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Risk assessment of *Citripestis sagittiferella* for the EU

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Abstract

Following a request from the European Commission, the EFSA Panel on Plant Health performed a risk assessment of *Citripestis sagittiferella* (Lepidoptera: Pyralidae), the citrus pulp borer, an oligophagous pest reported from South-East Asia and restricted to *Citrus* spp. The entry risk assessment focused on the citrus fruit pathway. Two scenarios were considered: scenario A0 (current practice) and A2 (additional post-harvest cold treatment). Based on the outputs of the entry model obtained in scenario A0, the median number of founder populations in the EU citrus-growing area is estimated to be slightly less than 10 per year (90%-uncertainty interval between about one entry per 180 years and 1,300 entries per year). The risk of entry and the simulated numbers of founder populations are orders of magnitude lower for scenario A2 compared to scenario A0. The key uncertainties in the entry model include transfer, the cold treatment effectiveness, the disaggregation factor and sorting. The simulated numbers of established populations are only slightly lower than the numbers of founder populations. As the probability of establishment has little impact on the number of established populations, it is not a major source of uncertainty, despite the lack of data on the thermal biology of the pest. The median lag period between establishment and spread is estimated to be slightly more than 1 year (90%-uncertainty interval between about 2 months and 33 months). After the lag period, the median spread rate by natural means (flying) and due to transport of harvested citrus fruit from orchards to packinghouses is estimated at about 100 km/year (90%-uncertainty interval between about 40 and 500 km/year). The main sources of uncertainties affecting the spread rate include the extent to which environmental factors could hamper the build-up of the populations and the lack of data on the spread rate at the origin. The median impact of *C. sagittiferella* in the EU citrus-growing area is estimated at about 10% of infested fruits among the harvested citrus fruits (90%-uncertainty interval between about 2% and 25%). Uncertainties affecting the impact assessment include the susceptibility of different *Citrus* species and cultivars.

Keywords: citrus, pathway model, pest prevalence, phytosanitary measures, quantitative risk assessment, uncertainty

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Summary

Following a request from the European Commission, the EFSA Plant Health Panel performed a risk assessment of *Citripestis sagittiferella* (Lepidoptera: Pyralidae) for the EU. This oligophagous (restricted to *Citrus* spp.) pest causes severe damage to citrus cultivation in Vietnam and other countries in South-East Asia.

The only entry pathway quantified in this assessment is the import of citrus fruit from affected countries. Two scenarios were considered for the entry assessment: scenario A0 (current practice) and scenario A2 (additional post-harvest cold treatment). The control option studied in scenario A2 was chosen among several possible measures.

The entry pathway is modelled by estimating the number of founder populations per year in the EU citrus-growing area. The model takes into account prevalence at the origin, trade flow of citrus fruit, sorting, disaggregation, transfer and (for scenario A2), the effectiveness of post-harvest cold treatment.

Based on the outputs of the entry model obtained in scenario A0, the median number of founder populations in the EU citrus-growing area is estimated to be slightly less than 10 per year (90%-uncertainty interval between about one entry per 180 years and 1,300 entries per year).

The risk of entry is orders of magnitude lower for scenario A2 compared to scenario A0, but the uncertainty is larger for scenario A2 compared to scenario A0 (median: about one founder population per 100 years; 90%-uncertainty interval between one founder population per about two million years and six founder populations per year).

In both scenarios, the uncertainty in the model outcome is due to combining the uncertainties of the model parameters. The main uncertainties in the entry assessment are the probability of transfer, the effectiveness of the post-harvest cold treatment (for scenario A2), the disaggregation factor and sorting.

When the probability of establishment is taken into account, model simulations lead to a median of about five established populations per year under current practice (90%-uncertainty interval between about one established population every 400 years and 800 established populations per year).

Adding post-harvest cold treatment, the median value of established population is reduced to one every 200 years (90%-uncertainty interval between about one established populations every five million years and about three established populations every year).

For both scenarios, the number of established populations is only slightly lower than the number of founder populations, revealing that establishment is not expected to be a major limiting factor for this pest.

As already noted for the entry risk, the risk of establishment is reduced under scenario A2 compared to scenario A0, but not eliminated, as post-harvest cold treatment is not expected to be 100% effective.

The main uncertainties in the establishment assessment are the probability of transfer, the disaggregation factor, sorting and, for scenario A2, the effectiveness of the post-harvest cold treatment. On the other hand, the probability of establishment has little impact on the number of established populations. As the numbers of established populations are less sensitive to the probability of establishment compared to the factors of the entry model, the probability of establishment is not a major source of uncertainty, despite the lack of data on the thermal biology of the pest.

The median lag period between establishment and spread, expressed as the time needed for a founder population to build up to a density enabling the colonisation of a neighbouring orchard, is estimated to be slightly more than 1 year (90%-uncertainty interval between about 2 months and 33 months).

After the lag period, the median spread rate by natural means (flying) and due to transport of harvested citrus fruit from orchards to packinghouses (part of common agricultural practices) is estimated at about 100 km/yr (90%-uncertainty interval between about 40 and 500 km/year).

The main sources of uncertainty affecting the assessment of the lag period include the extent to which natural enemies, differences in susceptibility of different *Citrus* species and cultivars, and other environmental factors could hamper the build-up of the pest populations.

The main sources of uncertainty affecting the assessment of the spread rate include the lack of data at the origin and the climate suitability of the initial spread focus. The median impact of *C. sagittiferella* in the EU citrus-growing area is estimated at about 10% of infested fruits among the harvested citrus fruits (90%-uncertainty interval between about 2% and 25%).

Uncertainties affecting the impact assessment include the susceptibility of different *Citrus* species and cultivars, especially those cultivated in the EU.

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1. Introduction

1.1. Background and terms of reference as provided by the requestor

1.1.1. Background

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

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

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

1.1.2. Terms of Reference

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

EFSA is requested to deliver 50 pest categorisations for the pests listed in Annex 1A, 1B and 1D. Additionally, EFSA is requested to perform pest categorisations for the pests so far not regulated in the EU, identified as pests potentially associated with a commodity in the commodity risk assessments of the HRP dossiers (Annex 1C). Such pest categorisations are needed in the case where there are not available risk assessments for the EU.

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

ANNEX 1 List of pests

A)

1. *Amyelois transitella*
2. *Citripestis sagittiferella*
3. *Colletotrichum fructicola*
4. *Elasmopalpus lignosellus*
5. *Phlyctinus callosus*
6. *Resseliella citrifrugis*
7. *Retithrips syriacus*
8. *Xylella taiwanensis*

1.2. Interpretation of the terms of reference

1.2.1. Pest categorisation

The EFSA Panel on Plant Health (hereafter Panel) published a pest categorisation on *Citripestis sagittiferella* (Lepidoptera: Pyralidae) (Moore, 1891) (EFSA PLH Panel, 2021a), which concluded that the pest met the criteria for consideration as Union quarantine pest. The reader is referred to that document for information on the identity, biology, detection and identification, establishment, spread and impacts of the pest. Information provided in the pest categorisation is not repeated here, unless required for the purposes of this risk assessment.

1.2.2. Interpretation of the terms of reference

The Panel interpreted the Terms of Reference (ToR) as a request to perform a risk assessment on *C. sagittiferella*. All the steps (entry, establishment, spread and impact) of the PRA are to be developed.

2. Data and methodologies

2.1. Data

A literature search on *C. sagittiferella* was conducted at the beginning of the risk assessment (May 2022) in the ISI Web of Science bibliographic database, using the scientific and common (citrus fruit borer) names of the pest as search terms, to retrieve relevant information and data appeared since the publication of the EFSA pest categorisation on this pathogen (EFSA PLH Panel et al., 2021a). Relevant papers were reviewed and further references and information were obtained from experts, as well as from citations within the references and grey literature.

Information on the pest distribution was retrieved from the EPPO Global Database (EPPO, 2022) and relevant literature.

Data on interceptions and outbreaks of the pest within the risk assessment area were searched in the Europhyt database.

For this opinion, the following additional data were searched:

- Data on the prevalence of *C. sagittiferella* in Malaysia, Indonesia, Vietnam and Thailand.
- Data on the EU import of citrus fruit from the above-mentioned countries.
- Data on the transfer rate of the pest.
- Data on the effectiveness of risk reduction options (RROs) targeting this pest.

2.2. Methodologies

The Panel performed this risk assessment following the Panel's guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018a).

Entry via trade in imported citrus fruit was assessed using pathway modelling in @Risk (https://www.palisade.com/risk/default.asp).

Expert elicitation was used to estimate model input numbers for each substep of the pathway model.

2.2.1. Specification of the scenarios

The following scenarios were considered:

Entry:

- Scenario A0 (current practice)
- Scenario A2 (additional RROs)

The additional RRO is a post-harvest cold treatment (see Section 2.2.3).

