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Pest Risk Analysis for

***Prodiplosis longifila* (Diptera: Cecidomyiidae)**

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:left: *Prodiplosis longifila* Adult (female); right Tomato leaf bud damage by *P. longifila* . Courtesy: Maria Manzano (Universidad de Colombia, sede Palmira, Colombia)

Based on this PRA, *Prodiplosis longifila* was added to the A1 Lists of pests recommended for regulation as quarantine pests in 2017.

Pest Risk Analysis for *Prodiplosis longifila* (Diptera: Cecidomyiidae)

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 the following experts: Maria Manzano (Universidad de Colombia, sede Palmira, Colombia), Jorge Pena (University of Florida, USA), Eddy Dijkstra (NPPO, The Netherlands). On specific issues, Maria Manzano also consulted, F. Diaz. (Responsable del Laboratorio de Biocontroladores. Proyecto Especial Chavimochic Sede Campamento San José de Virú. Región La Libertad, Perú), N. Toro-Perea (Department of Biology, Univalle, Cali, Colombia), and O. Valarezo (Ecuador) (pers. comm. included in this document).
All personal communications were obtained in November-December 2015.

Following the EWG, the following PRA core members provided comments: Alan MacLeod (UK), Dirk Jan van der Gaag (The Netherlands), José Maria Guitian Castrillon (and colleagues; Spain), Robert Steffek (Austria), Salla Hannunen (Finland), Silvija Pupelienė (and Henrikas Ostrauskas; Lithuania).
The Panel on Phytosanitary Measures considered the management options in 2016-11 and 2017-03. EPPO Working Party on Phytosanitary Regulation and Council agreed that *Prodiplosis longifila* should be added to the A1 Lists of pests recommended for regulation as quarantine pests in 2017.

<table>
<tr><td colspan="4">Summary of the Pest Risk Analysis for Prodiplosis longifila (Diptera: Cecidomyiidae)</td></tr>
<tr><td colspan="4">PRA area: EPPO region</td></tr>
<tr><td colspan="4">Describe the endangered area: The endangered area is considered to be the Mediterranean region, Portugal and the southern Black Sea coasts (and with a higher uncertainty the oceanic part of Western Europe),as well as indoors production of host plants throughout the PRA area. Hosts grown in these areas, especially tomato, capsicum and asparagus, are at risk of economic impact.</td></tr>
<tr><td colspan="4">Main conclusions
Overall assessment of risk: The gall midge Prodiplosis longifila is a pest of tomato, capsicum, potato and asparagus in some countries of South America. It attacks different parts of plants depending on host species. It also attacks different hosts in different countries, and there may be cryptic species with different host preferences. In particular, in the USA, it has been reported only on lime (flowers) and wild Gossypium in Florida, and on the weed species Solanum carolinense (leaves) in Virginia. In other countries, a wide range of hosts are attacked. Entry is considered likely, on plants for planting, fruit of tomato (both on the vine or not) and capsicum, as well as on asparagus and other cut plant parts (cut flowers and branches, cut herbs, leafy vegetables). In particular, there is a trade of tomato fruit and asparagus from South America, and the pest may be associated with both. The pest is expected to have a high impact on tomato, Capsicum and asparagus. P. longifila has possibly a larger potential area of distribution than the other tomato pests considered in this series of PRAs.
Spread will mainly be with traded commodities rather than natural spread.

Phytosanitary Measures to reduce the probability of entry: Risk management options were determined for plants for planting, fruit (e.g. tomato and Capsicum), and cut plant parts (e.g. asparagus).</td></tr>
<tr><td>Phytosanitary risk for the <u>endangered area</u> (Individual ratings for likelihood of entry and establishment, and for magnitude of spread and impact are provided in the document)</td><td>High ☒</td><td>Moderate ☐</td><td>Low ☐</td></tr>
<tr><td>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)</td><td>High ☐</td><td>Moderate ☒</td><td>Low ☐</td></tr>
<tr><td colspan="4">Other recommendations: Raising awareness and inspection of luggage for travellers carrying fruits, cut flowers, leafy vegetables or plants for planting of main hosts</td></tr>
</table>

Stage 1. Initiation

Reason for performing the PRA:

Prodiplosis longifila 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. *P. longifila* is present in the Americas. It attacks different hosts at different locations. It is a major pest of tomato and asparagus in some countries of the northern part of South America. In South America, it has gained importance as a pest since the 1980s.

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

Stage 2. Pest risk assessment

1. Taxonomy

Taxonomic classification. Order: Diptera; Family: Cecidomyiidae; Genus: *Prodiplosis* Felt; Species*:* *Prodiplosis longifila* Gagné, 1986.

Synonyms: none.

Common names. Cecidomyiido de los frutos del tomate (Diaz, 1981); negrita, chamusca, quereza (Vélez Salazar, 1998), liendrilla, tostón (Chavez-Vergara, 2002), prodi, caracha, mosquilla de los brotes (Castillo, 2006), pelabolsillo (Rendón 2015), caregat (M. Manzano, pers. comm. – *for all personal communications, see details at the beginning of the PRA*).

Additional notes. The pest was identified as a new *Prodiplosis* sp. at the beginning of the 1980s in Peru (previously misidentified as being *Contarinia medicaginis*) and was described as *P. longifila* by Gagné (1986).

Populations of *P. longifila* present differences in biology, behaviour and host range (Duque-Gamboa, no date). Molecular analysis of populations from several origins in South America and North America showed distinct populations on tomato and on *Citrus*, and the authors conclude there is a genetic differentiation within *P. longifila* associated with different host plants, suggesting the existence of a complex of cryptic species associated with different hosts (Duque-Gamboa, 2015, project description; Duque-Gamboa et al., 2014).

Other studies attempted to determine if variations between populations were due to environmental factors. Molecular analysis of populations attacking tomato at different altitudes (in the range 950-1775 m) in Colombia and one province of Ecuador did not show differences between them (Velasco-Cuervo and Toro-Perea, 2015). Gene flow between populations was detected, which produces low genetic differentiation, but the anthropogenic effect produced by farming practices causes passive dispersal of the pest throughout the Andes (M. Manzano, pers. comm., consultation with N. Toro-Perea).

2. Pest overview

Prodiplosis longifila is a major pest of tomato and asparagus in some countries of South America. It attacks different hosts in different areas.

Life cycle. There are many generations in a year (up to 33 in Peru). The duration of the life cycle from egg to adult is about 10-20 days at 20-27°C (Pena et al. 1989; Vélez Salazar 1998; Valarezo et al. (2003); Castillo-Valiente (nd); Rodriguez (1992) cited in Goldsmith et al. (2013)). Extreme durations found in the literature are 20-25 days (Díaz, 1981; Paredes, 1997 cited in Valarezo et al., 2003) and 7-10 days on potato (high temperature, high relative humidity – in less favourable conditions the pupal stage lasted longer –Haddad and Pozo, 1994 cited in Valarezo et al. 2003).

Eggs are transparent, elongate-ovoid ca. 0.25 mm, hatch within 1-2.6 days (Pena et al., 1989; Vélez Salazar, 1998; Rodriguez, 1992 cited in Goldsmith et al 2013), and are normally laid on plants in protected places or inside plant tissue, in small groups (2-3) (Vélez Salazar, 1998). On tomato, they are laid among the sepals of the calyx (also found on leaflets: M. Manzano, pers. comm.). The pest infests tomato fruits of 2-5 cm diameter (Gonzalez-Bustamente et al., 1996b). Vélez Salazar (1998) also reports that eggs are laid on new

leaves, or in flowers. In asparagus, *P. longifila* deposit its eggs under the bracts, in the flowers and in other structures (Goldsmith et al., 2013). On lime, eggs are laid in flower stamen or styles; with 1-66 larvae found per infested flower (mean ca. 24) (Pena et al., 1989; Pena, 2011). On *Phaseolus lunatus*, eggs are normally laid in buds and, in high populations, also at the surface of pods (Gonzales-Bustamante, 1996a).
Larvae can be transparent, white or yellowish-orange. Development takes 3-9 days (Pena et al., 1989; Vélez Salazar, 1998, citing INIAP 1997). The last (third) instar measures 1.15-1.90 mm long. Larvae feed on different parts of plants (buds, flowers, leaves, new growth, fruits, pods – see Damage below). Larvae are normally found on the fruit, under the calyx. The pest is also reported to attack the new growing tips of many different kinds of plants (Gagné, 1986). Larvae scrape epidermal tissues to feed (Hernandez et al., 2015). On lime, they are in flower buds and flowers (Hernandez et al., 2015). At the end of its development, the third instar moves into the soil to pupate (Vélez Salazar, 1998). No studies have been done regarding larval survival at different temperatures (J. Peña, pers. comm.).
Pupae are in the soil, on average at a depth of 1.5 cm (Pena et al., 1989). The duration of the pupal period is between 4 and 11.2 days (Pena et al., 1989; Goldsmith et al., 2013).
Adults are ca. 1.5 mm in length (Gagné, 1986). They do not feed on plant tissue (Muguerza, 2014) but on nectar and sugars and require humidity for their survival. Their life span is 1-8 days depending on food availability (Pena et al., 1989; Duque Vargas et al., 2014). Adults were active at temperatures between 17-26°C, and 60-98% relative humidity (Pena et al., 1989; Ventura and Ayquipa, 1999 cited in Valarezo et al., 2003). Adults hide during the day (e.g. on walls ('paretes'), trunks etc. (Vélez Salazar, 1998)). Mating is nocturnal. Adults appear in tomato crops as soon as plants start producing tender leaf shoots (Vélez Salazar, 1998). Adults are attracted by light and are transported with the wind (Castillo-Valiente, 2010).

