. At the end of the development, the colour of the fourth nymphal stage turns to black and is covered, and partly hidden by, thick cottony white filaments and exuviae, with a marginal row of teeth much paler than reminder of pupal case. They measure 0.8 mm in length.
Females generally lay eggs on the underside of young leaves. All nymphal stages actively feed; the last one has a feeding period followed by a non-feeding period. Adults are poor fliers but are readily transported by wind and clothes (Ryckewaert, 2011).

Kumar et al. (2016) report that life cycle (egg to adult) is approximately 29 days at room temperature (25±1°C, 65±5 % RH, 12:12 L:D); eggs take an average of eight days for emergence of first instar nymphs, seven days for first instar to develop into second instar, six days for completion of second instar, four days for third instar, and four days for the fourth instar to emerge into an adult. There is no data on life cycle in field conditions.In tropical regions, the duration of the life cycle is probably similar to that of *Bemisia tabaci* and *Trialeurodes vaporariorum* (3 weeks at 25°C.) and there are overlapping generations throughout the year (P. Ryckewaert, pers. comm.).

Damage. Direct feeding damage by whiteflies is caused by nymphal stages and adults through sucking of sap from the phloem tissue of the plant (Berlinger, 1986). Barroso and Diaz (2014) mention that *A. trachoides* mostly attacks leaves and young shoots, but also the fruit. In the tropics all stages are on leaves, but adults may also rarely be found on shoots and fruits themselves (P. Ryckewaert, pers. comm.).

Indirect feeding damage results from the accumulation of honeydew, a sticky excretory waste, produced by adult and nymphal whiteflies stages (Byrne and Bellows, 1991). The honeydew serves as a substrate for the growth of sooty mould on leaves and fruits. It results in aesthetical damage on fruit and reduces photosynthesis.

Detection. As for many whiteflies, direct observation of colonies (eggs, nymphs and adults) on undersides of leaves is the best way to detect the pest (J.C. Streito, pers. comm.). In some cases, symptoms on plants may trigger detection (e.g. in the case of large infestations in *Capsicum* crops, the new growth shows signs of chlorosis and leaf deformation – C. Malumphy, pers. comm.). Visual inspection of the plants is not fully reliable because the newly laid eggs and first nymphal instar of *A. trachoides* may remain undetected because their small size and transparent colour. However, the 'puparium' is dark with white wax covering and is easier to detect. Adults present at low densities may also remain undetected.
Signs and symptoms of infestation. Feeding causes weakening, early wilting and stunting of the plant, and, rarely, fruits with incomplete development. Heavy infestations by whiteflies can cause leaf chlorosis, leaf withering, premature dehiscence, defoliation, and rarely plant death, as well as the presence of sooty moulds (Byrne and Bellows, 1991).

No specific traps are available; adults may be trapped using yellow sticky traps, but adults are very difficult to differentiate from other Aleyrodidae, for example *B. tabaci* and *T. vaporariorum*.

Identification. Identification based on morphological characters is based on the 'puparium'. Identification to genus is described by Hodges and Evans (2005). There is currently no single key to the species of *Aleurotrachelus* nor closely related genera such as *Aleurothrixus*. A morphological key to pupal cases of 46 whiteflies (incl. *A. trachoides*) is given in Martin (1987), but there are 75 species of *Aleurotrachelus* in the world (Evans, 2008). Identification to species is difficult because of ambiguities in the description. For example it is unknown which other species have a light margin and not all specimens of *trachoides* have an equally light margin (M. Jansen, pers. comm.); the degree of pigmentation of the dorsum may also vary (C. Malumphy, pers. comm.). There may be confusion with related species with a similar distribution, such as *A. socialis*. Martin (2005) provides a good illustration of the morphology of the puparium of *A. trachoides*.

A molecular method for identification is described for adults (Ovalle et al., 2014), but this may not be of use for practical identification to species level. Molecular identification should be combined with morphological identification of 'puparia'. In addition such methods suppose that appropriate specimens are available. Sticky trap specimens are usually not suitable for molecular identification because they are degraded (could be some weeks old, and/or the trap is not kept in ideal conditions, so the insect starts to rot) and the glue/extraction solvent interferes with DNA extraction (A. Korycinska, pers. comm.).

3. Is the pest a vector? **Yes** ☐ **No** ✓

Very few Aleyrodidae species are vectors; no specific information was found for *A. trachoides*. *A. trachoides* was not considered as a vector in this PRA.

4. Is a vector needed for pest entry or spread? **Yes** ☐ **No** ✓

5. Regulatory status of the pest

A. trachoides is not mentioned in the phytosanitary regulations of EPPO countries according to EPPO Global Database (at December 2015). It is recorded as an A1 pest for 'Eastern Africa' and 'Southern Africa' (EPPO Global Database). *A. trachoides* was added to the Alert List in November 2015. Quarantine lists for a limited number of non-EPPO countries were consulted and this pest was not found.

6. Distribution

A. trachoides is native to the neotropics and present from South America to southern USA, and the Caribbean. It has spread to the Pacific, to Tahiti by the 1930s, has become more widespread since the late 1970s, reached Hawaii in the late 1990s (Hara, 2011), and Guam in 2003 (Martin, 2005). It was first found in La Réunion in 2000 (Ryckewaert, 2011). In continental Africa, checklists (incl. Evans et al., 2008, the most recent consulted) report its presence in Gambia, probably only based on multiple interception records (see in Table 1); however, there are now published records for at least Nigeria and Mozambique, and an unpublished record for Mayotte.

Table 1. Distribution of *A. trachoides*. All records are from EPPO Global Database, except where a reference is indicated. For EPPO Global Database records, references can be found in the database.