Establishment:

- Scenario A0 (current practice)
- Scenario A2 (additional RROs)

Spread:

- The elicitations (of the lag period and spread rate) apply to the EU citrus-growing area, assuming that human-assisted spread between citrus orchards is excluded by perfect sanitary measures or prohibited exchange of tools/workers, but taking into account the possible movement of harvested citrus fruit from orchards to packinghouses, as this is part of common agricultural practices.

Impact:

- The elicitation of the yield loss applies to the EU citrus-growing area, once the pest has spread to its entire extent.

2.2.2. Conceptual model and definitions

2.2.2.1. Definition of the pathways

The only pathway of entry considered in the model was citrus fruit. While *C. sagittiferella* has been reported mainly on pomelo (*Citrus maxima*), the Panel cannot exclude other *Citrus* spp. as hosts (EFSA PLH Panel, 2021a). No data were found on differences in prevalence on the different *Citrus* spp.; thus, all *Citrus* spp. were considered together in one single pathway.

Other potential entry pathways for *C. sagittiferella* are *Citrus* spp. plants for planting with foliage and soil/growing media, as well as soil/growing media. As these pathways are closed (EFSA PLH Panel, 2021a), they were not quantified.

2.2.2.2. Conceptual model

The entry pathway was modelled by estimating the number (per year) of founder populations of *C. sagittiferella* in the EU due to import in the EU of citrus fruit from countries where the pest was reported. The calculation took into account the parameters listed in Table 1 (prevalence at the origin, trade flow, sorting, disaggregation and transfer). The principle of this model is to compute the quantity of infested fruits that is able to enter into the EU and to produce founder populations.

2.2.2.3. Formal model

The following pathway model was implemented,

$$N_{inf} = N_{trade} \times p_{prevalence} \times \left(1 - p_{sorting}\right) \times \left(1 - RRO_{effectiveness}\right) \times d \times p_{transfer}$$

where the meaning and the units of the output and inputs are defined in Table 1. Note that one of the input parameters is a disaggregation factor (*d*) used to disaggregate the infested material entering into the EU to different locations in the risk assessment area. Because of this factor, one ton of infested citrus fruit can lead to several founder populations. In scenario A2, an additional input factor ($RRO_{effectiveness}$) is used to account for the effectiveness of the RRO (post-harvest cold treatment). In scenario A0, this factor is set to zero (Table A.2 and A.3).

Table 1: Definitions of the output variable (N_{inf}) and input parameters used in the entry model (pathway citrus fruit)

Name	Description	Units
N_{inf}	Number of founder populations of *C. sagittiferella*	Number of founder populations per year
N_{trade}	Total quantity of citrus fruit (infested or not) imported by the EU from Indonesia, Malaysia, Thailand and Vietnam	Tons (1,000 kg) per year
$p_{prevalence}$	Prevalence of *C. sagittiferella* at the origin where citrus fruit is harvested for export to the EU (expressed as the proportion of infested citrus fruit to all citrus fruit harvested in the areas considered)	Proportion of fruit
$p_{sorting}$	Proportion of infested citrus fruit removed following pre-import inspection (identification and removal of infested fruits before entry in the EU)	Proportion of fruit
$RRO_{effectiveness}$	Reduction in the proportion of infested citrus fruit with post-harvest cold treatment	Proportion of fruit
d	Disaggregation factor, reflecting the distribution of one ton of infested citrus fruit to several locations in the risk assessment area	Number of disaggregated batches of citrus fruit/ton
p_{transfer}	Probability that the pest in one disaggregated batch of citrus fruit is transferred to suitable hosts, thus leading to a founder population	Probability

The model includes five input parameters in scenario A0 (six in scenario A2). Five quantiles were provided for each parameter based on data and expert judgement, following EFSA guidance on expert knowledge elicitation and uncertainty (EFSA, 2014, 2019). In short: experts elicit five quantiles for each parameter (1, 25, 50, 75 and 99%) and a theoretical probability distribution is then fitted to these quantiles for each parameter, using least squares in @Risk. The fitted distributions reflect the level of plausibility of possible values of the different parameters.

The pathway model was run using Monte Carlo simulation, by repeatedly (10,000 times) drawing random realisations out of the elicited distributions for the input parameters and calculating the resulting 10,000 values of the output variable representing the number of founder (N_{inf}) and established (N_{est}) populations per year in the EU as a result of import of infested units. The model was run separately for scenarios A0 and A2 (see Section 2.2.3). The model was implemented in @Risk (see Supplementary Information – Annex A).

2.2.2.4. Ecological factors and conditions in the chosen scenarios

The risk assessment was performed under current ecological factors and conditions for the citrus-growing areas of the EU (risk assessment area) and countries of origin.

2.2.2.5. Temporal and spatial scales

The risk assessment area was the EU territory.

The temporal horizon considered for the risk assessment was 10 years (2023–2033). This temporal horizon delimits the scope of the parameter elicitations done by the Panel. Entry was considered as a separate process for each year. No time-cumulative processes were accounted for in the entry model, but this was included in the spread model.

2.2.3. Potential risk reduction options

The management options to reduce the probability of entry of *C. sagittiferella* must distinguish between measures applied before harvest (preharvest measures) and those applied after harvest (post-harvest measures).

2.2.3.1. Preharvest measures

According to experts in Vietnam, fruit bagging can control *C. sagittiferella* with more than 95% effectiveness. Two-week-old fruits are suitable for bagging and it is recommended to apply insecticides before bagging (Kris Wyckhuys, pers. com., September 2022). Fruit bagging is labour intensive and may not be feasible for large citrus areas, making its general adoption impractical.

Integrated pest management (IPM) combining insecticide spraying, light traps and the use of entomopathogenic fungi is more than 90% effective according to experts in Vietnam (Kris Wyckhuys, pers. com., September 2022). According to the same source, insecticide application alone is somewhat less effective (80%). Insecticides should be applied after fruit set and when > 2% of the fruit is damaged according to local recommendations.

In Indonesia, it was reported that spraying the trees with *Bacillus thuringiensis* overhead sprays could reduce *C. sagittiferella* damage more than abamectin. EFSA published a review of abamectin (EFSA, 2022). Some results suggest a possible abamectin resistance in Lebong, Sumatra (Saputra et al., 2019).

Although available, biological control is not a viable stand-alone option for quarantine pests and export commodities. It could be considered, however, as part of IPM.

Pest-free places of production based on surveys and control measures (FAO, 2016a) could be considered for plants for planting (nurseries), but this is not a feasible option for citrus fruit, as *C. sagittiferella* is a strong flyer.

2.2.3.2. Post-harvest measures

Cold treatment is commonly used as a phytosanitary measure for citrus fruits, but no information specific for *C. sagittiferella* was found. Nevertheless, data are available for several other citrus pests such as the false codling moth, *Thaumatotibia leucotreta* (Meyrick) (Lepidoptera: Tortricidae), and the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae) (De Lima et al., 2007; Moore et al., 2017).

The thermal biology (temperature requirements) of *C. sagittiferella* has not been studied yet. As a consequence, lower and upper temperature thresholds and thermal constant for this pest are unknown. This is a key knowledge gap that is reflected in the uncertainty in the conclusions of this opinion.

Some *Citrus* spp. and cultivars are not cold tolerant, thus limiting the feasibility of the measure (Alonso et al., 2007; Palou et al., 2008). In general, the lower the temperature, the shorter the exposure duration required to control the pest.

Although no experimental evidence is available on the effectiveness of cold treatment to control *C. sagittiferella*, it is plausible that the cold treatments already implemented to control *T. leucotreta* and *C. capitata* would work with similar effectiveness against *C. sagittiferella* given the tropical origin of this pest.

The 'temperature x duration' combinations of cold treatment already used as phytosanitary measures on *T. leucotreta* and *C. capitata* are listed below:

- Citrus (*T. leucotreta*) imported to the EU:
  a) a cold treatment of 0°C to −1°C for at least 16 days,
  b) or of −1°C to +2°C for at least 20 days.

  is required for '*Citrus sinensis* Pers.' fruits exported from countries of the African continent, Cape Verde, Saint Helena, Madagascar, La Reunion, Mauritius and Israel for which the origin from an area free from *T. leucotreta* in accordance with relevant International Standards for Phytosanitary Measures (ISPM) cannot be guaranteed (Commission Implementing Regulation (EU) 2022/959 of 16 June 2022 amending Annex VII to Implementing Regulation (EU) 2019/2072 as regards requirements for the introduction into the Union of certain fruits of *Citrus* L.; https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32022R0959&from=EN).

- Citrus (*C. capitata*) cold treatment (cold treatment for *C. capitata* on *Citrus sinensis*; FAO, 2017):

Schedule 1: 2 °C or below for 16 continuous days (mortality > 99.9937%), or.
schedule 2: 2 °C or below for 18 continuous days (mortality > 99.9999%) or.
schedule 3: 3 °C or below for 20 continuous days (mortality > 99.9989%) (FAO, 2017).

In addition to cold treatment, generic irradiation could be efficient to control the pest as well but, as fruit damage has to be avoided, the feasibility of the measure is limited. Data on effectiveness are available (Muruvanda and Hernandez, 2017).