Damage. *P. longifila* attacks different plant parts on different crops, but mostly attacks new growth and soft tissues. Details of damage are given here as it is important for the pathways. Hosts are listed in section 7 and their importance given in section 11.

Fruit (in the botanical sense, incl. vegetables and pods) is attacked on some hosts (especially tomato, *Capsicum annuum*, but also *C. bacattum*, *C. chinense*, *Citrullus lanatus*, *Cucumis melo*, *Cucumis sativus*, *Fragaria vesca*). Feeding damage creates scrapes on fruit; on tomato, this may lead to deformation; on capsicum, growth may stop (Hernandez et al., 2015). On *Phaseolus lunatus*, damage to buds is the most important (Gonzales-Bustamante, 1996a), but in high populations, larvae feed on the surface of young pods, leading to deformation. The beans are 'harvestable', although reduced in size. On other fruit hosts, from the information available in the literature, fruits are not attacked but other plant parts, see below (esp. *Citrus*, *Malus domestica*, *Persea americana*, *Vitis vinifera*, *Morus nigra*, *Carica papaya*).

Buds and flowers. On *Citrus* x *latifolia*, larvae feed on flower buds and flowers (Hernandez et al., 2015). On asparagus, larvae attacks the buds and flowers (Ortega Ramirez et al., 2014) causing deformation and stunting of the bud and stems (Castillo-Valiente, nd). Photos in Castillo-Valiente (nd and 2010) illustrate damage to inflorescence of artichoke (*Cynara scolymus*) (see uncertainties on hosts in section 7). On alfalfa and potato, larvae feed on buds, causing stunting of plants (Diaz, 1981).

New growth of plants. *P. longifila* attacks new growths, and young plants. This has been reported for avocado and grapes (as illustrated in Castillo-Valiente (2010)), *Citrullus lanatus* (Muguerza 2014), *Phaseolus* (plants stopped producing buds) (Vélez Salazar, 1998), *Brassica oleracea* (scrapes on tender plants), *Coriandrum sativum, Cynara scolymus*, *Pisum sativum* (scrapes on new leaves, perforation of leaves, halting of plant growth); *Spinacia oleracea* (scrapes on leaves, leaf borders turn down) (M. Manzano, pers. comm., consultation with F. Diaz) and *Carica papaya* (Diaz, nd). On *Glycine max*, there are 2-4 larvae per leaf, and it causes minimal damage (Vélez Salazar, 1998), only on young plants.

No specific indication on damage was found for other hosts on the list in Table 2.

Detection. Eggs and first instar larvae are in protected places (e.g. under the calyx) and are not visible with the naked eye (Gonzales-Bustamante et al., 1996b). In addition, symptoms may be confused with fungal infection. Adults are also difficult to observe because they hide during the day. No specific traps are available. Sticky coloured traps may be used to monitor the pest in the country of export (Pena and Duncan, 1992; Chavez Vergara, 2002).

Identification. A key to adults of Nearctic *Prodiplosis* is provided in Gagné (1986) and some morphological details on adults are provided by Hernandez et al. (2015). Several articles refer to molecular methods, also in relation to cryptic species (Duque-Gamboa et al., 2014); Velasco Cuervo and Toro Perea, 2015; Ortega Ramirez et al., 2014), but these may not be of use for practical identification to species level. Identification of Cecidomyiidae based on morphological characters is difficult, and there is a risk of misidentification (e.g. *Contarinia* in Jamaica – see section 6). Morphological identification of larvae to species is not possible.

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

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

5. Regulatory status of the pest

P. longifila is not mentioned specifically in the phytosanitary regulations of EPPO countries according to EPPO Global Database (at December 2015). It was added to the EPPO Alert List in November 2015.
P. longifila is a quarantine pest for Antigua and Barbuda (2005), Argentina (2011 - as *P. "longifolia*" – for asparagus), Brazil (2010) and Trinidad and Tobago (2010) (from the IPP). The EPPO Secretariat checked only a limited number of quarantine lists for non-EPPO countries, and *P. longifila* may be regulated in more countries.

6. Distribution

P. longifila occurs only in the Americas. Its origin is unknown. Records for the Caribbean are not valid (see below Table 1).

Table 1. Distribution of *P. longifila*

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 notes**
EPPO region	Absent	
North America	**USA :** Florida, Virginia (Gagné and Jaschhof, 2014)	First found in **Florida** in 1934 (Pena, 2011), in the 1990s in **Virginia** (Wise, 2007)
South America	**Colombia Ecuador, Peru**	**Colombia.** Initially reported from Valle del Cauca, then expanded (Hernandez et al., 2015 – with map of predictive distribution) **Ecuador**. First reported in 1986 in El Oro province, probably entered from Peru, then expanded until last new geographical report in 1998 (Valarezo et al., 2003 – with map) **Peru**. First found in Lima in 1979 (Diaz, 1981), then the whole coast (Gonzales- Bustamante, 1996b)

Invalid records:
- **Jamaica** (Lawrence, 2000; Caripest, no date). The pest present in Jamaica was confirmed in consultation with Dr R. Gagné (who described *P. longifila* – see section 2) as an undetermined species of *Contarinia* (Goldsmith et al., 2013).
- **West Indies** is mentioned in several publications. The Caribbean is not mentioned in Gagné and Jaschhof (2014). Records for West Indies are thought to arise from the previous record in Jamaica (see above), or from possible confusion with *Contarinia lycopersici*, a pest of tomato flowers present in this area.

7. Host plants and their distribution in the PRA area

The host situation of *P. longifila* is complex. It has been reported on different hosts (cultivated and weeds) at different locations. In South America, tomato is the main host in all countries, and other major hosts vary depending on countries (e.g. asparagus and *Capsicum annuum* in Peru, or potato in Ecuador). Fruit are only attacked in a limited number of host species (incl. tomato and *Capsicum annuum*, see section 2). In the USA, it was initially found on wild *Gossypium*, much later on *Citrus* x *latifolia*, and was collected only once on another host: tomato (flowers, never fruits or buds; J. Pena, pers. comm.). There may be several explanations to the different hosts in different countries, which are relevant for the PRA:

- *Hosts in areas where environmental conditions do allow or not for the presence of the pest*. For example, Hernandes et al. (2015) mention it is a pest of potato in Peru, but not in Colombia, where potato is grown at altitudes above the upper distribution limit of the pest (2500-3000 m).
- *Possible different species*. The identity of the different populations of *P. longifila* is not resolved, and some hosts records previously attributed to *P. longifila* may prove to be another species (e.g. *Asparagus officinalis*, *Capsicum annuum* and *Citrus* in Peru: Ortega Ramirez et al., 2014). In the meantime, all hosts are included in Table 2.
- *Previous misidentifications or uncertain records*. Identification of *Prodiplosis* based on morphology is complicated (Gagné, 1986) and requires specialist knowledge of Cecidomyiidae. Records in the literature relate to different sources, such as a world authority on Cecidomyiidae (Gagné), molecular analysis, researchers, and field observations by extension officers. In some publications, it is not clear how the pest was identified. Misidentifications as *P. longifila* are known (e.g. *Contarinia* in Jamaica – Goldsmith et al., 2013). This introduces some uncertainties.

Finally, this may simply be due to the absence of certain hosts where the pest is present, or that the host is not available to the pest for some reason, e.g. the host and pest lifecycles do not synchronise in a particular location.

Table 2 lists all hosts, with countries and details where available, separating hosts with records in the literature (e.g. studies for specific countries, as well as Gagné references), records with little information (including through personal communication between M. Manzano and F. Diaz), and weed hosts.

Table 2. Host plants. (In **bold**, species considered widely cultivated in the EPPO region)

Note: the identity of the different populations of *P. longifila* is not resolved, and some hosts records previously attributed to *P. longifila* may prove to be another species. In the meantime, all hosts are included in Table 2. The table is divided into three sections: hosts for which there is good evidence that the pest is associated with them; reported hosts for which less information was found; and weed hosts.