Region	*Distribution*	Additional comments
EPPO region	**Absent**	
Africa	**Reunion Isl.**, **Mozambique**, **Nigeria**. **Comoros** (Malumphy, 2013), **Mayotte** (unpublished data, J.C. Streito, pers. comm.). Unreliable records: **Gambia**	**Mayotte.** Many slides in collection in France ; specimen collected by the Direction de l'Agriculture, de l'Alimentation et de la Forêt of Mayotte; (unpublished data; J.C. Streito, pers. comm.) **Gambia** (in Evans, 2008) is probably based on multiple interception records (Malumphy, 2005). As per normal EPPO Global Database practices for records based only on interceptions, it is an 'unreliable record'. However, there are now records for at least Mozambique and Nigeria, and the pest is likely to be more widespread in Africa than currently known.
North America	**Mexico, USA** (California, Florida, Hawaii, Louisiana, Texas)	
Central America	**Belize, Costa Rica**, **El Salvador**, **Guatemala**, **Honduras**, **Nicaragua**, **Panama**	**Belize**. *A. trachoides* appears in the list of whiteflies present in Belize (Martin, 2005), however it is noted that some morphological variations were observed, at least on some specimens
Caribbean	**Antigua and Barbuda**, **Bahamas**, **Barbados**, **Cayman Isl.**, **Cuba**, **Netherlands Antilles** (Curaçao; Reyne, 1964), **Dominica**, **Dominican Rep.**, **Guadeloupe**, **Haiti**, **Jamaica**, **Martinique**, **Puerto Rico**, **St Barthélémy** (Streito et al., 2007), **Trinidad and Tobago**, **Virgin Isl.**	
South America	**Brazil**, **Colombia**, **Ecuador** (Galapagos), **French Guiana**, **Guyana**, **Peru**, **Suriname**, **Venezuela**	**Ecuador**: Evans et al. (2008) reports US interceptions, and the pest may be more widespread than just Galapagos.
Oceania	**Fiji, Guam, French Polynesia** (Rangiroa, Tahiti; Dumbleton, 1961), **Micronesia.** Uncertain records: **Nauru, Tonga** (Lal, 2009).	**Micronesia**. The pest was identified in 2013, but whiteflies had been causing problems for several years (USDA Forest Service, 2014) **Nauru** and **Tonga** are mentioned in a presentation relating to the use of biological control agents against pests in the Pacific. The distribution in Oceania may be wider. A number of additional records are given in Malumphy (2013) and are considered as unverified (C. Malumphy, pers. comm.).
Asia	**India (**Karnataka) (Dubey & Sundararaj, 2015)	Malumphy (2013) indicate it was observed in South-East Asia, although there are no published records.

7. Host plants and their distribution in the PRA area

A. trachoides is reported to have a preference for Solanaceae and also Convolvulaceae, although some species in other families are also attacked. Solanaceous hosts include major cultivated species (*Solanum lycopersicum*, *Capsicum*, *Solanum melongena*, *Nicotiana*), ornamentals (*Cestrum*, *Solanum pseudocapsicum*, *Solanum seaforthianum*) and wild plants/weeds (e.g. *Datura stramonium*, *S. nigrum*). The pest seems to attack especially *Capsicum*, and to a lesser extent *S. melongena* and *S. lycopersicum.* Although *Solanum* is mentioned as a genus, no record was found for species other than those mentioned in Table 2 (e.g. not *S. muricatum* - pepino).

Among Convolvulaceae, several *Ipomoea* spp. are attacked, incl. *I. batatas* (sweet potato).

The importance of host plants in other families is not clear (nor if there is confusion with some other *Aleurotrachelus* species). In the French Antilles, the pest has not been observed on families other than Solanaceae and Convolvulaceae (P. Ryckewaert, pers. comm.). *A. trachoides* is reported as attacking *Persea americana* (Colonia coral, 2013), and also mentioned without details as attacking *Psidium guajava*, *Theobroma cacao* (Barroso and Diaz, 2014 – also *Citrus*, see uncertainty below Table 2), *Colocasia esculenta*, *Piper methysticum* (Pestnet forum 2005), *Annona* (*cherimola* and *reticulata*; Peña and Bennet, 1995). Many hosts in Table 2 are mentioned only in one or few sources. This is especially the case for *Citrus limon*, *Citrus* and *Rosa*, for which no specific information on the pest status of *A. trachoides* was found.

Table 2. Host plants (from Evans, 2008, except species/genera with reference)

In **bold**, considered to be widely cultivated in the EPPO region.

hosts from collection specimen held in France (J.C. Streito, pers. comm.)

Solanaceae	
Capsicum annuum	***Nicotiana tabacum* (Vázquez, 2004)**
Capsicum frutescens	*Solanum americana#*
***Capsicum* sp.**	***Solanum lycopersicum***
Cestrum diurnum (Vázquez, 2004)	***Solanum melongena***
Cestrum nocturnum	*Solanum nigrum*
Datura stramonium	*Solanum seaforthianum*
Datura sp. (Dumbleton, 1961)	*Solanum* sp.
Lycopersicon sp.	*Solanum torvum*
Nicotiana sp.	*Solanum pseudocapsicum* (MIZA, 2013)
Nicotiana bentamiana (MIZA, 2013)	
Convolvulaceae	
Convolvulaceae: *Ipomoea* sp., *I. batatas*, *I. indica* (Ovalle et al., 2014), *I. tiliacea* (Vazquez, 2004; Streito et al., 2007), *Merremia* sp.	
Other families	
Acanthaceae: *Ruellia* (Reid and Malumphy, 2010); *Ruellia tuberosa* (MIZA, 2013)	Bignoniaceae: *Tabebuia glomerata*, *T. pallida*, *T. chrysantha* (MIZA, 2013), *T. rosea* (MIZA, 2013)
Amaranthaceae: *Althernanthera* sp. (MIZA, 2013)	Boraginaceae: *Cordia collococca*
Annonaceae: *Annona cherimola* (Pena and Bennett, 1995), *A. muricata*, *A. reticulata*, *A. squamosa* (Vázquez, 2004)	Cannaceae: *Canna coccinea*;
Apiaceae: ***Apium graveolens*** (MIZA, 2013)	Casuarinaceae: *Casuarina* sp.; *Casuarina equisetifolia* (PaDIL, nd)
Apocynaceae: *Plumeria* (Martin, 1987); *Tabernaemontana divaricata*	Chrysobalanaceae: *Licania michauxii*
Araceae: Alocasia (Martin, 1987), *Anubias#* (from interception), *Colocasia esculenta* (Vázquez et al., 1995), *Syngonium podophyllum*, *Xanthosoma sagittifolium*	Cleomaceae: *Cleome* sp.
Arecaceae: *Chamaedorea elegans*, *Chamaedorea* sp., *Cocos nucifera* (Cugala et al., 2013), *Dypsis lutescens*, *Veitchia merrillii*	Dioscoreaceae: *Dioscorea* sp.
Asteraceae: *Bidens pilosa*, *Mikania cordifolia*; *M. micrantha* (Fresh from Florida, nd)	Fabaceae: *Bauhinia divaricata*, *Canavalia ensiformis*, *Leucaena* sp.
	Guttiferae: *Calophyllum antillanum*; *Hypericum hypericoides*
	Lauraceae: ***Persea americana***
	Malvaceae: *Hibiscus elatus*, *Guazuma tometosa* (Vázquez, 2004)
	Melastomataceae: *Miconia magnifolia*