Phyto-certificate based on inspection would be required if the pest becomes a quarantine pest.

2.2.3.3. Systems approach

When exclusion measures (i.e. pest-free places of production) established according to International Standards on Phytosanitary Measures (FAO, 2016a) cannot be applied, fruits could be subjected to system approaches combining several RROs (FAO, 2019). The following RROs could be considered:

1) A package of IPM solutions to be implemented on-farm, ideally through an area-wide management programme (i.e. involving an entire commune or district – as to avoid the spillover of the pest from nearby infested orchards). This package could include:
   - Physical measures like removal and destruction of infested fruit (sanitation) and fruit bagging (Kris Wyckhuys, pers. comm., September 2022),
   - Conservation biological control measures such as avoidance of non-selective pesticides or the implementation of a cover crop to boost the ground-foraging predator community feeding on *C. sagittiferella* immature stages and adults (Rahim, 2019),
   - Inundative biological control measures such as soil applications of selective entomopathogenic nematodes (Dritsoulas et al., 2022) or fungi (*Paecilomyces* spp., *Metarhizium* spp.) (Kris Wyckhuys, pers. comm., September 2022) targeting soil-inhabiting stages of *C. sagittiferella* (mature larvae burrowing into the soil to pupate, pupae and emerging adults),
   - Augmentative biological control measures including periodic releases of egg parasitoids of *C. sagittiferella* like *Trichogramma* spp. or others (Le Quoc et al., 2021)
   - Biotechnical methods exploiting kairomone/pheromone traps when these are developed (Dung et al., 2021).

- In addition, IPM could include a targeted application of selective insecticides following sound monitoring of the pest in the orchards.

2) Post-harvest culling of infested fruit detected at the packing house (Kris Wyckhuys, pers. comm., September 2022),
3) Official inspections of consignments for the presence of *C. sagittiferella* in accordance with International Standards on Phytosanitary Measures (FAO, 2016b).
4) A quarantine treatment, which could be:
   - A cold treatment of 0 to −1°C for at least 16 days during transit, in accordance with International Standards for Phytosanitary Measures (FAO, 2018), or
   - An irradiation treatment with a minimum absorbed dose of 400 Gy, which has been determined by APHIS regulations (7CFR305.9) to be adequate to neutralise all insect pests excluding adults and pupae in the order Lepidoptera (Muruvanda and Hernandez, 2017)
5) Detection of adults at EU ports of entry, kairomone/pheromone traps could also be deployed to pick up any eventual incursion. Same as before, these traps have to be developed yet (Dung et al., 2021).

3. Entry

This section presents some background information, including the evidence dossier used for the elicitation of the model parameters. The scenarios used for the entry assessment are then recapitulated and the results presented. The main uncertainties are described, and an assessment of the overall uncertainty and of the dependencies among parameters is included.

3.1. Background information

3.1.1. Pest prevalence at the origin ($p_{prevalence}$)

C. sagittiferella is one of the main citrus pests in Vietnam and Thailand, with reported prevalence as high 40–70% of infested fruit (Le Quoc et al., 2021).

C. sagittiferella is considered by local experts as an expanding pest in Vietnam, in particular in the Mekong River Delta (southern Vietnam) which is a major citrus production region (39% of the production in 2021). The pest was first recorded in 2011 in Hau Giang province and is actively spreading there. The pest is now reported in all pomelo (*Citrus maxima*) growing areas, usually at a prevalence of 40–60% of infested fruit (max. > 90%) (Kris Wyckhuys, pers. comm., September 2022). No detailed record on occurrence or prevalence at province level was found, but a survey is underway in North and Central Vietnam (Kris Wyckhuys, pers. comm., September 2022). In the Mekong River Delta, high pest prevalence is usually reported in January–April and October–November on pomelo, while low prevalence is reported from May to September (rainy season).

In Thailand, year-round occurrences are reported, with peaks of infestation during the months of January, March, July–August, November–December (Kris Wyckhuys, pers. comm., September 2022). The pest was reported from Chiang Mai, Lop Buri, Prachin Buri, Chachoengsao, Chanthaburi, Chumphon and Nakhon Si Thammarat. In these areas, it primarily affects pomelo and tangerine (*C. reticulata*).

C. sagittiferella was reported in other countries of south-eastern Asia as well, i.e. Lebong, Kota (Sumatra), Tarakan (Borneo) and Bali – Indonesia (Rahayu et al., 2018; Rahim, 2019; Saputra et al., 2019; Elsa, 2019). The pest is not known to occur in the Philippines (Kris Wyckhuys, pers. comm., September 2022). Although it is not officially reported in Cambodia, southern Laos and Myanmar, the pest is likely to occur in these areas (Kris Wyckhuys, pers. com., September 2022).

3.1.2. Trade flow (N_{trade})

Data on yearly citrus fruit EU import from the countries of origin (2016–20) were extracted from EUROSTAT (Table 2).

Table 2: Citrus fruit EU import from countries of origin (2016–2020) (in tons). Source: EUROSTAT, accessed September 2022

Year	2016	2017	2018	2019	2020	Average
Vietnam	28,649	46,738	70,934	73,964	63,728	56,803
Indonesia	567	556	779	836	864	720
Thailand	426	1,283	660	625	195	638
Malaysia	4.2	39	83	7.7	–	33
Sum	29,646	48,616	72,456	75,432	64,787	58,187

3.1.3. Sorting ($p_{sorting}$)

Several individuals of *C. sagittiferella* can be found in one fruit, thus making the pest more detectable than if one fruit contained a single individual only. Entry holes can be spotted due to frass. Oviposition takes place on the surface of the fruit, thus larvae have to make their way into the fruit (EFSA PLH Panel et al., 2021a). In some cases, infested fruit may be discarded already in the orchard, but it is unclear how the inspection is done in the countries where the pest is present. An EPPO protocol for the inspection of citrus fruit consignments is available (EPPO, 2020).

3.1.4. Transfer rate ($p_{transfer}$)

Adults of *C. sagittiferella* are strong flyers, particularly in the evening. It is possible that wind could disperse the moths over relatively longer distances (Anonymous, 2015). Consequently, transfer is not likely to be difficult, as citrus packinghouses in the risk assessment area are often close to citrus orchards. As *C. sagittiferella* is not a parthenogenic species, at least one female and one male are needed to start a new infestation. Theoretically, one fruit with several larvae could be enough to provide the founder population.

3.2. Entry assessment

3.2.1. Scenario recapitulation

The following scenarios for entry were considered:

- Scenario A0 (current practice)
- Scenario A2 (additional RROs)

The additional RRO is a post-harvest cold treatment.
A scenario A1 (deregulation) was not considered, given that the pest is currently not regulated in the EU under current conditions (Table A.1).

3.2.2. Definition of the input parameters and elicitation of their distributions

3.2.2.1. Prevalence at the origin

The prevalence at the origin ($p_{prevalence}$) is defined in Table 3.

Table 3: Definition of the parameter prevalence at the origin ($p_{prevalence}$)

Name	Definition	Sources
$p_{prevalence}$	Prevalence of *C. sagittiferella* at the origin (Indonesia, Malaysia, Thailand and Vietnam) (expressed as the proportion of infested citrus fruit to all citrus fruit harvested in the areas considered)	Literature (see Section 3.1.1.) and expert knowledge

The elicited distribution of the prevalence at the origin on prevalence at the origin are reported in Table 4 and Figure 1.

Table 4: Elicited quantiles of prevalence at the origin $p_{prevalence}$ (both scenarios)

Quantile	1%	25%	Median	75%	99%
Scenarios A0/A2	1%	10%	20%	30%	50%

Justification

In Vietnam, a pest prevalence of 40–60% of infested fruit is commonly reported, with maximum values above 90% (K. Wyckhuys, pers. comm., September 2022). The pest is endemic at the origin (see Section 3.1.1), but it might not be present in all orchards and is not reported from all provinces in the countries where the pest is known to occur. In Indonesia, surveys carried out in a citrus-growing area in the Karo District of north Sumatra reported *C. sagittiferella* larvae in about 3% of the fruit (Hammig et al., 2008).

For the 1% quantile, it was considered that the farmers/pickers can remove infested fruit at harvest and that insecticide sprays were applied, but without complete effectiveness. For the 99% quantile, the worse situation was considered, i.e. absence of fruit removal and no insecticide spray. The median estimation considered the studies of Marthana et al. (2018) and Le Quoc et al. (2021), with reported prevalence values of 17–30% in districts where some control measures were applied, although their level of application was uncertain. Furthermore, the effectiveness of control measures can be reduced because *C. sagittiferella* can also oviposit at the end of the season, thus leading to infested fruit even if farmers have taken control measures before. It was also considered that insecticides can kill natural enemies of the pest as well. As indicated in the parameter definition (Table 3), estimations were made for the export of all types of citrus fruits.