Hosts with direct records for the country concerned or in Gagné references		
Host	Countries	References
Solanaceae		
Capsicum annuum	Colombia, Peru	Hernandez et al. (2015); Goldsmith et al. (2013, citing Castillo, 2006), Valarezo et al., 2003, literature survey, F. Diaz*#
Solanum lycopersicum	Ecuador, Peru, Colombia	Vélez Salazar, 1998 (citing INIAP, 1997); Valarezo et al., 2003; Diaz, 1981; Hernandez et al., 2015; Gagné and Jaschhof, 2014; Rodriguez, 1992 cited in Goldsmith et al., 2013
Solanum		Gagné, 1986
Solanum tuberosum	Ecuador, Peru	Valarezo et al., 2003; Diaz, 1981; Gagné, 1986; Gagné and Jaschhof, 2014, Kroschel, 2012 Not in Colombia, Hernandez et al., 2015 – environmental conditions
Amaryllidaceae		
Allium cepa	Peru	Goldsmith et al. (2013, citing Castillo, 2006), F. Diaz*#
Asparagaceae		
***Asparagus officinalis* (see note 1)**	Peru	Castillo-Valiente (2010) (also photo), F. Diaz*#, R. Gagné (M. Manzano, J. Pena, pers. comm.), Ventura & Ayquipa (1999, cited by Valarezo et al., 2013), Goldsmith et al. (2013, citing Castillo, 2006) Not in Colombia: Hernandez et al., 2015
Asteraceae		
Cynara scolymus	Peru	Goldsmith et al. (2013, citing Castillo, 2006 – as *Cynara carduncul*us); Castillo-Valiente, 2010 (also photo); F. Diaz*#
Tagetes	Peru	Diaz, 1981
Tagetes erecta	Peru	Goldsmith et al. (2013, citing Castillo, 2006); F. Diaz*#, ;
Cucurbitaceae		

Citrullus lanatus	Peru, Ecuador? (as 'sandia')	Muguerza, 2014; Valarezo et al., 2003 (extension officers reports); Goldsmith et al. (2013 citing Castillo, 2006); F. Diaz*#
Cucurbita	Peru	Goldsmith et al. (2013, citing Castillo, 2006)
Cucumis melo	Peru, Ecuador	Triviño et al. 1997; Vélez Salazar, 1998 (citing INIAP, 1997); Valarezo et al., 2003; Goldsmith et al., 2013, F. Diaz*#
Cucumis sativum	Peru, Ecuador	Valarezo et al., 2003; F. Diaz*#
Euphorbiaceae		
Ricinus communis	Ecuador, Peru (in the wild?)	Valarezo et al., 2003; Diaz, 1981; Gagné and Jaschhof, 2014 ; F. Diaz*#
Fabaceae		
Glycine max	Ecuador	Triviño et al., 1997; Valarezo et al., 2003, F. Diaz*#
Medicago sativa	Peru	Diaz, 1981; Gagné, 1986; Gagné & Jaschhof 2014
Phaseolus	Ecuador, Peru	Gagné, 1986; Gagné and Jaschhof, 2014, Valarezo et al., 2003; Castillo-Valiente, 2010 (also photos)
Phaseolus lunatus	Peru	Diaz, 1981; Gonzales-Bustamante 1996a; F. Diaz*#
Phaseolus vulgaris	Ecuador, Peru	Goldsmith et al. (2013, citing Castillo, 2006); Valarezo et al., 2003 (for Ecuador, and for Peru based in literature survey); F. Diaz*#
Lauraceae		
Persea americana	Peru	Goldsmith et al. (2013, citing Castillo, 2006); Castillo-Valiente, 2010 (photo only); Valarezo et al., 2003, based on literature survey; F. Diaz*#
Malvaceae		
Gossypium	Peru	Castillo-Valiente, 2010; Gagné and Jaschhof, 2014; F. Diaz*#
Gossypium hirsutum (see note 2)	Ecuador, Peru, USA	Valarezo et al., 2003; Pena et al., 1987; F. Diaz*
Rutaceae		
***Citrus* (see note 3)**	Peru	Goldsmith et al. (2013, citing Castillo, 2006), Castillo-Valiente, 2010 (in general list), F. Diaz*#
***Citrus* x *latifolia* (see note 3)**	USA, Colombia	Peña et al., 1987; Gagné and Jaschhof, 2014 (as *C. aurantifolia*) Hernandez et al., 2015
Vitaceae		
Vitis vinifera	Peru	Goldsmith et al. (2013, citing Castillo, 2006); Castillo-Valiente, 2010 (photo only), F. Diaz*#
Hosts for which little information was found		
Solanaceae		
Capsicum	Peru	Castillo-Valiente, 2010 (also photo)
Capsicum baccatum	Peru	F. Diaz*#
Capsicum chinense	Peru	F. Diaz*#
Solanum pimpinellifolium	Peru	F. Diaz*#
Amaranthaceae		
Amaranthus caudatus	Peru	F. Diaz*#
Spinacia oleracea	Peru	Valarezo et al., 2003, literature survey, F. Diaz*#
Apiaceae		
Coriandrum sativum	Peru	Valarezo et al., 2003, literature survey
Petroselinum crispum	Peru	F. Diaz*
Asteraceae		
Gerbera jamesonii	Peru	F. Diaz*#
Tagetes patula	Peru	Castillo-Valiente, 2010; Valarezo et al., 2003, literature survey
Brassicaceae		
Brassica oleracea	Peru	Valarezo et al., 2003, literature survey
Brassica oleracea* var. *italica	Peru	F. Diaz*#
Caricaceae		
Carica papaya	Peru	F. Diaz*#

Cucurbitaceae		
Cucurbitaceae	Peru	Castillo-Valiente, 2010 (also photos)
Cucurbita pepo	Peru	F. Diaz*
Euphorbiaceae		
Plukenetia volubilis	Peru	F. Diaz*#
Fabaceae		
Lens culinaris	Peru	F. Diaz*#
Melilotus albus	Peru	F. Diaz*
Pisum sativum	Peru	Valarezo et al., 2003, based on literature survey; F. Diaz*#
Vicia faba	Peru	F. Diaz*#
Lamiaceae		
Salvia hispanica	Peru	F. Diaz*#
Moraceae		
Morus nigra	Peru	F. Diaz*#
Rosaceae		
Fragaria vesca	Peru	F. Diaz*#
Malus domestica	Peru	Valarezo et al., 2003, literature survey, F. Diaz*
Rutaceae		
Citrus sinensis **(as Valencia orange) (see Note 3)**	USA	Pena et al., 1987
Weeds		
Acalypha virginica	Ecuador	Valarezo et al., 2003
Amaranthus	Peru	Castillo-Valiente, 2010
Amaranthus hibridus	Peru	F. Diaz*
Chenopodium ambrosioides	Peru, others?	Gagné, 1986; ; Gagné and Jaschhof, 2014, Valarezo et al., 2003, literature survey
Chenopodium murale	Peru	Diaz, 1981, F. Diaz*#, Goldsmith et al., 2013 (citing Castillo, 2006)
Datura stramonium	Peru	Valarezo et al., 2003, literature survey
Desmodium	Ecuador	Vélez Salazar, 1998; Valarezo et al., 2003
Desmodium tortuosum	Ecuador	Vélez Salazar, 1998
Fleuria aestuans	Colombia	Delgado, 1998
Lycopersicon	Ecuador	Valarezo et al., 2003
Merremia	Ecuador	Vélez Salazar, 1998, Valarezo et al., 2003
Nicandra physalodes	Peru	Castillo-Valiente, 2010
Physalis angulata	Ecuador	Valarezo et al., 2003
Richardia scabra	Ecuador	Vélez Salazar, 1998; Valarezo et al., 2003
Sida spp.	Ecuador	Vélez Salazar, 1998 (citing INIAP, 1997), Triviño et al (1997)
Solanum carolinense	USA	Wise, 2007
Solanum nigrum	Peru	Valarezo et al., 2003, literature survey, F. Diaz*#

* M. Manzano, pers. comm. in consultation with F. Diaz
\# F. Diaz website: http://ffernandodiazs.galeon.com/aficiones1589212.html.

Uncertainties

- **Note 1.** It is not known if other species of *Asparagus* used as ornamentals (e.g. *A. densiflorus*) are hosts.
- **Note 2**. Whereas Peña et al. (1987) refer to *Gossypium hirsutum*, later US references refer to wild *Gossypium*. Both are repeated in other publications. In the USA, only wild *Gossypium* was found attacked (J. Peña, pers. comm.); in Peru, attacks on young leaves of cultivated *Gossypium hirsutum* were observed (M. Manzano, pers. comm., consultation with F. Diaz).
- **Note 3.** *Citrus*. In Florida and Colombia, the pest was found only on Tahiti lime (flowers). The *Citrus* species concerned was initially recorded in publications as *Citrus aurantifolia* (Pena et al., 1987, repeated in e.g. Gagné and Jaschhof, 2014). However, there was confusion at the time on the Latin name of the *Citrus* species, and the correct name of Tahiti lime is now *Citrus* x *latifolia*. *C. aurantifolia* is not a host of *P. longifila* in Florida or Colombia. No details were found on the *Citrus* species attacked in Peru (see references in table above). In Florida, originally there was a record

on *C. sinensis* (without damage) (Pena et al., 1987), but it has not been further observed on this species (J. Pena, pers. comm.).