Moraceae: *Ficus membranaceae*, *Ficus retusa*
Myrsinaceae: *Ardisia escallonioides*
Myrtaceae: *Psidium guajava*
Phytolaccaceae: *Petiveria alliacea*
Piperaceae: *Piper methysticum* (as 'kava' – Pestnet, 2005), *Piper#*
Polygonaceae: *Coccoloba uvifera*
Rosaceae: ***Rosa#*** (Vázquez, 2004)
Rubiaceae: *Morinda citrifolia*, *Psychotria nervosa*, *Randia aculeata*
Rutaceae: ***Citrus limon, Citrus#*** (CABI CPC, 'citricos' in Barroso and Diaz, 2014 and EcuRed, nd)
Sapindaceae: *Serjania* sp. (MIZA, 2013)
Sapotaceae: *Pouteria sapota*
Scrophulariaceae: *Capraria biflora* (Vázquez, 2004; Streito et al., 2007)
Sterculiaceae: *Theobroma cacao*
Verbenaceae: *Citharexylum* sp., *Cytharexylum spinosum#, Clerodendron sagraei* (Vázquez, 2004), *Duranta erecta* (Pestnet, 2005; Dubey and Sundararaj, 2015), *Duranta#*, *Tectona grandis*
Zygophyllaceae: *Guaiacum officinale* (Vázquez, 2004)

Uncertainties on hosts:

- ***Citrus* species that are hosts**. There are records for '*Citrus* sp.' and *Citrus limon* (see Table 2), and collection specimens from *Citrus* (3 slides from Réunion Isl., with many puparium; J.C. Streito, pers. comm.). There are also interception records in the USA on *Citrus* sp. and *Citrus aurantium* (also in Evans, 2008) and in the Netherlands on *Citrus reticulata* (M. Jansen, pers. comm.). *C. aurantium* was not added to the host list as only interception data was found. Apart from *C. limon* (listed as host in Evans, 2008), there is an uncertainty on which species of *Citrus* are hosts.
- ***Piper***. *A. trachoides* is reported as causing problems on kava (*Piper methysticum*) in Micronesia, and has been intercepted on *Piper betle* and other species of the genera *Piper* in the USA (Evans, 2008). *P. methysticum* was added to the list despite the nature of the source (Pestnet, internet forum), as well as *Duranta erecta* (ornamental – also Pestnet). There are also collection specimen on *Piper* sp. from Guadeloupe (3 slides with few puparium) and *Duranta* (5 slides of puparium from Réunion ; J.C. Streito, pers. comm.).

The following species and genera have not been included in Table 2 due to uncertainties.

- **Brassicaceae**, **Cucurbitaceae**, ***Lactuca sativa*** (CABI CPC): not in other sources.
- Interceptions on species not reported as hosts. ***Areca***, ***Citrus* sp**., ***Citrus aurantium***, ***Heckeria umbellate (Piper umbellatum)***, ***Hibiscus rosa-sinensis***, ***Ixora***, ***Jasminum***, ***Mentha***, ***Musa***, ***Oncidium***, ***Punica granatum*** (Evans, 2007). ***Phoenix***, ***Solanum macrocarpon***, ***Cestrum***, ***Citrus reticulata*** (in the Netherlands).

8. Pathways for entry

PaDIL (nd) considers fresh vegetables, ornamentals and leaves as possible pathways. For *Bemisia tabaci*, EFSA (2013) analyses plants for planting, cut flowers and branches with foliage, and vegetables (incl. leafy herbs). The EWG noted that *A. trachoides* has been introduced to isolated islands (Reunion, French Polynesia), and that it has a potential for entry on pathways other than natural spread.

There are interceptions records for *A. trachoides*, in the UK on sweet potato leaves (Malumphy, 2005); in the Netherlands on *Capsicum frutescens* (2), *Phoenix* (1), *Solanum macrocarpon* (1), *Cestrum* (1), *Citrus reticulata* (2) and unknown (2), on fruits (3), herbs (2), vegetables (2) and plants for planting (2) (M. Jansen, pers. comm.); in the USA (Evans, 2008; commodity not specified), on species recorded as hosts in Table 2 (*Annona muricata, Capsicum, Chamaedorea elegans, Chamaedorea, Citrus, Coccoloba uvifera, Plumeria, Piper*), but also many others (*Areca, Citrus aurantium, Heckeria umbellata (Piper umbellatum), Hibiscus rosa-sinensis, Ixora, Jasminum, Mentha, Musa, Oncidium, Punica granatum*). The commodities were not specified.

The pathways in Table 3 were studied in this PRA. For the pathway fruit, Solanaceae are major hosts, and were considered separately from other hosts. The pathways also cover species that are not in Table 2 but on which there were interceptions. Finally some of the commodities below may be transported by travellers in their luggage, and measures are considered in Section 16.

Table 3. Species or genera covered for different commodities

Pathway	Hosts covered
Fruit (in the botanical sense, incl. vegetables) of cultivated Solanaceae hosts (with or without green parts)	*Capsicum*, *Solanum*
Other fruit (in the botanical sense, incl. vegetables) (with or without green parts)	Cultivated hosts: *Psidium guajava*, *Persea americana*, *Annona*, *Citrus limon* Other *Citrus* species that are hosts (see section 7, uncertainties)
Plants for planting (except seeds and tubers)	All hosts except weeds. Note: the analysis of which hosts may be traded as plants has not fully been made. Species not listed as hosts but with interceptions (see *Uncertainties on hosts*)
Cut plant parts (cut flowers and branches, cut herbs, leafy vegetables)	Cultivated hosts, incl. *Apium graveolens*, *Ipomoea batatas*, *Rosa*, *Citrus* leaves and *Psidium* leaves (on which live insects are intercepted; FERA unpublished data), *Piper*. Note: the analysis of which hosts may be traded as cut plant parts has not been fully made. Species not listed as hosts but with interceptions: *Mentha*, *Musa*, *Jasminum*, *Oncidium*

A summary of the consideration of pathways is given in Table 4. For all pathways, the following is taken into account:

- All stages are generally on the underside of leaves, and occasionally may be present on other green parts (stems, shoots, calyx). They may be associated with fruit only if green parts are attached (especially leaves).
- All stages are expected to survive transport (as the pest has been intercepted, and also intercepted on species that are apparently not hosts). During the last nymphal instar after apolysis (pharate adult), whiteflies do not feed (Byrne and Bellows, 1991; Gelman et al., 2002) and are resistant to desiccation, so they can survive on dry foliage (Caciagli, 2007). Biological data specific to *A. trachoides* (esp. on temperatures) is lacking to assess the likelihood of multiplication during storage and transport. Fruits may be transported at various temperatures, depending on the species and on the degree of maturity, but some fruit are commonly transported under cooling which will slow down the development of the insect.
- Transfer to suitable hosts resulting in establishment would be higher if the pest is introduced in an area where it can survive outdoors.