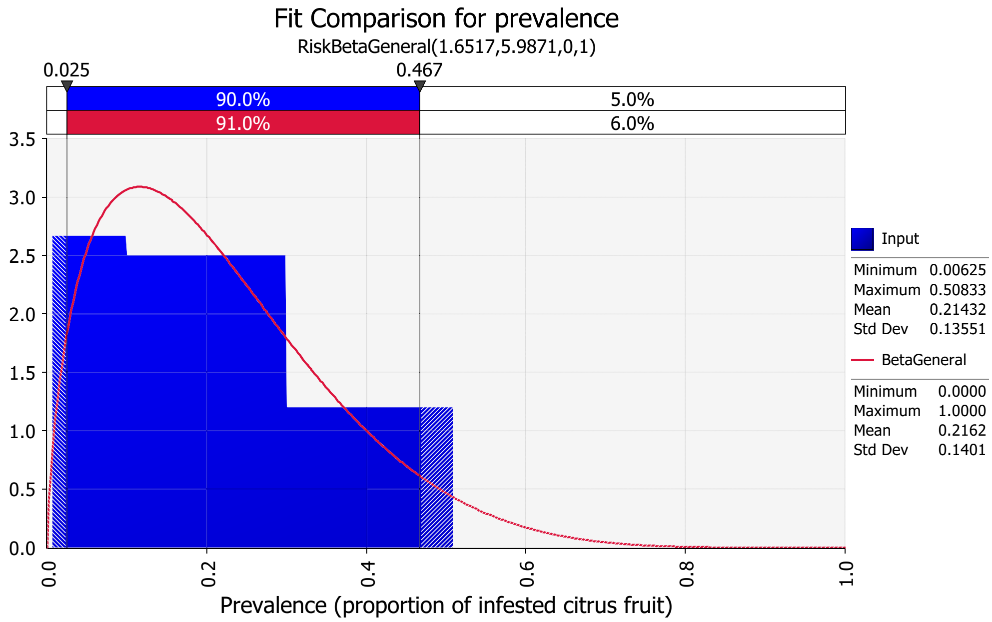

Figure 1: Fitted distribution for prevalence at the origin ($p_{prevalence}$) defined as the proportion of infested citrus fruit (both scenarios)

3.2.2.2. Trade flow

Trade flow is defined in Table 5. A trend analysis is shown in Figure 2.

Table 5: Definition of the parameter trade flow (N_{trade})

Name	Definition	Sources
N_{trade}	Total quantity of citrus fruit (infested or not) imported by the EU from countries where *C. sagittiferella* is reported	Eurostat

The elicited distribution of the trade flow is reported in Table 6 and Figure 3.

Table 6: Elicitation of trade flow in metric tons (1,000 kg) of citrus fruit per year, averaged over the time horizon period 2023–2033 (both scenarios)

Quantile:	1%	25%	Median	75%	99%
N_{trade}	3,000	9,000	13,000	16,000	20,000

Justification – EU imports (2016–2020) of citrus fruit from countries where *C. sagittiferella* is known to occur ranged between about 3,000 tons and 7,500 tons, with an average of about 5,800 tons (EFSA PLH Panel, 2021a). Nevertheless, Figure 2 shows an increasing trend when considering data over a longer period. Without considering the data points for 2020–2021, when trade was strongly reduced due to COVID-19, the increasing trend would be even stronger. Pomelo is seldom grown commercially in the EU, so the growing import of fruit of this *Citrus* species from South-East Asia is likely to carry on over the next years. Indeed, it seems pomelo is becoming more and more popular in the EU and this trend is likely to continue in the future (Anonymous, 2021). For all these reasons, the upper bounds of the confidence and prediction intervals of the regression appear as relevant references for the elicitation.

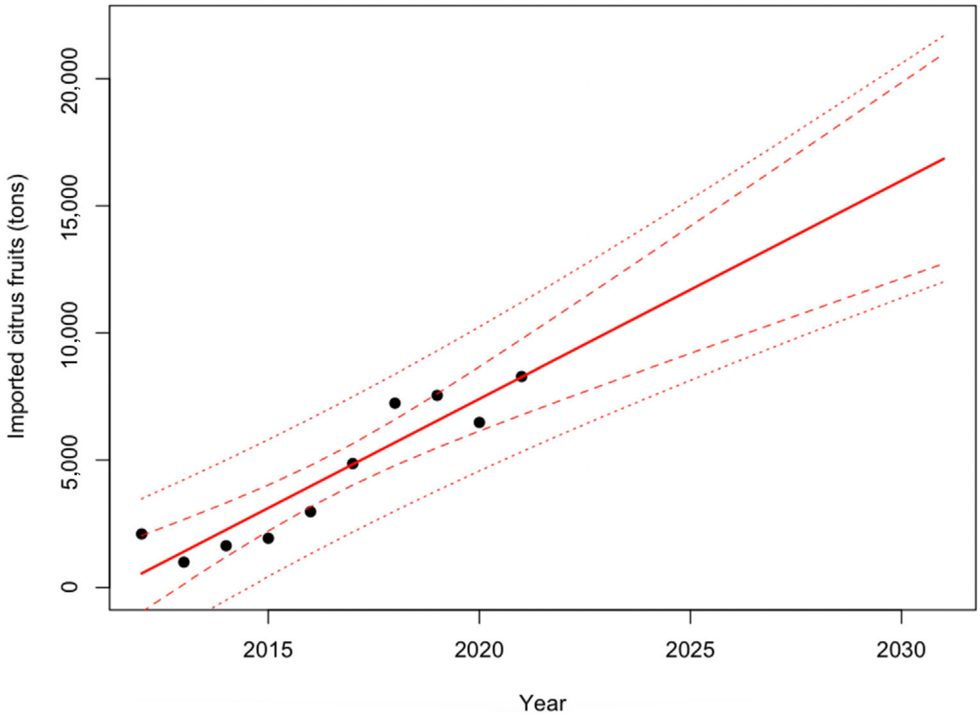

Figure 2: Trend analysis of the import into the EU of citrus fruit (tons) from countries with reports of *Citripestis sagittiferella*, based on 2012–2021 EUROSTAT data, over the 10 years of the PRA time horizon (2023–2032). Dashed and dotted lines indicate the 95% confidence and prediction intervals.

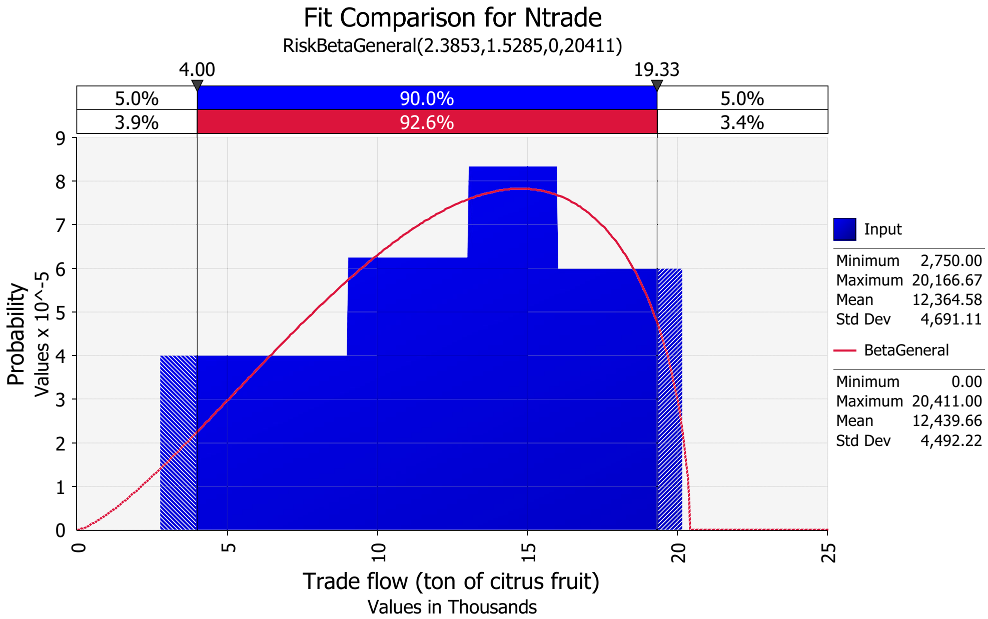

Figure 3: Fitted distribution for trade flow (N_{trade}) for citrus fruit as tons per year (both scenarios)

3.2.2.3. Sorting

The parameters $p_{sorting}$ and the RRO effectiveness are defined in Table 7.