- **Invalid host records:**
  - ***Zea mays*, Gramineae**. Vélez Salazar (1998) citing Valarezo and Canarte (1997) note that there is constant relation between attacks by *P. longifila* and proximity of Gramineae such as maize, pastures and weeds. However *P.longifila* is not recorded to breed on these plants. In Peru, *P. longifila* was observed only once on *Zea mays* young plants, in a field that was very close to higly infested *Asparagus officinalis* ; however, Zea mays is not considered to be a host (M. Manzano, pers. comm., consultation with F. Diaz).. *Zea mays* or Gramineae are not considered as hosts of *P. longifila* in this PRA.
  - **Lúcumo** (*Pouteria lucuma* or *Lucuma obovata* - Del Castillo, 2006, M. Manzano, pers. comm.) is listed as a host in Valarezo et al. (2003). This was based on information from Peru (where this plant is grown). However, after further verification of original sources, there is no evidence that it is a host plant (e.g. M. Manzano, pers. comm., consultation with O. Valarezo, Ecuador, and F. Diaz, Peru).

8. Pathways for entry

Hernandez et al. (2015) mention that unchecked transport of plant material has contributed to the dispersal of the species. The pathways described in Table 3 were studied in this PRA. For fruit, only the hosts on which there are some indications that the fruit is attacked are listed below (see section 2). In addition, if the specimens of *P. longifila* carried with commodities are in a late instar, pupation is expected to occur in packaging material (pupae are normally formed in soil). 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 – main hosts in bold

Pathway	Species covered
Fruit (in the botanical sense, incl. vegetables) (species for which feeding on fruit is reported)	***Solanum lycopersicum***, *Capsicum* sp., ***Capsicum annuum***, *Phaseolus lunatus.* For fruits on which scrapes are reported: *Citrullus lanatus, Cucumis melo, C. sativus*, and on hosts on which little information was found (see table 3 in section 7): *Fragaria vesca*, *Capsicum bacattum*, *Capsicum chinense*.
Plants for planting (except seeds, potato tubers and bulbs)	All hosts in Table 2. Note: the analysis of which hosts may be traded as plants has not been made.
Cut plant parts (cut flowers and branches, cut herbs, leafy vegetables)	Cultivated hosts: ***Asparagus officinalis***, *Tagetes* sp., *Tagetes erecta* More uncertain hosts: *Brassica oleracea*, *Coriandrum sativum*, *Cynara scolymus*, *Petroselinum crispum*, *Spinacia oleracea*, *Tagetes patula*
Packaging of host commodities	-

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

- Eggs and larvae are located as described in pest overview on the different plant (i.e. fruit or only green parts). Pupae are normally in soil. Pupae may be produced during transport (in soil or in packaging, e.g. in paper tissue), as well as adults.
- Early life stages are in protected/hidden places on the commodity, and are very small, i.e. difficult to detect by visual inspection. In addition, symptoms may not be conspicuous if these stages are present.
- It is considered here that eggs, larvae and pupae could survive transport. Adults survive ca. 1 day without food (if water is present), and it is not known if this would be available in consignments (except plants for planting). Multiplication during transport is considered very unlikely. Fruits may be transported under refrigeration (e.g. for ripe tomatoes 7-10°C, sometimes higher for less ripe stages; EPPO, 2015). UK PI (2006) indicates an optimal transit temperature of 10°C for capsicum, melon, watermelon and cucumber. Castillo-Valiente (2010) indicates a reduction of populations below 11°C, so conditions for survival may be appropriate in some circumstances of transport and storage.
- 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)

Packaging: If the population of the pest carried with commodities is in the late instar, pupation can occur in packaging (e.g. in paper tissue). Multiplication in transport is considered unlikely. If adults emerge from pupae, they may transfer to a host if the packaging is imported (or discarded) close to facilities where hosts are grown. **Likelihood of entry**: moderate, if imported (or discarded) close to production sites; **uncertainty**: moderate.

Pathway	Fruit	Plants for planting (except seeds, potato tubers and bulbs)	Cut plant parts
Pathway prohibited in the PRA area?	No	Partly, in some EPPO countries. e.g. EU: Solanaceae, *Citrus*, *Malus, Vitis* (in the category of more uncertain hosts, *Fragaria*). However, import of these hosts is permitted in some other EPPO countries, e.g. in Turkey, ornamental Citrus, propagation material of *Vitis* and *Malus*	No
Pathway subject to a plant health inspection at import?	Partly e.g. EU, *Capsicum*	Most probably partly in many EPPO countries. e.g. EU: all	No
Pest already intercepted?	No records found	No records found	No records found
Most likely stages that may be associated	Eggs and larvae on fruit, or on green parts associated with the fruit (vine tomato). Pupae and adults may be associated with consignments only if they have developed during transport.	Eggs, larvae on plant, pupae in soil. Adults may be present if developed during transport. Larvae have been seen on tomato seedlings from nurseries (M. Manzano, pers. comm.).	Eggs, larvae on buds or leaves. Pupae and adults may be associated with consignments only if they have developed during transport.
Important factors for association with the pathway	Tomato and *Capsicum* (at least *C. annuum*) are main hosts and fruits are attacked. Fully formed tomato fruit may be infested. On tomato, Vélez Salazar (1998) mentions up to 80 larvae per fruit in soft fruits of 2-3 cm diameter. The pest may be associated with green parts or fruit with calyx which will increase the probability of association with vine tomato or *Capsicum*. *Phaseolus* pods are only infested when populations of the pest are high. For *Phaseolus*, it is superficial on pods, and will not be associated with the commodity if the beans are traded without the pods. For other fruit, there is an uncertainty on whether eggs or larvae occur on fruit. The importance of cucurbit and *Fragaria vesca* hosts are unknown.	In the EU, current requirements on growing media accompanying plants aim to prevent the presence of harmful organisms in the soil or growing medium before transport (but pupae may be formed during transport and storage if larvae were on the green parts of the plants)	*Asparagus officinalis* is a main host, on which the pest causes damage to buds and stems ('spear', the edible parts). The pest is considered more likely to be associated with crops of *Asparagus officinalis* and *Tagetes,* but it may also be associated with the more uncertain hosts.
Survival during transport and storage	Likely for eggs and larvae, both if green parts are attached or not. There is an uncertainty for pupae (packaging material needs to be appropriate for pupation) and adults (see above the present table)	Likely for eggs, larvae and pupae. There is an uncertainty for adults (see above the present table)	Likely for eggs and larvae. There is an uncertainty for pupae and adults (see above the present table)

Trade	At least tomato and *Capsicum* are traded into the EPPO region ((origins were not considered in detail). Probably some cucurbits in small volumes. Data in Eurostat indicate there have been imports in the EU of *Phaseolus* from Peru, Ecuador and Colombia and of *Capsicum* from Ecuador	Not known. Import of some host plants for planting are prohibited in part of the EPPO region (at least in the EU). However, the pest has many hosts, and some plants for planting may be traded.	Peru is a main exporter of asparagus (1st worldwide in O'Brien and Diaz, 2004, incl. to Europe), and there are also imports from Ecuador and Colombia (Eurostat). There may be a trade of cut flowers (*Tagetes*) and herbs (*Coriandrum sativum*). No data were sought on whether other hosts under this pathway (especially artichoke (*Cynara scolymus*)) are traded from South America to Europe.
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 and pepper), or private gardens with hosts. As some host weeds occur in the EPPO region (e.g. *S. nigrum*), 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 or green parts that may not eliminate the pest, such as domestic compost in private gardens, 'green bins', discarding prior to processing.	Plants for planting will be planted in favourable conditions for their development and for transfer.	Transfer is likely if packing and handling facilities are located near production areas of hosts, in particular if infested stems are discarded. No information is available on whether this is the case. If traded directly to consumer, or used for processing, transfer is unlikely. However, there are circumstances for discarding fruit or green parts that may not eliminate the pest, such as domestic compost in private gardens, 'green bins', discarding prior to processing.
Likelihood of entry	Moderate-high for tomato vines and *Capsicum* Moderate for other tomato Low otherwise (for other species considered, assumed lower volumes, uncertain association with fruit)	High, despite the assumed low volume of trade: a large diversity of hosts and high likelihood of survival and transfer	Moderate-high for *Asparagus officinalis* Moderate otherwise
Uncertainty	Moderate (species traded, volume of trade)	Moderate (species traded, volume of trade)	Moderate for *Asparagus officinalis* (association, trade volumes) High for others (even more uncertainty on association, trade volumes)

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

- **Fruit of *Malus domestica*, *Citrus*, *Persea americana*, *Vitis vinifera*, *Carica papaya*, *Morus nigra*.** Only leaves/young plants of these species are attacked, and leaves are not usually associated with the fruit. **Uncertainty:** low.
- **Soil or growing media from areas where *P. longifila* occurs.** Only pupae are likely to be associated with soil. Soil associated with plants for planting of hosts is covered under the 'plants for planting' pathway. Regarding soil on its own, the importation of soil into many EPPO countries (at least the EU, Turkey and Israel) from countries where the pest occurs is forbidden. Finally, entry with soil associated with plants for planting of non-hosts is considered unlikely (pupae are formed in the soil under host plants, and have a limited life span of about 6 days). **Uncertainty***:* low
- **Underground parts of plants (potato tubers, onions).** Pupae may be associated with soil, and therefore with soil associated with these commodities. However, it is expected that only small amounts of soil would accompany these underground plant parts. In addition, these are probably not main hosts. This pathway was considered unlikely. Also, at least in the EU, while potatoes are subject to a prohibition from the origins concerned, onions may be imported only for consumption (*Allium cepa* for planting are prohibited). **Uncertainty**: low.
- **Fodder of *Medicago sativa*.** Larvae may be associated with leaf of alfalfa but it is expected that pest will leave plant material when it is dried to produce hay, or made into sillage. **Uncertainty**: moderate.
- **Hitch-hiking, natural spread.** There is no evidence that hitch-hiking (as contaminant on e.g. non-host commodities, conveyances) could be pathways. Natural spread is not possible from its current origins. **Uncertainty**: low
- **Seeds, tissue cultures, processed commodities made from hosts, etc.**: The pest is not associated with those substrates.