Table 4. Consideration of pathways (refer to Table 3 for the exact coverage of pathways)

Pathway	**Fruit – Solanaceae hosts**	**Fruit - other families hosts**	**Plants for planting (except seeds and tubers)**	**Cut plant parts**
Pathway prohibited in the PRA area?	No	Partly e.g. Psidium in Israel EU: *Citrus* fruits should be free from peduncles and leaves, otherwise prohibited	Partly, in some EPPO countries. e.g. EU: Solanaceae, *Citrus.* However, import of these hosts is permitted in some other EPPO countries, e.g. ornamental Citrus in Turkey	Partly e.g. EU: *Citrus* leaves
Pathway subject to a plant health inspection at import?	Partly e.g. EU *Solanum melongena*, *Capsicum*	Partly e.g. EU *Psidium*, *Annona, Citrus*	Most probably partly in many EPPO countries. e.g. EU: all	Partly e.g. EU *Apium* (leaf vegetable), Orchidaceae (cut flowers), *Oncidium* (cut flowers)
Pest already intercepted?	Yes, *Capsicum frutescens, Solanum macrocarpon* (Netherlands), *Capsicum* (in the USA; uncertainty on whether it was fruit or another commodity)	Yes: *Citrus reticulata*, and other unknown fruits (Netherlands), *Annona muricata*, *Citrus* (commodity not specified); *Citrus aurantium*, (not listed hosts, commodity not specified)	Yes. At least *Phoenix* sp., *Cestrum* sp. (Netherlands; pers. comm. A. Loomans)	Yes (*Ipomoea batatas* leaves – Malumphy, 2005). Possibly others: it was intercepted on *Oncidium* and *Mentha*, i.e. plants or cut flowers/herbs, *Musa* (suspected to be leaves)
Most likely stages that may be associated	All stages are generally on the underside of the leaves and occasionally may be present on other green parts. This is most likely to occur for tomato on the vine. On *Capsicum* and eggplant, the only green part is the calix and this limits association (but there is no information on whether the pest is present on those).	All stages are generally on the underside of the leaves and occasionally may be present on other green parts. The fruit concerned (see Table 3) are unlikely to be traded with green parts (with the exception of Citrus where not prohibited)	All stages are on leaves, adults also on other parts	All stages on leaves
Important factors for association with the pathway	These are the main hosts. There is no information on the levels of infestation. Association will be more likely if green parts are attached.	The pest is considered more likely to be associated with fruit with green parts. *Citrus limon* is a host and the pest was also intercepted on *Citrus reticulata*.	Solanaceae and *Ipomoea* are main hosts (there are ornamental *Ipomoea*). The importance of most other plants concerned as hosts is not known. However, there are a number of hosts used as fruit crops (*Persea americana*, *Psidium guajava*) or ornamentals (e.g. Arecaceae). The pest could be associated with cuttings.	The importance of most plants concerned as hosts is not known. The pest was intercepted on *Musa* (suspected to be leaves) (*Musa* is not reported as host plant).
Survival during transport and storage	Likely if there are green parts. If eggs and, nymphs are attached to green parts (e.g. calyx, peduncles and leaves - tomatoes on the vine), the quality of the material may degrade over time. However, the last nymphal instar/puparium of whiteflies do not feed and they are resistant to desiccation, so they can survive on dry foliage (Caciagli, 2007). Unlikely if no green parts attached.	Likely if there are green parts (e.g. *Citrus* with leaves). Unlikely if no green parts.	Likely (all stages may feed on the plants)	Moderately likely (the last nymphal stage does not feed and is expected to survive. However, other nymphal stages may not be able to feed, and this may impact survival).

Pathway	Fruit – Solanaceae hosts	Fruit - other families hosts	Plants for planting (except seeds and tubers)	Cut plant parts
Trade	At least small volumes for tomato (EPPO, 2015), eggplant, *Capsicum,* probably smaller volumes of more 'exotic' Solanaceae. It is not known which volume of tomatoes is traded with green parts attached from countries where *A. trachoides* occurs.	No details searched, but there is a trade of some species at least *Persea americana*, *Annona, Psidium guajava, Citrus limon*, other *Citrus,* also *Musa*, *Punica granatum*.	Not known. Solanaceae and *Citrus* plants for planting are prohibited in part of the EPPO region (e.g. the EU). There is globally a large trade of ornamental plants for plantings, and herbs and cultivated plants may also be traded.	No details were searched. At least roses and herbs are traded into the EPPO region.
Transfer to a host	Transfer is more likely if packing and handling facilities are located near production areas (but this is a known situation for at least tomato, pepper and eggplants), and private gardens with hosts. As weeds are hosts, this increases the probability of transfer. Transfer with fruit directly provided to the consumer or used for processing is generally unlikely (the pest will be destroyed at processing or discarded by the final consumer). However, there are circumstances for discarding fruit that may not eliminate the pest, such as domestic compost in private gardens, 'green bins', discarding prior to processing. Green parts from tomato vines may be discarded, and favour transfer of the pest.	See Solanaceae fruit. However no information is available on whether packing and handling facilities are located near production areas.	Plants for planting will be planted in favourable conditions for their development. Transfer to another host will depend where the plants will be used.	Transfer is more likely if the commodity is imported to facilities where hosts are grown.
Likelihood of entry	Moderate: tomatoes with green parts attached Low otherwise.	For fruit with green parts: moderate-low For all others: low (low association)	High: probably moderate volumes, but some main hosts, large diversity of species, higher likelihood of survival and transfer	Moderate-low, if imported close to production sites: but material becoming unsuitable rapidly and transfer more difficult
Uncertainty	Moderate tomato with green parts (volume of trade) Low for others (association)	High with green parts (association, volumes) Low otherwise	Moderate (association, volumes, species that are traded)	High (association, volume, species that are traded)

Pathways considered unlikely (likelihood very low) and not considered further.

- **Underground parts of hosts (e.g. *Ipomoea batatas*, *Colocasia esculenta*, *Piper*).** No life stage of *A. trachoides* is associated with underground parts of plants. **Uncertainty***:* low
- **Natural spread.** Introduction from countries where the pest occurs through natural spread is considered unlikely. It is not possible from the Americas, Oceania or Réunion. Even if present in continental Africa (see *Distribution*), it is separated from the EPPO region by the Sahara. **Uncertainty**: low
- **Hitch-hiking (e.g. non-host commodities, passengers' clothes).** Species that are not hosts but on which the pest was intercepted were covered in the pathways (thereby covering possible cases of hitch-hiking). *A. trachoides* is not likely to be associated as contaminant to other commodities. **Uncertainty:** low
- **Soil or growing media, seeds, tissue cultures, processed commodities made from hosts, etc.**: No life stage of *A. trachoides* is associated with those substrates. **Uncertainty:** low.
- **Packaging (having carried hosts).** No life stage is likely to survive in the packaging material once the product is taken out. **Uncertainty**: low.