Table 7: Definition of sorting ($p_{sorting}$) and risk reduction option (RRO) effectiveness

Name	Definition	Sources
$p_{sorting}$	Proportion of infested citrus fruit removed following pre-import inspections (identification and removal of infested fruits before entry in the EU)	Expert knowledge (see justification below)
RRO effectiveness	Reduction in the proportion of infested citrus with post-harvest cold treatment	Expert knowledge (see justification below)

The elicited distributions of $p_{sorting}$ and of the RRO effectiveness are reported in Table 8 and Figures 4 and 5. For $p_{sorting}$, two components were considered: (i) the proportion of infested citrus fruit removed following inspection and culling at the packinghouse ($p_{sorting\ packing}$); and (ii) the proportion of infested citrus fruit removed following inspection at the border ($p_{sorting\ border}$) in the exporting country. The two components were combined as:

$$p_{sorting} = 1-\left(1-p_{sorting\ packing}\right) \times \left(1-p_{sorting\ border}\right).$$

Table 8: Proportion of infested citrus fruit removed from trade due to sorting ($p_{sorting}$) or cold treatment (RRO effectiveness). $p_{sorting}$ was calculated as a combination of sorting at the packinghouse ($p_{sorting\ packing}$) and sorting at the border ($p_{sorting\ border}$) in the exporting country

Quantile	1%	25%	Median	75%	99%
$p_{sorting\ packing}$	0.80	0.90	0.95	0.97	1.00
$p_{sorting\ border}$	0.05	0.30	0.50	0.70	0.95
$p_{sorting}$*	0.838	0.954	0.977	0.990	0.999
RRO effectiveness	0.85	0.99	0.999	0.9994	1

*: $p_{sorting} = 1 - (1-p_{sorting\ packing}) \times (1-p_{sorting\ border})$.

Justification – sorting:

The elicitation focuses on sorting at the packinghouse and subsequent sorting at the border.

Sorting at the packinghouse

For the 1% quantile, it was considered that lesions caused by *C. sagittiferella* are relatively easy to detect and pest prevalence in the orchard (and thus in the harvested fruit) is high. Some sorting will already be done in the orchards, but fruit pickers often miss infested fruit during harvest. There will be a mixture of pest eggs and larvae, but only a small fraction will have eggs. For the 99% quantile, it was considered that sorting at the packinghouse can in some cases be 100% effective, given the high pest prevalence. The median was set close to the upper boundary, as the pest is easily detected, and packinghouse workers are familiarised with pest symptoms.

Sorting at the border

For the 1% quantile, it was considered that if inspection is effective at the packinghouse, then pest prevalence is reduced substantially and, as a consequence, inspection at the border is no longer removing much infested material. It was considered also that trade data are provided considering sorting to some extent, as rotten fruit is normally not exported. This would imply that $p_{sorting\ border}$ is close to zero. For the 99% value: nevertheless, with the high reported prevalence of the pest, overall inspection (both at the packinghouse and at the border) is supposed to be effective. Median value: This was chosen in between the 1% and 99% values, as *C. sagittiferella* is not regulated, so there is no specific inspection for this pest, although inspectors will be looking for the presence of pests in general, thus including *C. sagittiferella*. The 25% and 75% values were chosen to reflect the high uncertainty on this parameter, as sample size at the border is unknown and random sampling (FAO, 2016b; EPPO, 2020) might not be easily achieved.

Justification – RRO (cold treatment)

For the 1% quantile, it was considered the case of no proper implementation of the cold treatment, e.g. temperature/duration required not strictly followed, for instance to avoid cold damage to the fruit (Khumalo et al., 2021). For the 99% quantile, it was considered that the cold treatment applied against *T. leucotreta* would be effective also for *C. sagittiferella*, as this pest is of tropical origin and thus likely to be negatively affected by low temperatures. This is plausible because tropical pests are generally not prepared to adapt to environmental changes, as their typical climate is stable, and because *T. leucotreta* occurs in both tropical and temperate regions, while at present *C. sagittiferella* is reported from tropical areas only. The median was set based on the target mortality for *T. leucotreta* and considering the lack of data for *C. sagittiferella*. Finally, it was considered that insects in fields are usually more robust than insects reared in the lab for cold treatment experiments.

The elicited values are consistent with the uncertainty distribution of *T. leucotreta* mortality rates during cold treatment obtained in the EFSA commodity assessment of *Citrus* fruits (Table B.25 in EFSA PLH Panel, 2021b).

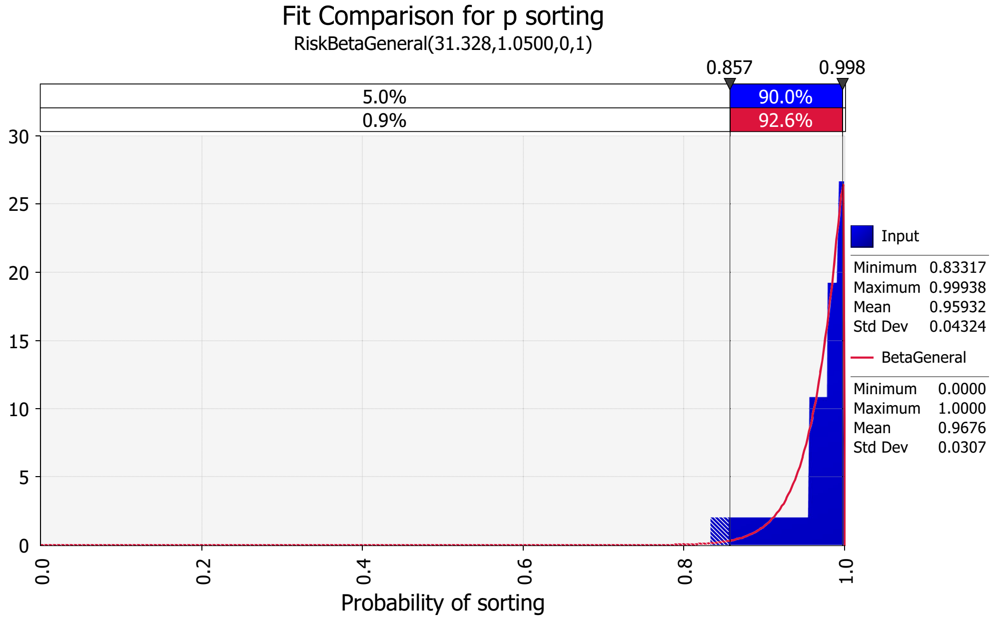

Figure 4: Fitted distribution for sorting ($p_{sorting}$) as the proportion of infested fruit (both scenarios)

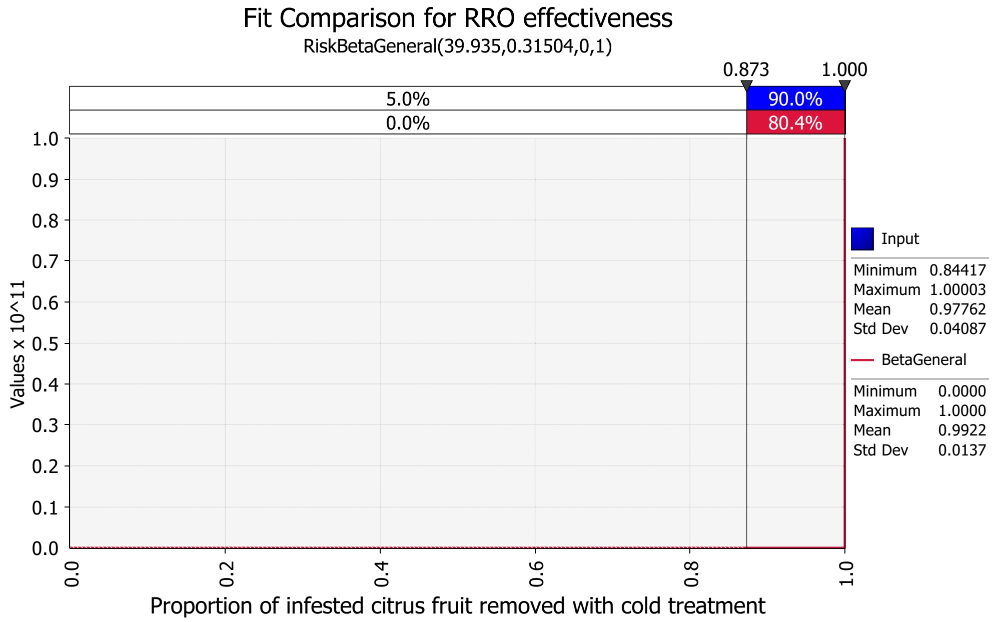

Figure 5: Fitted distribution for RRO effectiveness as the proportion of infested citrus fruit removed with cold treatment

3.2.2.4. Disaggregation factor

The disaggregation factor is defined in Table 9.

Table 9: Definition of the parameter disaggregation factor (*d*)

Name	Definition	Sources
d	Disaggregation factor for one ton (1,000 kg) of infested citrus fruit, to take into account the number of suitable locations for transfer to which one ton of infested citrus fruit is delivered	Expert knowledge (see justification below)

The elicited distribution of the disaggregation factor is reported in Table 10 and Figure 6.

Table 10: Disaggregation factor (*d*) for citrus fruit

	1%	25%	Median	75%	99%
d	1	6	10	50	500

Justification:

For the 1% quantile, it was considered a whole ton of citrus fruit is delivered to one single location. For the 99% quantile, it was considered that lots of 2 kg of citrus fruits were allocated to different locations. The median was set to reflect the situation when one ton of infested citrus fruit is delivered to 10 different locations in the risk assessment area (100 kg per location).