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 some hosts are present in the wild (e.g. *S. nigrum*). Among main hosts, tomato and *Capsicum* 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 has a more southern and eastern distribution (EPPO, 2014). Details on tomato are provided in the EPPO tomato study (EPPO, 2015).

There are other hosts of importance in the EPPO region. For example, *Asparagus officinalis* production is reported in 22 EPPO countries in FAOStat, and in some countries (e.g. Germany, Spain), this crop has been grown in large areas, in excess of 10,000 hectares.

Suitable host crops are expected to be present throughout the EPPO region, although some are more southerly than others (e.g. *Citrullus lanatus*), and the production systems may vary (e.g. grown only in the field, only under glasshouse conditions, or both; in commercial production and in gardens; many hosts are widely planted as garden plants).

The abundance of plants and the type of plants will influence the suitability of the area for establishment. In some parts of the PRA area, solanaceous hosts (possibly others) are grown all year round (e.g. at least North Africa, Turkey, Portugal), which will favour establishment. Existing management practices for tomato and eggplant are described in the PRAs for other tomato pests *Keiferia lycopersicella* and *Neoleucinodes elegantalis* (EPPO 2012, 2014), but the main targets of these practices are not Cecidomyiidae and it is unknown whether current management practices could prevent establishment of this pest.

Climatic conditions

A review on climatic requirements is available in Annex 1, as well as the outputs of a preliminary CLIMEX model.

It is concluded that the pest can establish outdoors in the Mediterranean basin, Portugal, and southern Black Sea coasts and, with an lower likelihood and an higher uncertainty, also in areas with an oceanic climate in Western Europe, such as Western France and Southern UK.

The pest seems influenced by temperature ('warm'), relative humidity ('high') and rainfall. Biologically, adults need some humidity to survive. *P. longifila* has a very wide host range, and may use wild hosts to maintain populations. It could form transient populations and may also survive in glasshouses in absence of its hosts outdoors. Given its short development time, it may be possible to have several transient generations within a growing season where conditions are favourable outdoors. However, there are several unknown factors that would influence the limits of establishment:

- The effect of irrigation in hot, dry areas (i.e. the south of the EPPO region).
- Whether sufficient temperatures and relative humidity are present, especially for the survival of adults (although the canopy of the plant may provide sufficient humidity)

Regarding altitude, the distribution of the pest varies between countries. The pest is not expected to establish in central and northern parts of the EPPO region where frosts occur. However, the situation of the pest outdoors in Virginia is unclear. If further information about *P. longifila* in this location is found, this may alter some of conclusions of the current assessment.

Other considerations.
The duration of the life cycle may be short, and there may be high levels of infestation on one plant.

Uncertainty: Moderate (Adaptability to climate outdoors in different areas of the EPPO region; existence of a diapausing life stage)

Mediterranean Basin, Portugal, and eastern and southern Black Sea coasts

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

Areas with an oceanic climate in Western Europe where hosts are grown

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, tunnel, glasshouse) in the EPPO region, including *S. lycopersicum*, *Capsicum*, *Citrullus lanatus*, *Cucumis sativus*, *Cucumis melo* and *Asparagus officinalis*. In its native range, *P. longifila* is found under protected conditions, and is present all year round in the field and under protected conditions (Chavez Vergara, 2002). It is also found in Colombia in tomato grown in greenhouses (M. Manzano, pers. comm.). Establishment in glasshouses is unlikely where there is a sufficient crop-free period, weeds are eliminated, the growing medium is removed or treated to eliminate pupa, and the pest cannot survive outdoors. However in many locations in the EPPO region, crops under protected conditions are maintained all year round or with a short crop break, thus increasing the likelihood of establishment.

Uncertainty. Moderate: existence of a diapausing life stage, differences in cultural practices between South America and EPPO region.

Mediterranean Basin, Portugal, eastern and southern Black Sea coasts

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

Adults fly and are also dispersed by the wind (Castillo-Valiente, 2010). No details were found on the flight capacity but Cecidomyiidae are known to be weak flyers. Due to its size and short life span of the adult, it is not likely to spread naturally at long distance. However, it may spread through human-assisted pathways. The only mean of long-distance spread would be infested commodities. The spread would be highest if it is introduced into an area where it can survive outdoors, and from which host commodities are traded. It has many hosts that are traded within the EPPO region, including fruit, cut plant parts and plants for planting. Transport of commodities within countries (e.g. markets, private use, passengers) may also play an important role.

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

12. Impact in the current area of distribution

P. longifila is considered as a pest of different crops in different countries, and causes different types of damage in different crops (see section 2 for the parts of plants attacked). Damage below is considered by country and not by crop.

- In Peru, on tomato severe attacks on fruits were observed for the first time in 1979 in one crop located close to alfalfa and potato crops that showed infestations of 90% and 60% of buds by larvae, respectively; in tomato fruit in 1981, the level of infestation reached 90% (Diaz, 1981). At the time, it also caused a major problem on alfalfa buds, occasionally attacked potato, and was regularly found on *Phaseolus lunatus*, *Tagetes* flowers and several other plants (Diaz, 1981). On wild plants, infestations occurred in areas where host plants were densely planted in humid soils, and where wild hosts acted as reservoirs for the infestation of cultivated hosts. Recently, reports of damage seem to concern mostly Solanaceae and asparagus. Hernandez et al. (2015, citing others) mention considerable losses in *Asparagus officinalis* and *Solanum tuberosum* (with infestations reaching 16% of buds). In the coastal area, *P. longifila* reduces yield by 80% in *Capsicum* and asparagus (Goldsmith et al., 2013). On *Phaseolus lunatus*, there is no indication of levels of damage. The beans are 'harvestable', although reduced in size (Gonzales-Bustamante, 1996a). On potato, if infestation starts after flowering, the pest does not affect the yield (Valarezo et al., 2003, citing Peruvian publication).
- In Colombia, it is an important pest of tomato indoors and outdoors (A. Diaz Montilla, Corporación Colombiana de Investigación Agropecuaria, Antioquia, Colombia; pers. comm. during PRA EWG on *Neoleucinodes elegantalis*; M. Manzano, pers. comm.). It became economically important after 1994 (Chavez Vergara, 2002). Losses up to 100% are mentioned (Hernandez et al., 2015 citing Valarezo et al 2003). Use of plant protection products has increased in areas where this pest has emerged as a problem. In surveys in Colombia, it was found to consume fruit of sweet pepper, and flower buds and flowers of Tahiti lime *Citrus* x *latifolia* (although no details of economic damage are available) (Hernandez et al., 2015).
- In Ecuador, *P. longifila* was a new pest of tomato that became important economically (Vélez Salazar, 1998). It is now the most important pest of tomato (and the main insect pest) according to Valarezo et al. (2003). Although it also attacks other crops, it has economic importance only on tomato; losses up to 60% were reported, with attacks in the field and on protected tomatoes, resulting in abandonment of tomato cropping (by 48-86% of farmers in some areas) (Valarezo et al., 2003). It also affects potato, and minor damage is observed on watermelon, green pepper, beans and melons (Goldsmith et al., 2013, citing Valarezo et al., 2013).
- In the USA (Florida), it was first identified in the 1930s (on wild *Gossypium*), but damage on Tahiti lime was reported only in the 1980s. Levels of infestation of 25% of flower buds are mentioned. It was also reported on Valencia orange at the same time, but without significant damage resulting at harvest (Pena et al., 1987; Pena, 2011). Unpublished data by Pena and Duncan showed that lime trees can sustain 30% damage to its flowers (due to pest damage and natural flower shedding), but there was no yield reduction. In Florida, the pest is considered to be under control, and the native parasitoid *Synopeas* spp. keeps it at

very low densities (J. Peña, pers. comm.). In Virginia (USA) (Wise, 2007) it was found on *Solanum carolinense* (a weed, causing damage to leaves, which leads to stunting as it often damages meristems), and its current pest status is not clear.