The ratings of the likelihood of entry and the uncertainty are given in Table 4.

9. Likelihood of establishment outdoors in the PRA area

Host plants in the EPPO region

Many hosts are grown in the EPPO region (see Table 2), and many hosts are also present in the wild or as weeds (e.g. *S. nigrum, Datura*). A number of Solanaceae (incl. tomato, capsicum and eggplant) are grown commercially in the field or under protected conditions (glasshouse, tunnels, plastic) as well as in gardens. Tomato is cultivated throughout the PRA area, whilst sweet pepper and eggplant have a more southern and eastern distribution (EPPO, 2014). Details on tomato are provided in the EPPO tomato study (EPPO, 2015). Many *Solanum* species are hosts, and it is not known if other species may be attacked if the pest establish in the PRA area.

In addition to the genera *Ipomoea*, many cultivated or wild genera belonging to Convolvulaceae family are present in the EPPO region. Some *Ipomoea* species are grown as ornamentals.

Together, the host crops are expected to be present throughout the EPPO region, although some are more southerly than others (e.g. *Persea americana*), and the production systems may vary (i.e. grown only in the field, only under glasshouse, or both).

The abundance of plants and the type of plants will influence the suitability of the area for establishment (e.g. all-year tomato crops, mixed tomato-other host, solely other hosts, mix of host plants). In some parts of the PRA area, solanaceous hosts (possibly others) are grown all year round (e.g. at least North Africa), which will favour establishment. As for other tomato pests, such as *Keiferia lycopersicella* and *Neoleucinodes elegantalis*, it is not considered likely that the existing management practices in the field will prevent establishment (EPPO, 2012, 2014). Details of the management practices for tomato and eggplant are given in EPPO management practices for tomato and eggplant (EPPO, 2012).

Climatic conditions

A. trachoides is considered as neotropical (Malumphy, 2005). According to the classification of Köppen Geiger (see map in Annex 1), it occurs mostly in countries of tropical/equatorial climates. In Florida, according to Kumar et al. 2016, most of the records are from Miami-Dade county (where climate is tropical) but it also occurs in Northern Florida (Alachua), which has a Cfa climate. It is also reported in California where part has a Mediterranean-type climate. Its current distribution corresponds to some climates that occur in the EPPO region, around the Mediterranean Basin, and in Portugal.

No detailed information was found on temperature and humidity requirements for *A. trachoides*. However, in Reunion island (subtropical climate), this species is found below 300 m (P. Ryckewaert, pers. comm.), and in Dominican Republic, it is present below 500 m, mainly on pepper (Colmar Serra, pers. comm.). Cugala et al. (2013) report high levels of infestation of whiteflies (with focus on *Aleurotrachelus atratus*, but *A. trachoides* is also discussed) on coconut in coastal areas of Mozambique where the level of infestation is favoured by high temperatures (min 20.2°C and max of 29.1°C) and high relative humidity(70%). It is also considered as favoured by high temperatures and high humidity in Antilles and French Guyana (P.

Ryckewaert, pers. comm.). In California (with Mediterranean-type climates), it is not reported as a pest and no information was found on whether it occurs in the field or in protected conditions. However, it is not known if this is because of marginal conditions, or because of other factors (e.g. if it is controlled by current plant protection practice applied against other pests, or because of the presence of natural enemies).

It is considered likely that *A. trachoides* can establish outdoors mainly in southern part of the EPPO region (temperature is the key factor), but with a high uncertainty regarding limits of establishment. If climatic conditions are suitable, it may also establish where its host crops are not present all year round, as it may survive on a number of weeds. It may also form transient population and may survive in glasshouses in absence of its hosts outdoors.

The most likely areas at risk of establishment outdoors in the EPPO region may be comprised within the southern part of the Mediterranean Basin (south of a line from southern Spain to southern Turkey) and southern Portugal.

Uncertainty: High (Adaptability to climate outdoors in different areas of the EPPO region, temperature and humidity requirements).

Southern part of the Mediterranean Basin (south of a line from southern Spain to southern Turkey) and southern Portugal

Rating of the likelihood of establishment outdoors	*Low* ☐	*Moderate* ✓	*High* ☐
Rating of uncertainty	*Low* ☐	*Moderate* ☐	*High* ✓

Rest of the EPPO region

Rating of the likelihood of establishment outdoors	*Low* ✓	*Moderate* ☐	*High* ☐
Rating of uncertainty	*Low* ✓	*Moderate* ☐	*High* ☐

10. Likelihood of establishment in protected conditions in the PRA area

Many hosts are grown under protected cultivation (plastic, tunnels, glasshouses) in the EPPO region, including *S. lycopersicum*, *S. melongena*, *Capsicum* and various herbs. Armstrong and Cabrera (2005), for Puerto Rico, note that it is a minor pest of *Capsicum* in the field, but that it can be serious in glasshouses. The same observations were made in Martinique (P. Ryckewaert, pers. comm.). Generally in hot and rainy tropical countries (such as Puerto Rico) glasshouses are used to protect the crops against rain and are not closed ("umbrella" protection). It is assessed that *A. trachoides* may establish in glasshouses in the EPPO region (in a similar manner as *B. tabaci* and *T. vaporariorum*).

Southern part of the Mediterranean Basin (south of a line from southern Spain to southern Turkey) and southern Portugal

Rating of the likelihood of establishment indoors	*Low* ☐	*Moderate* ☐	*High* ✓
Rating of uncertainty	*Low* ☐	*Moderate* ✓	*High* ☐

Rest of the EPPO region

Rating of the likelihood of establishment indoors	*Low* ☐	*Moderate* ✓	*High* ☐
Rating of uncertainty	*Low* ☐	*Moderate* ✓	*High* ☐

11. Spread in the PRA area

Whiteflies are not good fliers, but may be transported by wind. *A. trachoides* may also be transported on human-assisted pathways. The spread would be highest if it is introduced into an area where it can survive outdoors and from which host commodities are traded. Transport of plants and fruit within countries (e.g. markets, private use, passengers etc.) may also play an important role. Spread at very short distances (e.g. between glasshouses) in cases of high levels of infestation may occur with the movement of persons (e.g. association with clothes). *A. trachoides* has a wide host range, which may help its spread once established.

Uncertainty: moderate: lack of ethological and biological data, uncertainties on pathways.