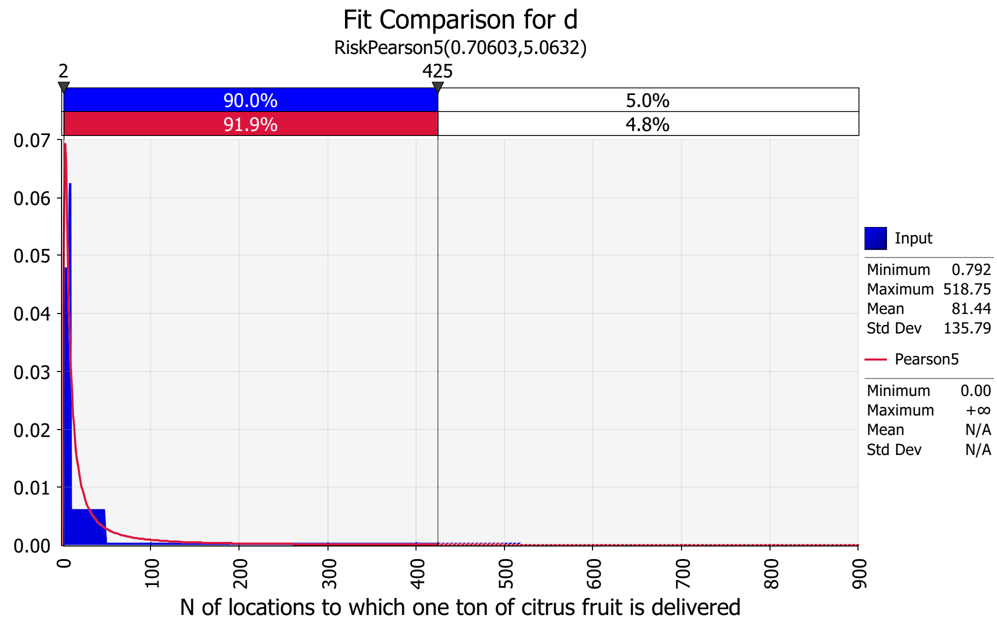

Figure 6: Fitted distribution for the disaggregation factor (*d*) for citrus fruit (number of suitable locations for transfer to which one ton of infested citrus fruit is delivered) (both scenarios)

3.2.2.5. Transfer

The probability of transfer is defined in Table 11.

Table 11: Definition of the parameter transfer ($p_{transfer}$)

Name	Definition	Sources
$p_{transfer}$	Probability that the pest in one disaggregated batch of citrus fruit is transferred to suitable hosts, thus leading to a founder population	Expert knowledge (see justification below)

The elicited distribution of the probability of transfer is reported in Table 12 and Figure 7.

Table 12: Probability of transfer ($p_{transfer}$) for citrus fruit (both scenarios)

Quantile:	1%	25%	Median	75%	99%
$p_{transfer}$	0	0.007 7 out of 1,000	0.01 1 out of 100	0.10 1 out of 10	0.33 1 out 3

Justification

For transfer to occur:

- Infested fruit should be discarded under suitable temperatures in the risk assessment area, mainly in summer or warm periods in spring and autumn, also during winter in citrus-growing areas of EU southern MS.
- The insect should emerge from the fruits discarded close to a citrus orchard.

- Then one male and at least one female have to meet, mate and find a suitable host for the female(s) to oviposit.

For the 1% quantile, it was considered that the need for these subsequent steps to take place greatly reduces the probability of transfer. In addition, some sorting will take place also after import, for instance at market and consumer level and the culled fruit with be subjected to composting or burial. For the 99% value, the most favourable conditions were considered, when one ton of infested fruit is delivered to a packinghouse in close proximity to citrus orchards, and then, the fruits are disseminated at a suitable time of the year. Mediterranean climate can be warm enough to allow the adult insects flying all year round to find suitable hosts. The median was set considering the most frequent situation, with about 100 kg of infested fruit (median of the disaggregation factor). This bulk quantity would favour transfer, as several infested fruits are likely to be in the same lot.

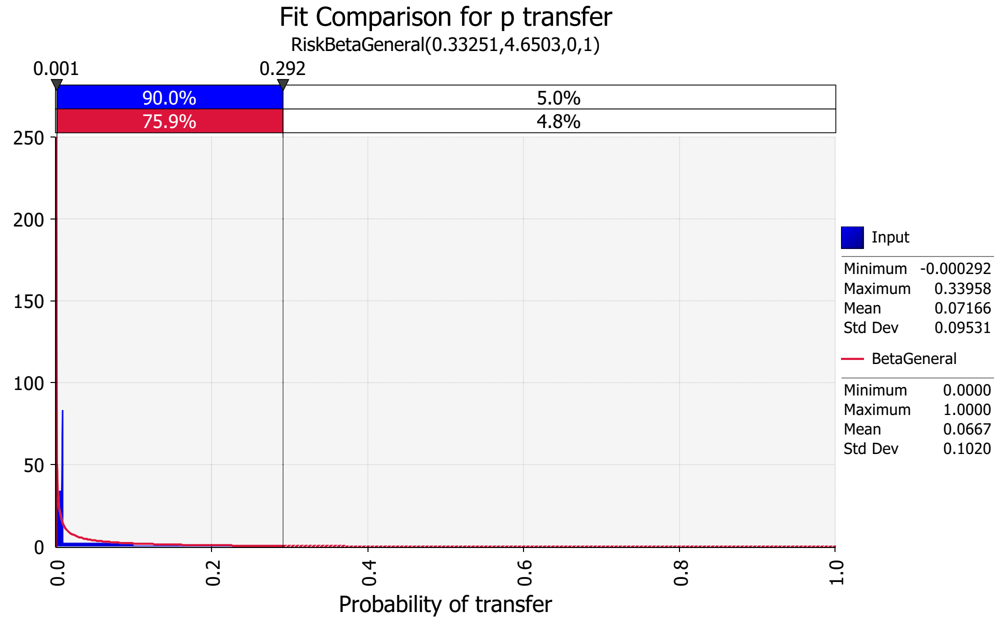

Figure 7: Fitted distribution for the probability of transfer ($p_{transfer}$) for citrus fruit (all scenarios)

3.2.3. Entry assessment results

Table 13 shows the outcome of the model calculations (N_{inf}) expressed as the number of *C. sagittiferella* founder populations per year due to import into the EU of infested citrus fruit for the two considered scenarios. The results are visualised in Figures 8 and 9.

According to model results,

- under scenario A0 (current practice), slightly less than 10 founder populations per year are expected (median = 9.5; 90%-uncertainty interval between about one founder population per 180 years and about 1,300 founder populations per year),
- the risk of entry is orders of magnitude lower for scenario A2 (additional RROs) compared to scenario A0 (median = about one founder population per 100 years; 90%-uncertainty interval between one founder population per about 2 million years and about 6 founder populations per year),
- the uncertainty is larger for scenario A2 (the 90%-uncertainty range spans eight orders of magnitude) compared to scenario A0 (the 90%-uncertainty range spans six orders of magnitude).

Table 13: Outcome of the model calculation for the output variable N_{inf} (number of founder populations of *Citripestis sagittiferella* in the EU due to import of infested citrus fruit) under the considered scenarios A0 (current practice) and A2 (additional RROs), using 10,000 simulation runs

Scenario	Mean	St. dev.	1%	25%	Median	75%	99%
A0	4×10^3	1.5×10^5	3×10^{-5}	0.7	9.5	74	14,000
A2	16	550	7×10^{-10}	3.2×10^{-4}	0.01	0.18	68

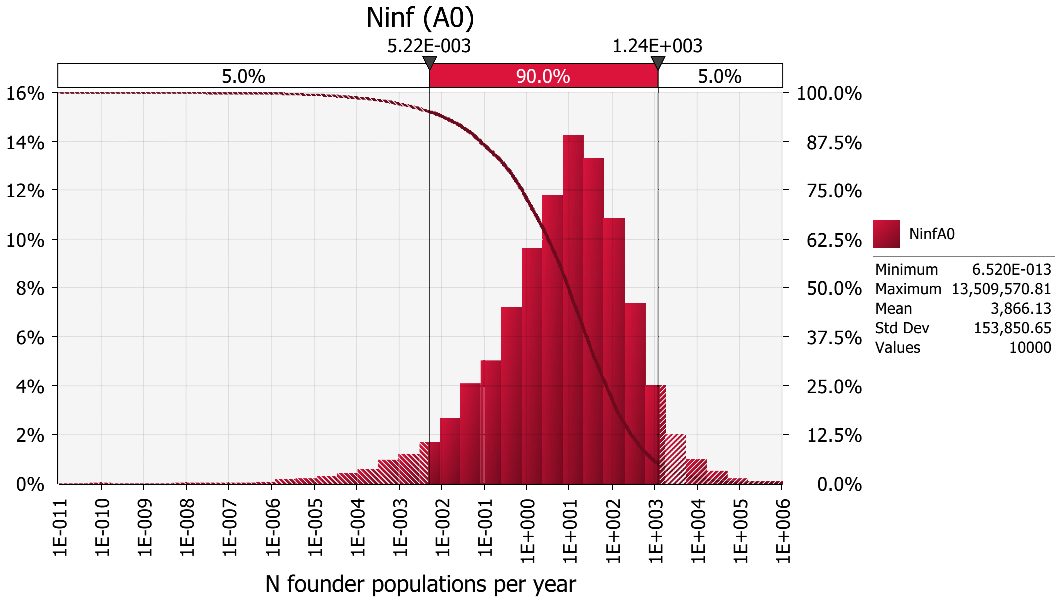

Figure 8: Outcome of the model simulations for scenario A0 (current practice) showing the relative frequency and cumulative descending probability; log-scale x-axis. The number of founder populations of *Citripestis sagittiferella* in the EU per year due to import of infested citrus fruit is estimated between about 5×10^{-3} and 1,240 with a 90% probability