Control is difficult as life stages are protected (under sepals, buds, internal part of the plant etc.) (Muguerza, 2014). It has relied on extensive use of pesticides, although they are not effective due to the biology of the pest. 45-80% of producers of some areas of Ecuador carried out 21-30 applications against *P. longifila* in one crop cycle, incl. during harvest (Valarezo et al., 2003). Some cultural control methods exist, such as avoiding planting tomato and potato close to alfalfa, rotation with less susceptible crops, eliminating weeds in areas of high soil humidity, planting alfalfa in rows to facilitate mechanical weeding and insecticide application (Diaz, 1981). An IPM programme has been in place since 2000 in Peru, including mass trapping, and physical, cultural and chemical control methods (Goldsmith et al., 2013). As this programme has been in place for some years, it is assumed that some control has been obtained through the measures used.

An overall rating was made based on the worst impacts, i.e. on tomato, asparagus and *Capsicum annuum*, recognizing that such impacts are recorded only in part of the distribution of the pest.

Uncertainty: Low-moderate because of lack of data on impact on hosts other than tomato, Capsicum annuum and asparagus. Different impacts on different crops in different countries.

Tomato, asparagus, *Capsicum annuum*

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

Other hosts

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**

Damage is expected to be lower as climatic conditions outdoors may not be not optimal and it may have fewer generations in the PRA area than in the area of origin (although the pest will find a wide range of hosts throughout the PRA area). **However, impact on the quality (external appearance) of fruit and vegetables (incl. asparagus) may be high, and there is a low tolerance for fruit or vegetables with defects in many countries of the PRA area**. It could also cause damage to crops indoors. In its USA distribution, where climatic conditions are more similar to part of the PRA area, there are few reports of damage, and none on tomato. This may be due to a variety of factors, e.g. less favourable conditions, different cropping practices, presence of natural enemies, but also that a cryptic species may be present, which is associated with *Citrus* and not tomato.

There is an uncertainty on whether *P. longifila* would survive without host crops, but it could probably develop several generations in transient populations in part of the PRA area and populations may survive on wild hosts. However *P. longifila* is not a migratory species, so transient populations would occur only after an introduction with infested plant products near places of production of host plants.

Specific control measures will be needed. IPM strategies are widely used in the EPPO region, and would have to be modified as they do not target Cecidomyiidae. *P. longifila* may cause loss of harvest, rejection of harvested fruit, increase in production costs, disruption of IPM programmes and have an impact on external markets, as well as on the large scale trade of commodities within the EPPO region.

Environmental impacts would relate to pesticide applications. Social impacts are expected to be minor overall, but possibly major locally.

Uncertainty. Differences in damage at different locations (e.g. Florida), whether populations would survive *on wild hosts.*

Tomato, asparagus, *Capsicum annuum* in the area of potential establishment

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

Other hosts

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 the Mediterranean region, Portugal and the southern Black Sea coasts. Hosts grown in these areas, especially tomato, capsicum and asparagus, but also others such as potato, alfalfa or phaseolus, are at risk of economic impact.
It could also establish in more Northern areas of Western Europe but the impact would be lower as there are less host crops and the number of generations would be lower.

15. Overall assessment of risk

P. longifila attacks different parts of plants depending on host species. It also attacks different hosts in different countries, and there may be cryptic species with different host preferences. In particular, in the USA, it has been reported only on lime (flowers) and wild *Gossypium* in Florida, and on the weed species *Solanum carolinense* (leaves) in Virginia. In other countries, a wide range of hosts are attacked. Entry is considered possible, with a high likelihood on plants for planting, a moderate-high likelihood on fruit of tomato on the vine and capsicum, and asparagus, and a moderate likelihood on other tomato fruit and other cut plant parts (cut flowers and branches, cut herbs, leafy vegetables), with different likelihoods and uncertainties (see Table 4 in section 8). In particular, there is a trade of tomato fruit and asparagus from South America, and the pest may be associated with both. The pest is expected to have a high impact on tomato, *Capsicum* and asparagus. *P. longifila* may establish indoors and outdoors, and has possibly a larger area of distribution than the other tomato pests considered in this series of PRAs. Its potential distribution outdoors covers the Mediterranean region, Portugal and the southern Black Sea coasts. The pest may cause outbreaks and transient populations under protected conditions in the rest of the EPPO region. Consequently, *P. longifila* is considered to present a high risk for the EPPO region,

Phytosanitary measures were elaborated for plants for planting, tomato and *Capsicum* fruit, and cut plant parts.

Stage 3. Pest risk management

16. Phytosanitary measures

Measures were considered for fruits, cut plant parts, plants for planting, packaging, as well as entry with travellers carrying host fruit and plants from countries where the pest occurs.

For fruit: The Panel on Phytosanitary Measures considered that ideally measures should apply to all fruit hosts (e.g. tomato, *Capsicum annuum* as well as minor hosts such as *Cucumis melo*, *Cucumis sativus*, *Citrullus lanatus*, as well as those for which there is more uncertainty on whether fruits are attacked (*Capsicum baccatum*, *C. chinense*, *Fragaria vesca*). However, for minor hosts, a PC requirement may be considered sufficient by the NPPO, depending on local circumstances, as it will ensure inspection of consignements.

For cut plant parts and plants for plantings, measures were considered for all hosts in Table 3 (section 8). However, depending on local circumstances, the importing NPPO may –considere~~d~~ that it is sufficient if applied to the main hosts, especially *Asparagus officinalis*.
Annex 2 summarizes the consideration of measures. Measures regarding packaging are not detailed in Annex 2, but combined below with those for the different commodities.

Possible pathways *(in order of importance)*	**Measures identified (see details in Annex 2)**
Plants for planting (except seeds) of cultivated hosts Note: for many EPPO countries, the import of Solanaceae plants for planting is prohibited, but other host plants are permitted	Phytosanitary certificate and: - PFA (with general surveillance and specific surveys) + appropriate packing/handling methods to avoid infestation during transport Or - Pest free production site/place of production under complete physical isolation (following EPPO Standard PM 5/8) (including regular inspections during the growing period) + appropriate packing/handling methods to avoid infestation during transport (on the basis of bilateral agreement) In all cases above, - only new packaging should be used at origin, and packaging should be destroyed or safely disposed of at import.
Fruit of host plants tomato, *Capsicum annuum Cucumis melo*, *Cucumis sativus*, *Citrullus lanatus, Capsicum baccatum*, *C. chinense*, *Fragaria vesca*	Phytosanitary certificate and: - Pest Free Area (with general surveillance and specific surveys) Or - Pest free site of production under complete physical isolation (following EPPO Standard PM 5/8) Or - Systems approach (on the basis of bilateral agreement): Treatment of the crop + monitoring + removal of calyx and green parts + inspection at packing Or - Import only in winter, for direct consumption or immediate processing (only in countries where the pest cannot establish outdoors) Or - Surveillance in the importing country + separation of trade and production flows (only in countries where the pest cannot establish outdoors, on the basis of bilateral agreement) In all cases above, - Only new packaging should be used at origin, and packaging should be destroyed or safely disposed of at import.
Cut plant parts (cut flowers and branches, cut herbs, leafy vegetables,) of cultivated hosts	As for fruit + appropriate packing/handling methods to avoid infestation during transport
Travellers carrying fruits, cut plant parts or plants for planting of main hosts	Raising awareness and inspection of luggage

Eradication and containment. Eradication, as well as containment, would be difficult and costly. There is no species-specific trapping, and visual inspection is difficult, especially for early life stages. The best chance of eradication would be for an introduction under protected conditions in an area where the pest cannot survive outdoors. Rather, it is considered here that introduction should be prevented.

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

17. Uncertainty

The main uncertainties are as follows:

- identity of the pest and possible cryptic species with different host range
- distribution and possible confusion with other species
- biology and limiting factors (e.g. whether there is a larval diapause, effect of irrigation in hot/dry areas)
- host range and damage on the different hosts
- whether pupae would survive transport, and for adults survival at destination when host plants are not immediately available.

18. Remarks

None.