Rating of the magnitude of spread	*Low* ☐	*Moderate* ☐	*High* ✓
Rating of uncertainty	*Low* ☐	*Moderate* ✓	*High* ☐

12. Impact in the current area of distribution

A. trachoides causes direct damage by feeding on plants and through the production of honeydew on leaves and fruits, which in turn favour the development of sooty moulds. This indirect damage is the most important, not only for aesthetic damage but also due to the physiological detrimental impacts on the plant (e.g. photosynthesis reduction). *A. trachoides* may cause stunting, wilting, weakening of the plants, yield reduction and impact the quality of fruits (MIZA, 2013). On avocado, *A. trachoides* may cause leaf yellowing, defoliation and general weakening of the plants (Colonia Coral, 2013). Feeding on young fruit may lead to deformation (EcuRed, nd). In some circumstances (heavy infestation, young plants), whiteflies can cause death of plants (see section 2).

No quantitative or economic data were found on impact. For the Caribbean, Vázquez (2004) note that *B. tabaci*, *T. vaporariorum* and *A. trachoides* have all importance for cultivated crops. In Cuba, *A. trachoides* is mentioned as having economic importance on *Capsicum* and *Annona* (Vazquez, 1999), and as a minor pest of capsicum in the field, but may be a major problem in glasshouses (Armstrong and Cabrera, 2005); it is subject to control measures on *C. annuum* in urban agricultures systems (Moreno and Gonzalvez, 2007). In Venezuela, it is occasionally a primary pest of sweet pepper in some areas, and a secondary pest of different solanaceous crops (MIZA, 2013); same observation in West Indies (P. Ryckewaert, pers. comm.). In the USA, it has been for more than five decades an intermittent pest of pepper although, until recently, it was never considered a key pest of economic importance. However, in the past few years, records of its spread and damage have been reported from private residences and nurseries throughout Florida. No details were found on damage in the Mexico or Central America. In the Pacific, it is recorded as mostly attacking chilli, taro (*Colocasia esculenta*), tomato and sweet potato (Waterhouse et al., 1997). It was severe on kava (*Piper methysticum*, a crop of increasing importance in the Pacific), capsicum, *Duranta erecta* (ornamental) and other crops in Micronesia (Pestnet forum, 2005, 2011). In Guam, *A. trachoides* caused problems in hot pepper before declining (Pestnet, 2011).

It is worth noting that there is no evidence that *A. trachoides* transmits viruses, and it is not given the importance given to the related *B. tabaci* as a vector of many virus species (EFSA, 2013).

Uncertainty: moderate (impact on hosts other than Solanaceae; impact in some countries (very little information is available)).

Rating of the magnitude of impact in the current area of distribution	*Low* ☐	*Moderate* ✓	*High* ☐
Rating of uncertainty	*Low* ☐	*Moderate* ✓	*High* ☐

13. Potential impact in the PRA area

Will impacts be largely the same as in the current area of distribution? **No (outdoors)**

Damage is expected to be lower outdoors as climatic conditions are probably not optimal.

However, it could cause direct damage to crops indoors. Specific control measures will be needed: IPM strategies are widely used in the EPPO region, and may have to be modified. *A. trachoides* may cause yield reduction (for fruit, plants for planting, cut flowers), rejection of fruit (due to low quality), effects on market value of ornamental hosts (due to consumer tolerance for whiteflies on the plants) or increases in production costs. IPM programmes will need to be adapted (natural enemies of *A. trachoides*, for example *Encarsia cubensis*) are different from the ones used in biocontrol against other whiteflies, and observations indicate that *A. trachoides* is more susceptible to insecticides than other whiteflies – P. Ryckewaert, pers. comm.). *A. trachoides* may have impact on external markets as well as on the large trade of host commodities within the EPPO region.

No environmental impact is expected apart if pesticide applications increase. Social impacts are expected to be minor overall.

Rating of the magnitude of impact in the area of potential establishment	*Low* ✓	*Moderate* ☐	*High* ☐
Rating of uncertainty	*Low* ☐	*Moderate* ✓	*High* ☐

14. Identification of the endangered area

The pest has the potential to establish in glasshouses and other protected conditions (screenhouses/ polytunnels) throughout the PRA area. In the long-term, populations are likely to maintain only if they can also survive outdoors. Outdoors, it is most likely to establish in southern part of the Mediterranean Basin (south of a line from southern Spain to southern Turkey) and southern Portugal.

15. Overall assessment of risk

The life stages of *A. trachoides* are present mostly on leaves, and occasionally on other green parts. Entry is considered possible on plants for planting, on fruit with green parts (incl. tomato), and on cut plant parts (cut flowers and branches, cut herbs, leafy vegetables). *A. trachoides* may cause outbreaks and transient populations under protected conditions (where it may cause damage even though it is does not establish permanently). The area of potential establishment is considered to be the southern part of the Mediterranean Basin (south of a line from southern Spain to southern Turkey) and southern Portugal, as well as indoors production throughout the PRA area. However impact on hosts grown in these areas (*Capsicum*, but also tomato and eggplant) is expected to be low with a moderate uncertainty.

Stage 3. Pest risk management

16. Phytosanitary measures

During its meeting, the EWG elaborated phytosanitary measures for host plants for planting, fruit with green parts, and cut parts of plants (see Annex 2).

When reviewing the PRA, The Panel on Phytosanitary Measures considered that, as the PRA concludes that *A. trachoides* poses a low risk to the endangered area, it should not be recommented for regulation as a quarantine pest and no phytosanitary measures should be recommended.

Eradication and containment. Eradication of whiteflies is possible (e.g. EPPO Standard PM 10/13(1) *Disinfestation of production site against Bemisia tabaci)*. However, eradication has a better chance of succeeding for introductions under protected conditions in an area where the pest cannot survive outdoors (as reflected in the current distribution and eradication reports of *B. tabaci*). Where the pest can survive outdoors, eradication would be very difficult and the pest may also sustain populations on its many hosts, including some weeds. Rather, it is considered here that introduction should be prevented.

Due to the nature of this PRA (short), it was not possible to provide detailed requirements for eradication and containment.

17. Uncertainty

The main uncertainties are as follows:

- biology (including conditions and durations of the life cycle under different conditions, temperature and humidity requirements), ecology
- identification to species
- distribution (especially that it may be more widespread than current records indicate in Africa)
- establishment and level of damage
- hosts and damage on the different hosts
- pest status (and whether it is present indoors or outdoors) in the USA in Mediterranean-type climates (California), and reason for the apparent lack of damage reports
- effectiveness of biological agents used for the other whiteflies.

18. Remarks

A small project in the framework of EUPHRESCO would be useful to address some of the uncertainties, such as to conduct life history/development studies under quarantine conditions in order to determine threshold temperatures for development and better inform the potential distribution in the EPPO region.