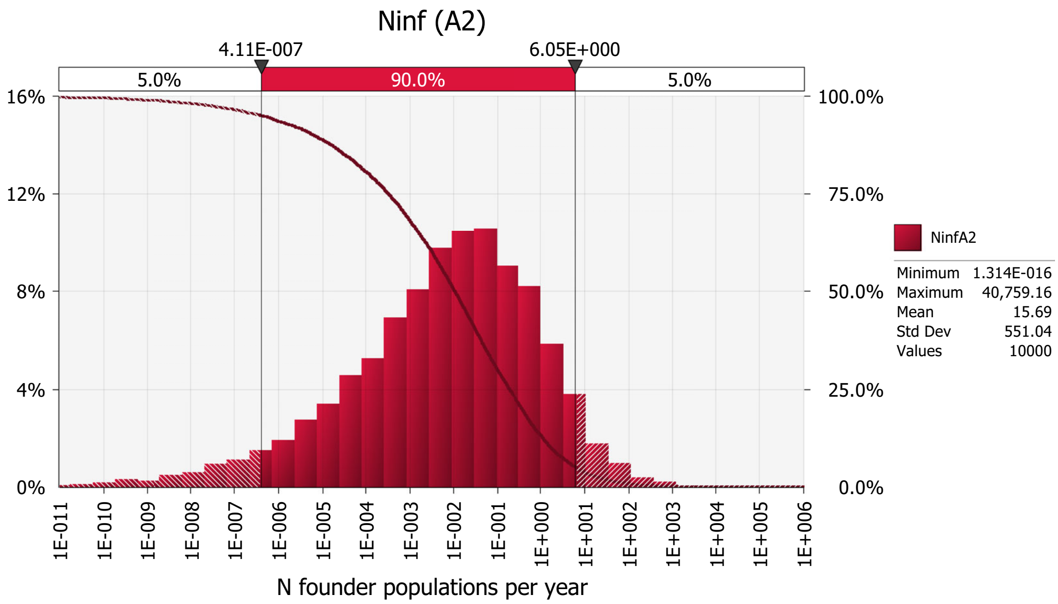

Figure 9: Outcome of the model simulations for scenario A2 (additional RROs) showing the relative frequency and cumulative descending probability; log-scale x-axis. The number of founder populations of *Citripestis sagittiferella* in the EU per year due to import of infested citrus fruit is estimated between about 4×10^{-7} and 6 with a 90% probability

3.3. Sensitivity analysis of number of founder populations

A sensitivity analysis was conducted, where correlations between the output variable (N_{inf}) and the parameters of the entry pathway model were estimated using the Spearman rank coefficient (Figures 10 and 11). Spearman is non-parametric, so no assumption about the data distribution (e.g. normality) is needed. Based on the sensitivity analysis, the parameters included in the entry model most correlated with the output variable are:

- Transfer ($p_{transfer}$)
- RRO effectiveness (scenario A2)
- Disaggregation factor (d)
- Sorting ($p_{sorting}$)
- Prevalence at the origin ($p_{prevalence}$)

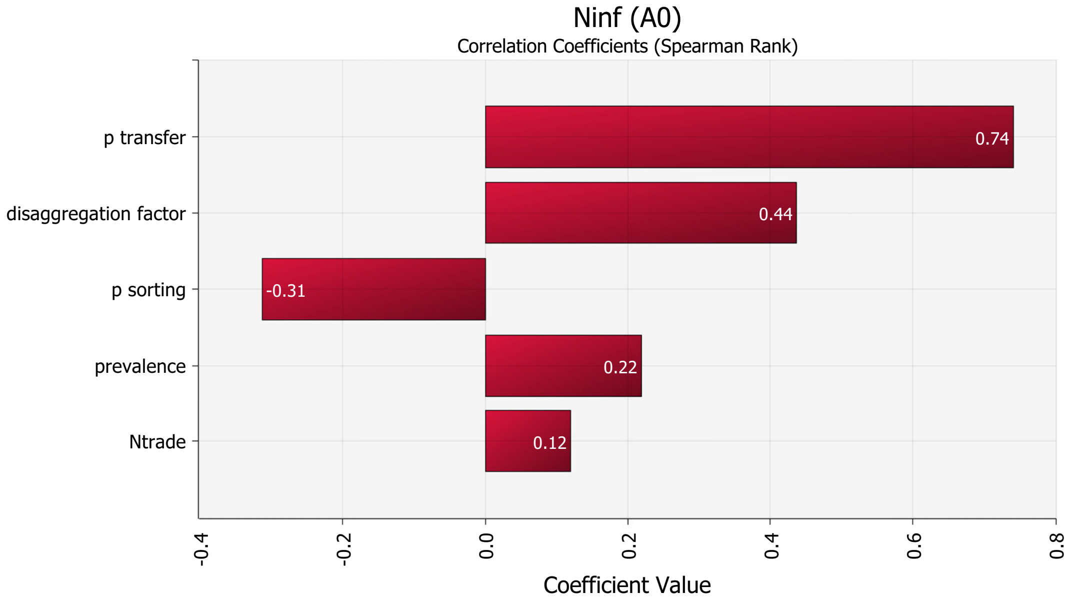

Figure 10: Correlation between the output variable (N_{inf}) and the parameters of the entry pathway model for scenario A0 (current practice). The parameter $p_{sorting}$ has a negative correlation coefficient as it is inserted in the model as ($1-p_{sorting}$).

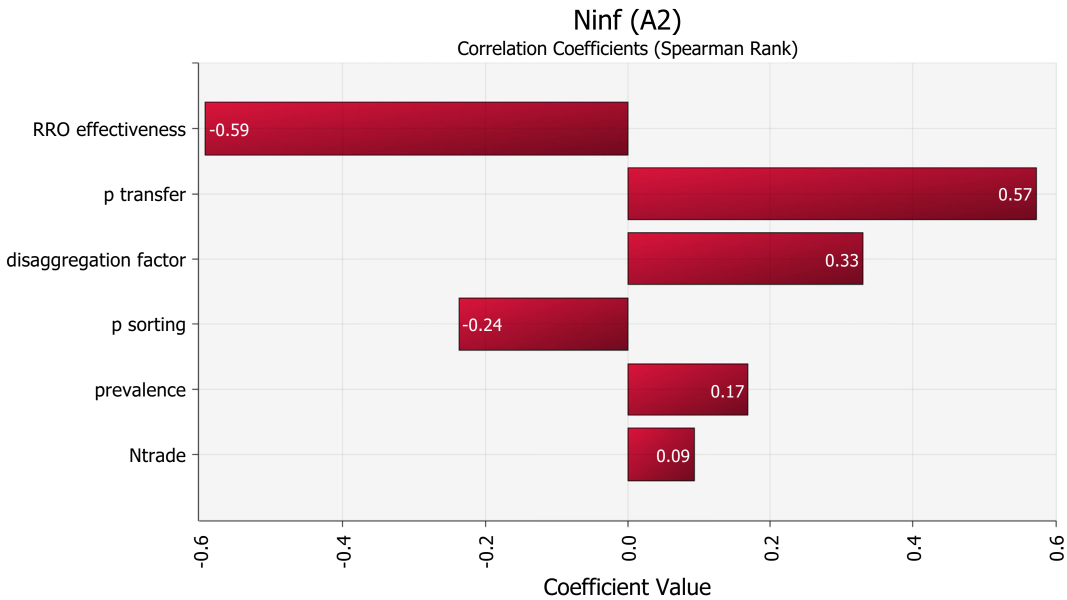

Figure 11: Correlation between the output variable (N_{inf}) of the parameters of the entry pathway model for scenario A2 (additional RROs). RRO effectiveness and $p_{sorting}$ have negative correlation coefficients, as they are inserted in the model as (1–RRO effectiveness) and ($1-p_{sorting}$).

3.4. Additional uncertainties

From a biological point of view, various uncertainties regarding *C. sagittiferella* have been listed by the Panel in the previous pest categorisation (EFSA PLH Panel, 2021a). These uncertainties include:

- Uncertainty on the pest distribution, as the pest is currently expanding, additional countries might be affected even in the absence of official report.
- Uncertainty on the thermal biology of the pest.