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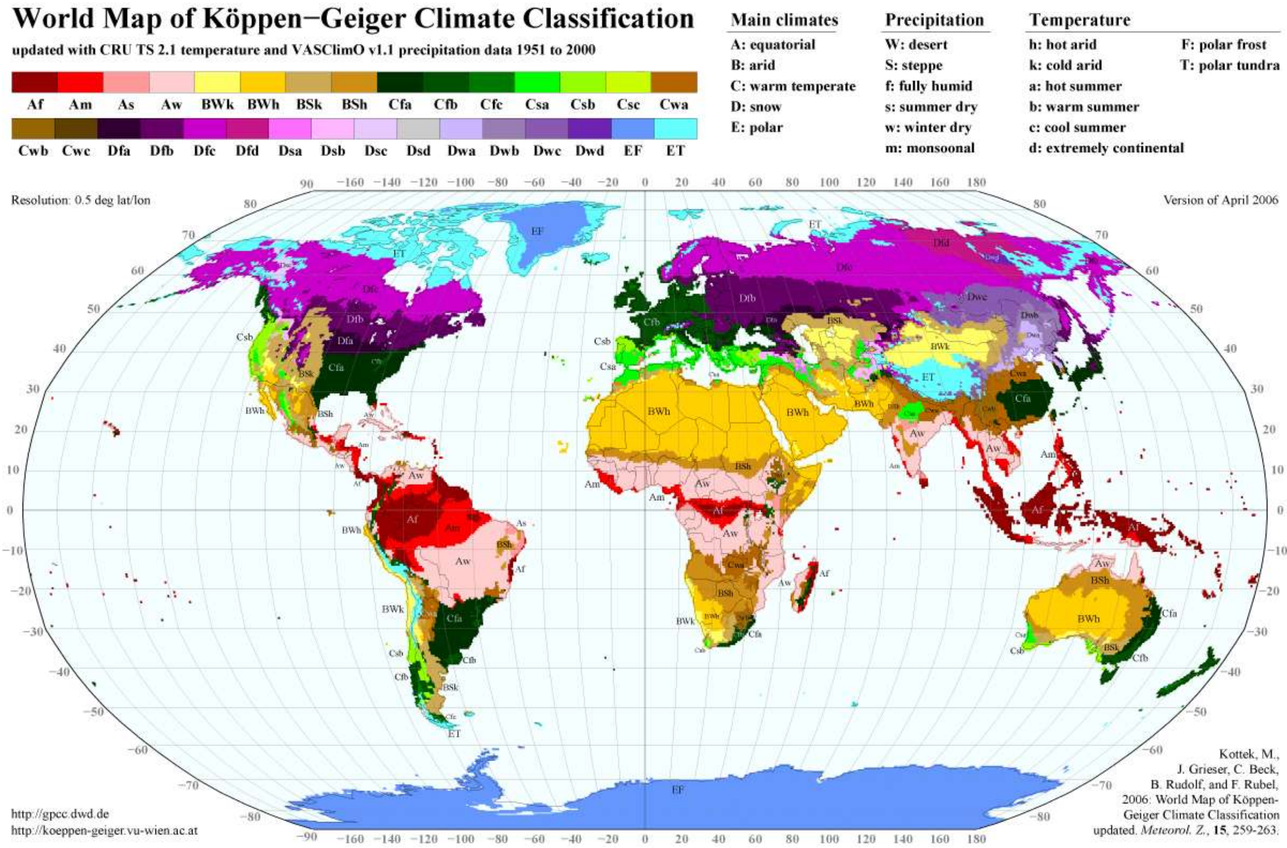
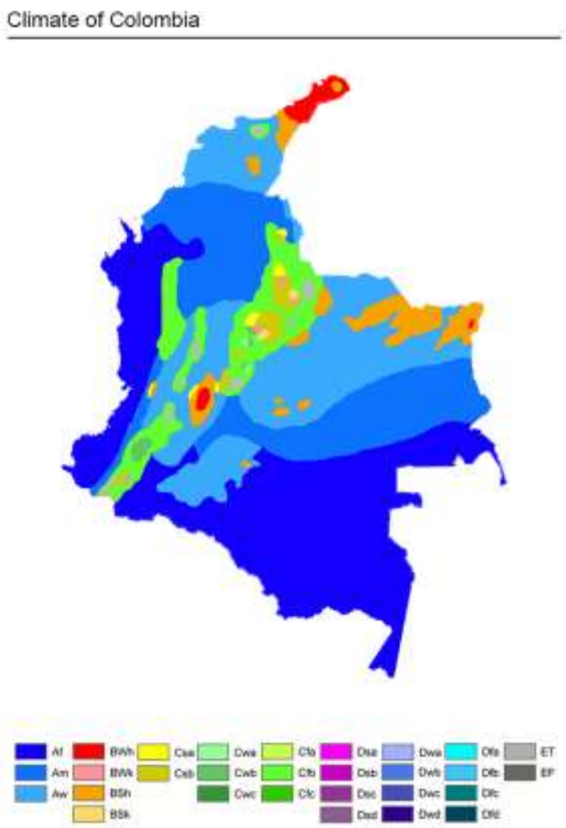
Annex 1. Consideration on the climatic suitability of the PRA area for the establishment of *P. longifila*

According to the classification of Köppen Geiger (see map in Annex 1), *P. longifila* occurs mostly in countries with equatorial climates, however these include mountainous regions where the climate is not directly comparable to lower altitudes. It also occurs in Florida and Virginia (USA), which have a climate similar to part of the EPPO region (Cfa) but its incidence and hosts in these area are very different



In Colombia, according to the map of distribution provided by Hernandez et al. (2015), it is present in Am, Aw, Cfb; Csb, Cwb climate zones.



Left: distribution of P. longifila according to Hernandez et al. (2015). Right: Climate of Colombia using Köppen System (https://commons.wikimedia.org/wiki/File:Climate_of_Colombia.png)

Temperature requirements There are many generations in a year (21-33 according to Goldsmith et al. (2013)). The duration of the life cycle from egg to adult is about **10-20 days at 20-27°C** (Pena et al. 1989; Vélez Salazar 1998; Valarezo et al. (2003); Castillo-Valiente (nd); Rodriguez (1992) cited in Goldsmith et al. (2013)). Extreme durations found in the literature are 20-25 days (Díaz, 1981; Paredes, 1997 cited in Valarezo et al., 2003) and 7-10 days on potato (high temperature, high relative humidity – in less favourable conditions the pupal stage lasted longer –Haddad and Pozo, 1994 cited in Valarezo et al. 2003).

In studies on life cycle, the pest was reared at 24.5 and 35.6°C (Paredes 1997) and 25.8 and 22.5 (Ventura y Ayquipa,1999).

Castillo-Valiente (2010) mention that temperatures below 11°C reduce populations, and above 28°C are detrimental to the pest (no details were found on the source of these figures, although 28°C is also mentioned in Valarezo et al., 2003). It is unknown if there is larval diapause (Hernandez et al., 2015) and how this would influence survival of the pest.

According to Goldsmith et al. (2013), it is found (and cause damage) in the coastal region of Peru where average temperatures are 16-25°C, with lowest temperatures that reach 5°C. Insect developemental temperatures are between 11°C and 33°C.

According to Wise, 2007, it was found outdoors in Virginia in Blandy Experimental Farm (Shenandoah Valley at 39ºN, 78ºW, Clarke County). Average temperature in this area may go below 0°C and remain below 5°C from December to March (http://en.climate-data.org/location/1717/) while maximum monthly temperatures are above 20°C only in summer. These temperatures are much lower than in other areas where the pest is recorded, which may explains that the population does not thrive.

Humidity requirements: The pest seems influenced by temperature (‘warm’), relative humidity (‘high’) and rainfall. Biologically, adults need some humidity to survive. Mature larvae need humid soil to enter and pupate (Diaz, 1981). Hernandez et al. (2015) note that rainfall is necessary, but that too high levels are unfavourable; similarly, irrigation changes soil moisture, and may influence pupae.