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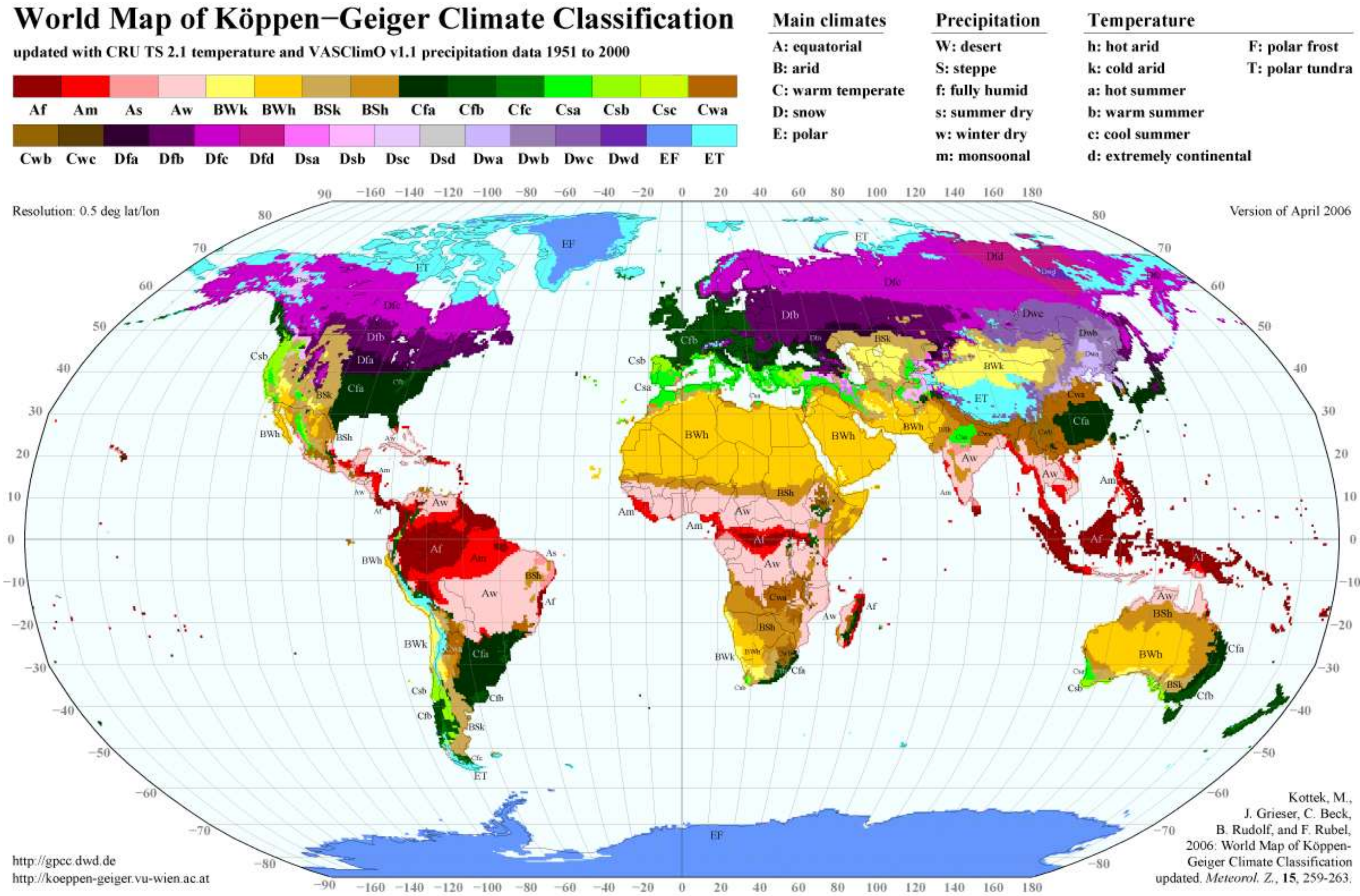
Annex 1



World Map of Köppen−Geiger Climate Classification
updated with CRU TS 2.1 temperature and VASClimO v1.1 precipitation data 1951 to 2000
Af Am As Aw BWk BWh BSk BSh Cfa Cfb Cfc Csa Csb Csc Cwa
Cwb Cwc Dfa Dfb Dfc Dfd Dsa Dsb Dsc Dsd Dwa Dwb Dwc Dwd EF ET
Main climates
A: equatorial
B: arid
C: warm temperate
D: snow
E: polar
Precipitation
W: desert
S: steppe
f: fully humid
s: summer dry
w: winter dry
m: monsoonal
Temperature
h: hot arid
k: cold arid
a: hot summer
b: warm summer
c: cool summer
d: extremely continental
F: polar frost
T: polar tundra
Resolution: 0.5 deg lat/lon
Version of April 2006
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Annex 2. Consideration of pest risk management options

The table below summarizes the consideration of possible measures for the different pathways (based on EPPO Standard PM 5/3). When a measure is considered appropriate, it is noted "yes", or "not alone" if it should be combined with other measures in a systems approach. "No" indicates that a measure is not considered appropriate. A short justification is included.

For fruit:

- Solanaceae are the main hosts. The risk exists if green parts are attached (i.e. tomato on the vine, possibly *Capsicum* and eggplant if the pest is associated with calyxes). Given the diversity of hosts, the measures proposed cover the genera *Capsicum* and *Solanum*. Note: this would cover cultivated species that are not on the host list (e.g. *S. muricatum* – pepino; *S. betaceum* - tamarillo).
- For other families (e.g. *Psidium guajava*, *Persea americana*, *Annona)*, fruit are normally not traded with green parts. Only Citrus fruit may be traded with leaves. In many EPPO countries, including the EU, Citrus fruit from third countries "shall be free from peduncles and leaves". The only recommended measure is that consignments should be free from leaves and other plant parts.

Option	**Plants for planting (except seeds and tubers)**	**Fruit (Solanaceae)**	**Cut parts of plants**
Existing measures in EPPO countries	Partly (Prohibition exists on import of Solanaceae plants for planting in EU and other countries but other hosts are not regulated). The existing measures are not sufficient to prevent the risk of entry of the pest (at the scale of the whole EPPO region)	No. The existing measures are not sufficient to prevent the risk of entry of the pest (at the scale of the whole EPPO region)	
Options at the place of production			
Visual inspection at place of production	Not alone Small pest (1-2 mm for adults). Yellow sticky traps may be used, but adults are very difficult to differentiate from other Aleyrodidae e.g. *Bemisia tabaci* and *T. vaporariorum*. At low levels of infestation, the pest may also be difficult to detect. Eggs are small but colonies at undersides of leaves are easy to detect and 'puparium' can also be detected easily (they are dark with white cotton expansions). Adults and 'puparia' are similar to other whiteflies: they can be detected but not identified without microscopic examination (J.C. Streito, pers. comm.). Regular inspections during the growing period will be needed.		
Testing at place of production	No. Not relevant for an insect.		
Treatment of crop	Not alone Aimed at lowering population below economic threshold, not reliable to guarantee pest freedom, but can be combined with others. Insecticides are not efficient against all life stages (in particular eggs). The use of insecticides may in some cases reduce the pest populations and make detection during inspection more difficult. This is proposed as an option in the EU Directive for plants for plants for planting for *B. tabaci* to aim at eradication of the pest after a finding. EFSA (2013) lists a large number of options (cultural methods, biological control, chemical control and IPM) to reduce pest population of *B. tabaci* during crop production. It is not known if these options will be effective against *A. trachoides*, especially for biological control It may be noted that parasitoids of *B. tabaci* in Martinique do not attack *A. trachoides* (P. Ryckewaert, pers. comm.).		
Resistant cultivars	No. Not relevant		
Growing the crop in in glasshouses/ screenhouses	Yes (+ handling/packing preventing infestation) but difficult to implement in practice This would require complete physical isolation (following EPPO Standard PM 5/8; i.e. including additional measures to guarantee pest freedom). Possible, but difficult to implement in commercial production. Screenhouses should have an appropriate mesh size (<0.9 mm for *A. trachoides*). It is difficult to implement in practice because of the temperature in the tropics and the difficulty to have appropriate ventilation in such screenhouses.		

Option	Plants for planting (except seeds and tubers)	Fruit (Solanaceae)	Cut parts of plants
Specified age of plant, growth stage or time of year of harvest	No Plants for planting without young shoots, leaves and fruit are covered further down.	No. Not relevant	
Produced in a certification scheme	No. Not relevant for an insect.		
Pest free production site	Yes: only growing under complete physical isolation (following EPPO Standard PM 5/8, see 3 rows above)		
Pest free place of production	Not alone (if not under complete physical isolation) Place of production freedom (not in protected conditions) is an option in EU Directive 2000/29 for *B. tabaci*, if accompanied with official inspections at least once each three weeks during the nine weeks prior to export. EFSA 2013 considers that this monitoring period is sufficient to ascertain whether the pest has been eliminated from the place of production. It considers that this monitoring period could be effective if applied in a close environment. It also concludes that PFPP provides a lower level of effectiveness than a PFA and require additional measures. The Panel on Phytosanitary Measures considered that a PFPP outdoors would not provide a suitable level of protection for this type of pests.		
Pest free area	Yes PFA as described in ISPM 4 (based on surveys). It will require trapping using yellow sticky traps followed by identification. There should be controls on movement of all host fruit and plants, other hosts, equipment and packaging, etc. in and out of the area.		
Options after harvest, at pre-clearance or during transport			
Visual inspection of consignment	Not alone. During visual inspection of the plants, eggs and young nymphal instars may remain undetected owing to their small size and transparent colour. Adults present at low densities may also remain undetected.	Not alone	Not alone Visual inspection immediately prior to export is proposed as a stand-alone measure for some cut flowers and leafy vegetables in EU Directive 2000/29 for *B. tabaci*. However, this would apply to a limited range of host species. In addition, when dealing with large volumes and low population densities, detection may be difficult.
Testing of commodity	No. Not relevant.		
Treatment of the consignment	No. Although plants may be treated with insecticides, there are issues of efficacy, applicability and feasibility, and this may not guarantee absence of the pest.	Yes? (+ handling/packing preventing infestation) Treatment may be possible but no specific data is available for *A. trachoides*. The effect of irradiation, hot water immersion, vapour heat treatment, cold treatment, insecticide sprays (from USDA treatment manual) is not known Fumigation with methyl bromide is not recommended (phased out in 2015)	
Pest only on certain parts of plant/plant product, which can be removed	No Council Directive 2000/29/EC states that a number of plant species which are exported to the EU should be dormant and free from flowers and fruits. Considering that eggs and nymphs are mostly on leaves and adults may be on green parts, removal of flowers and fruits will not have any effect if the pest is present on the planting material (similarly as the consideration for *B. tabaci*	Yes for tomato Eggs and nymphs are mostly on leaves. Adults may be on green parts. For fruit with green parts (tomato, *Citrus*), removing those would remove the pest.	No. Eggs and nymphs are mostly on leaves. Adults may be on green parts.

Option	Plants for planting (except seeds and tubers)	Fruit (Solanaceae)	Cut parts of plants
	in EFSA 2013) Requiring that plants are dormant is not applicable because plants are not dormant in the area of origin (tropics), and the pest is present all year round For cuttings on non-herbaceous plants, absence of leaves would reduce the association. However, it may not completely remove the pest. Eggs may be present. This measure should be combined with dipping in insecticide (e.g. oil), as done against *B. tabaci* (EPPO, 2011).		
Prevention of infestation by packing/handling method	Not alone: Commodities may already be infested. For plants for planting and cut plant parts, suitable packing/handling methods should be used to prevent reinfestation. It is considered unlikely that the pest will infest fruits after harvest.		
Options that can be implemented after entry of consignments			
Post-entry quarantine	Not alone (should be combined with regular inspections). Possible in theory for small consignment of high value plants, on the basis on bilateral agreements (but may not be practical/cost-effective). (No data to decide on length, but should allow the development of at least 1 generation, i.e. at least 3 weeks at 25°C)	Not relevant	
Limited distribution of consignment in time and/or space or limited use	No Not applicable for plants as the intended use is for planting.	Yes but difficult to implement in practice (should be applied on the basis of a bilateral agreement) Consignments may be imported when temperatures are cold (for example for fruit, for immediate processing or direct consumption), where the pest cannot survive outdoors. However, there are no data on the conditions under which they may survive outdoors. Immediate processing of the fruit and destruction of the waste (e.g. burning, deep burial) is possible, but it is not practical and difficult to control in practice. Adults that have emerged during transport might also escape. Cut flowers and herbs would normally be used indoors, and the risk of transfer should therefore be low where the pest cannot survive outdoors. However, the exact limit of this area is not known.	
Only Surveillance and eradication in the importing country	No	Only for fruit (in the framework of bilateral agreement. Difficult to implement in practice. In the part of the EPPO region where the pest cannot establish outdoors (not precisely defined), infested consignments could in theory	

Option	Plants for planting (except seeds and tubers)	Fruit (Solanaceae)	Cut parts of plants
		be imported. This would require the separation of trade and production flows (separate facilities for imported consignments and for growing hosts) and a good surveillance system (although this will be challenging as there are no species-specific traps). Eradication is considered possible in greenhouses in that part of the PRA area. This would be possible only as long as the trade volumes are very low. This may be possible in individual EPPO countries in the northern part of the region, but may not be feasible overall	