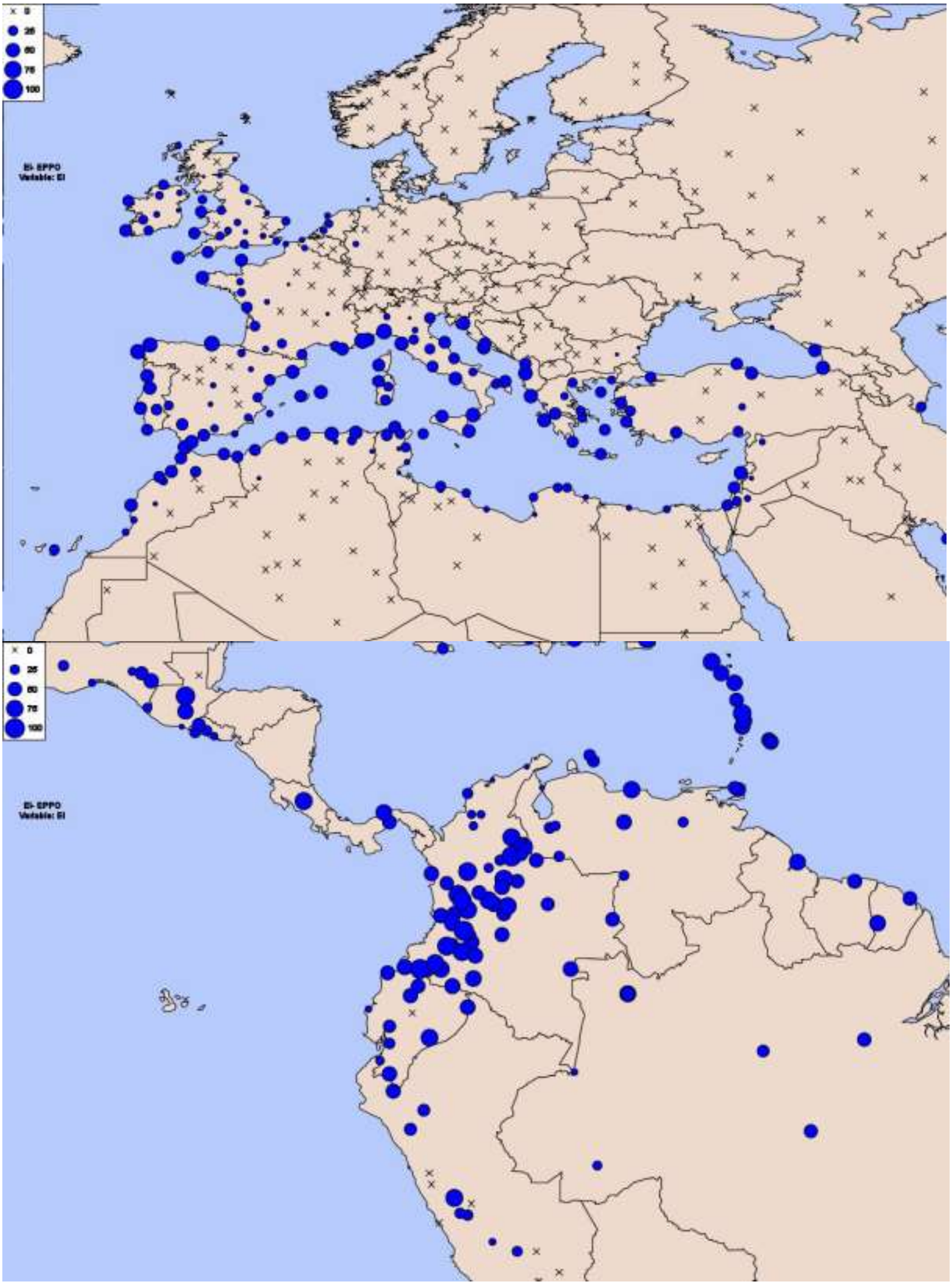
Regarding altitude, the distribution of the pest varies between countries, probably linked to the existence, or not, of suitable environmental conditions. For example it occurs in Colombia at medium altitudes (around 740-2100 m - Hernandez et al., 2015), while in Peru it is present in a large coastal area. In Ecuador, it occurs on the coast and at altitudes up to 1000-1700 m (Valarezo et al., 2003). This results in differences of hosts attacked between countries; for example, it is a pest of potatoes in Peru (where some potato crops are found at low altitudes where the pest occurs), but not in Colombia, where potato is grown mainly at altitudes above the pest's distribution (2500-3000 m). Altitude is not considered a factor that would influence establishment, provided other conditions are met. However, it does suggest that this pest is able to adapt to different climatic conditions (in particular it is unknown if there is larval diapause – see section 2.).

CLIMEX modeling

Based on the current distribution of *P. longifila*, a preliminary attempt was made to adjust the CLIMEX model parameters in such a way that the resulting ecoclimatic suitability map resembled the geographic distribution pattern as good as possible. The results and model parameters are presented. From this model it can be concluded that *P. longifila* is able to establish outdoors in the Mediterranean basin and Portugal but also in areas with an oceanic climates in France and more Northern Europe.

Parameters: Prodiplosis longifila

		Edit Comments...		Copy to Clipboard	
☑ Moisture Index					
SM0	SM1	SM2	SM3		
0.1	0.5	2	4		
☑ Temperature Index					
DV0	DV1	DV2	DV3		
5	20	27	35		
☐ Light Index					
☐ Diapause Index					
☑ Cold Stress					
TTCS	THCS	DTCS	DHCS	TTCSA	THCSA
5	-0.001	0	0	0	0
☑ Heat Stress					
TTHS	THHS	DTHS	DHHS		
35	0.002	0	0		
☐ Dry Stress					
☐ Wet Stress					
☐ Cold-Dry Stress					
☐ Cold-Wet Stress					
☐ Hot-Dry Stress					
☐ Hot-Wet Stress					
Day-degree accumulation above DV0					
DV0	DV3	MTS			
5	35	7			
Day-degree accumulation above DVCS					
DVCS	*DV4	MTS			
8	100	7			
Day-degree accumulation above DVHS					
DVHS	*DV4	MTS			
33	100	7			
Degree-days per Generation					
PDD					
0					



Results of CLIMEX model for *P. longifila* for the EPPO region, and the area where the pest is present. Blue dots indicate locations where climate is suitable for establishment outdoors based on ecoclimatic index DV0 is the limiting low temperature, DV1-DV2, the optimal range, DV3 the limiting low temperature. The CLIMEX model includes both a ‘heat stress’ and a ‘cold stress’ factors to take into the fact that the pest seems to prefer conditions which are not too hot (above 27°C), nor too cold (below 5°C).

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.

Option	Plants for planting (all hosts)	Fruit (Solanaceae)	Cut plant part
Existing measures in EPPO countries	The measures in place 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, life stages in hidden places, early stages difficult to see. No specific trapping for adults (and need expertise to perform identification). However this may be used as part of a systems approach.		
Testing at place of production	No. Not relevant		
Treatment of crop	Not alone. Not reliable to guarantee pest freedom		
Resistant cultivars	No. No resistant cultivar seems to be available. One study on resistance found (tomato and *S. habrochaites* in Mena Perez, 2012)		
Growing the crop in glasshouses/ screenhouses	Yes (+ handling/packing preventing infestation). This would require complete physical isolation (see EPPO Standard PM 5/8). Possible, but difficult to implement in commercial production. Screenhouses should have an appropriate mesh size. It is difficult to implement in practice because of the temperature in the tropics and the need to have sufficient ventilation in such screenhouses. It should include requirements for growing media (to make sure it is free from pupae) Plants for planting and cut plant parts should be appropriately packaged/handled to avoid infestation during transport out of the physical isolation for trade.		
Specified age of plant, growth stage or time of year of harvest	No. The pest may be on various plant parts, including fruits and buds.		
Produced in a certification scheme	No. Not relevant for an insect.		
Pest free production site	Yes. Only growing under complete physical isolation (see 3 rows above)		
Place of production freedom	Yes. Only growing under complete physical isolation Place of production freedom in the open is not considered a relevant option, due to flight and transport by wind.		
Pest free area	Yes. PFA as described in ISPM 4. It will require the use of traps and identification capabilities. There should be controls on movement of all host fruit and plants, other hosts, equipment and packaging, etc., in and out of the area. Plants for planting and cut plant parts should be appropriately packaged/handled to avoid infestation during transport out of the PFA.		
Options after harvest, at pre-clearance or during transport			
Visual inspection of consignment	Not alone. Small pest, life stages in hidden places, early stages difficult to see.		
Testing of commodity	No. Not relevant		

Treatment of the consignment	No. Insecticide sprays would probably not be appropriate as life stages are hidden.	No. There may be treatments for fruit or cut plant parts, but none were identified. When infested commodities are treated, dead larvae will remain and this may not be acceptable for the consumers. The only mention of treatment was found in Caripest (nd; on *Contarinia*, not *P. longifila*) noting that fumigation of hot pepper fruits with aluminium phosphide (pellets) can kill more than 80% of larvae within fruits (which may not be considered sufficient) Insecticide sprays would probably not be appropriate as life stages are hidden.	
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 larvae may be on buds or young shoots, removal of flowers and fruits will not have any effect if the pest is present on the planting material.	No	
Prevention of infestation by packing/handling method	Not alone. Commodities may already be infested. Only new packaging should be used. For plants for planting and cut plant parts , suitable packing/handling methods should be used to prevent infestation during transport		
Options that can be implemented after entry of consignments			
Post-entry quarantine	Not alone. Possible in theory for small consignment of high value plants in the framework of bilateral agreements (but may not be practical/cost-effective) Not relevant for fruit and cut plant parts.		
Limited distribution of consignments in time and/or space or limited use	No. Not applicable for plants as the intended use is for planting.	Yes, but it may be difficult to implement in practiceas it is not always possible to be sure of the final destination of a consignment. Consignments may be imported when temperatures are cold, where the pest cannot survive outdoors (for example for fruit: for immediate processing or direct consumption). However, there is limited knowledge on the conditions under which the pest may survive outdoors. Immediate processing of the fruit and destruction of the waste and the packing material (e.g. burning, deep burial) is possible, but it is not practical and difficult to control in practice. Adults that have emerged during	Yes, but it may be difficult to implement in practice as it is not always possible to be sure of the final destination of a consignment. Consignments may be imported when temperatures are cold, where the pest cannot survive outdoors. However, there is limited knowledge on the conditions under which the pest may survive outdoors. Cut plant parts would normally be used indoors, and the risk of transfer should therefore be low where the pests cannot survive outdoors. However, the exact limit of this area is not known.

		transport might also escape.	
Surveillance and eradication in the importing country	No	Yes, but it may be difficult to implement in practice. Only possible in individual EPPO countries in the northern part where the pest cannot establish outdoors. In the part of the EPPO region where the pest cannot establish outdoors (not precisely defined), infested consignments could in theory 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 a good surveillance system to detect any occurrence of the pest in crops (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.	