Furthermore, there is a lack of data to estimate sorting and transfer, as well as the effectiveness of RROs.

This lack of information is reflected in the parameter distributions and in the outcomes of the entry model.

Uncertainties that were not quantified in the entry model include:

- Seasonality of pest prevalence in relation to fruit harvesting.
- Current practice includes some refrigeration during overseas transport, which was not considered in the scenario A0.

The Panel expects the conclusions of the entry model not to be modified substantially by the additional uncertainties not quantified in this assessment.

3.5. Dependencies between parameters

The Panel considers the parameters of the entry model to be independent of each other, with the possible exception of prevalence at the origin and sorting (the higher the prevalence at the origin, the more likely the sorting), but this dependency is expected not to affect the conclusions of the assessment, as it was considered during the elicitation of sorting (see Section 3.2.2.3).

Increased prevalence at the origin might lead to lower trade, but exporting growers might find areas for production in other regions less affected by the pest, thus making the conclusions of this assessment robust to this potential parameter dependency.

Transfer is likely to be dependent on prevalence, as males and females are needed to mate for transfer to occur. Similarly, for transfer and disaggregation, if the infested ton of citrus fruit is not disaggregated, transfer is going to be more likely, but again this dependency between model parameters was taken into account during the elicitation of the probability of transfer (see Section 3.2.2.5) and should thus not affect the conclusions of the assessment.

3.6. Conclusion on the assessment of entry for the different scenarios

According to model results, under scenario A0 (current practice), the median number of founder populations in the EU citrus-growing area is estimated to be slightly less than 10 per year (90%-uncertainty interval between about one entry per 180 years and 1,300 founder populations per year). The risk of entry is orders of magnitude lower for scenario A2 (additional RROs) compared to scenario A0 (median = 0.01, i.e. about one founder population per 100 years; 90%-uncertainty range between one founder population per about 2 million years and about 6 founder populations per year), but the uncertainty is larger for scenario A2 compared to scenario A0.

In both scenarios, the uncertainty in the model outcome is due to combining the uncertainties of the model parameters. The main uncertainties in the entry assessment are the probability of transfer, the RRO effectiveness (for scenario A2), the disaggregation factor and sorting.

4. Establishment

4.1. Background information and host distribution

Almost no data are available on the climate requirements of *C. sagittiferella*, especially on upper/lower developmental temperature thresholds, cold hardiness and thermal constant. In Vietnam, high levels of infestation seem to be associated with high temperatures and low rainfall, while relatively low levels occur during the rainy season (Kris Wyckhuys, pers. comm., September 2022). In Sumatra (Indonesia), infestation level appears to be related to fruit age/ripening status (Siagian et al., 2021).

In the absence of data on temperature requirements of *C. sagittiferella*, it can be useful to consider the data obtained for two species native from the same area of origin of *C. sagittiferella* which feed on *Citrus* spp., i.e. the citrus leaf miner, *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae), and the Asian citrus psyllid, *Diaphorina citri* Kuwayama (Hemiptera: Sternorrhyncha: Liviidae). Their temperature requirements are summarised in Table 14 (data from: Hong and Tsai, 2000; Hyun et al., 2017).

Table 14: Temperature requirements of two pests of citrus present in the area of current distribution of *Citripestis sagittiferella*. The temperature requirements depend on the immature stage (most vs. less robust)

Immature stage	*Phyllocnistis citrella*		*Diaphorina citri*	
	Most robust	**Less robust**	**Most robust**	**Less robust**
LDT (°C)	7.1 (larva)	12.4 (pupa)	11.1 (larva)	9.0 (egg)
UDT (°C)	53.5 (egg)	44.6 (larva)	~ 33	
Optimal T (°C)	31.7		28.0 (25–28)	
K (DD)	242.6		250.0	

Note: LDT: lower developmental threshold; UDT: upper developmental threshold; K: Kelvin, DD: degree days.

Citrus species are not native to Europe but to Australasia and many pests occurring on citrus in the EU originate from this area (Jacas and Urbaneja, 2010). *C. sagittiferella* is native to south-east Asia (EFSA PLH Panel, 2021a), a region where other citrus insect pests currently occurring in areas with Köppen–Geiger Mediterranean Climate types (Csa-hot summer and Csb-warm summer types) (Figure 12) are also native.

On the one hand, this is the case for the citrus spiny blackfly, *Aleurocanthus spiniferus* (Quaintance) (Hemiptera: Sternorrhyncha: Aleyrodidae) (EFSA PLH Panel, 2018b), the California red scale, *Aonidiella aurantii* Maskell (Hemiptera: Sternorrhyncha: Diaspididae), the citrus leafminer, *P. citrella* (Karamaouna et al., 2010), and the black citrus aphid, *Toxoptera citricida* (Kirkaldy) (Hemiptera: Sternorrhyncha: Aphidae) (EFSA PLH Panel, 2018c), which are known to occur in citrus orchards in the EU. Some of these introduced pests, due to their current restricted distribution in the EU (*A. spiniferus*, *T. citricida*), are regulated as EU quarantine pests (Commission Implementing Regulation (EU) 2019/2072).

On the other hand, there are species such as the citrus blackfly, *Aleurocanthus woglumi* Ashby (Hemiptera: Sternorrhyncha: Aleyrodidae), which occurs in South Africa (EFSA PLH Panel, 2018b), the oriental fruit fly, *Bactrocera dorsalis* (Hendel) (Diptera: Tephritidae), which has been detected several times in California, US, but also in the EU (EFSA PLH Panel, 2020), and the Asian citrus psyllid, *D. citri*, which occurs in Israel (EPPO Reporting Service, 2022) and California (EFSA PLH Panel, 2021c). These non-EU species are now regulated as quarantine pests in the EU (Commission Implementing Regulation (EU) 2019/2072).

Note that the countries where *C. sagittiferella* is known to occur are characterised by tropical climate types, and Csa and Csb climates are not present there. The only climate type occurring in the countries of origin (in only very few pixels in mountainous areas) and also in the EU, is the Cfb oceanic climate (Rossi and Maiorano, 2023).

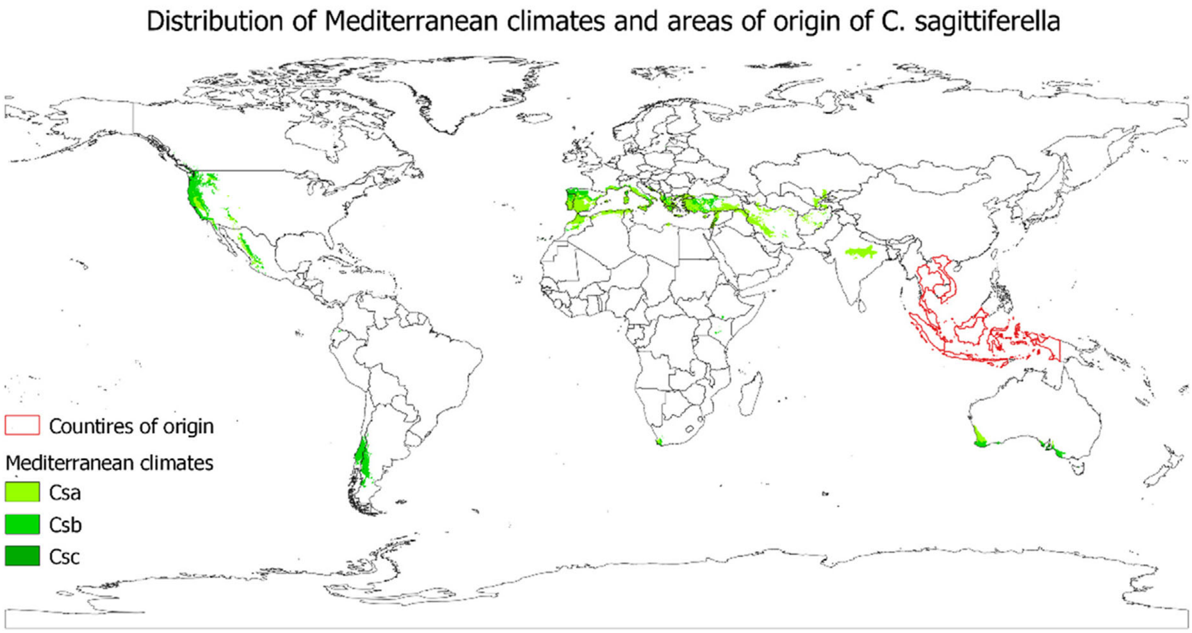

Figure 12: World distribution of Mediterranean climate types. Hot summer-Csa and warm summer-Csb occur in citrus-growing areas of the EU, whereas the cold summer-Csc Mediterranean climate type is found in scattered high-altitude locations along the west coasts of North and South America and does not occur in the EU. Note that the in the region of origin of *Citripestis sagittiferella* (South-East Asia, highlighted in red), Mediterranean climate types do not occur

To define the risk assessment area, the map for citrus production areas in EFSA PLH Panel (2019) was used (Figure 13).

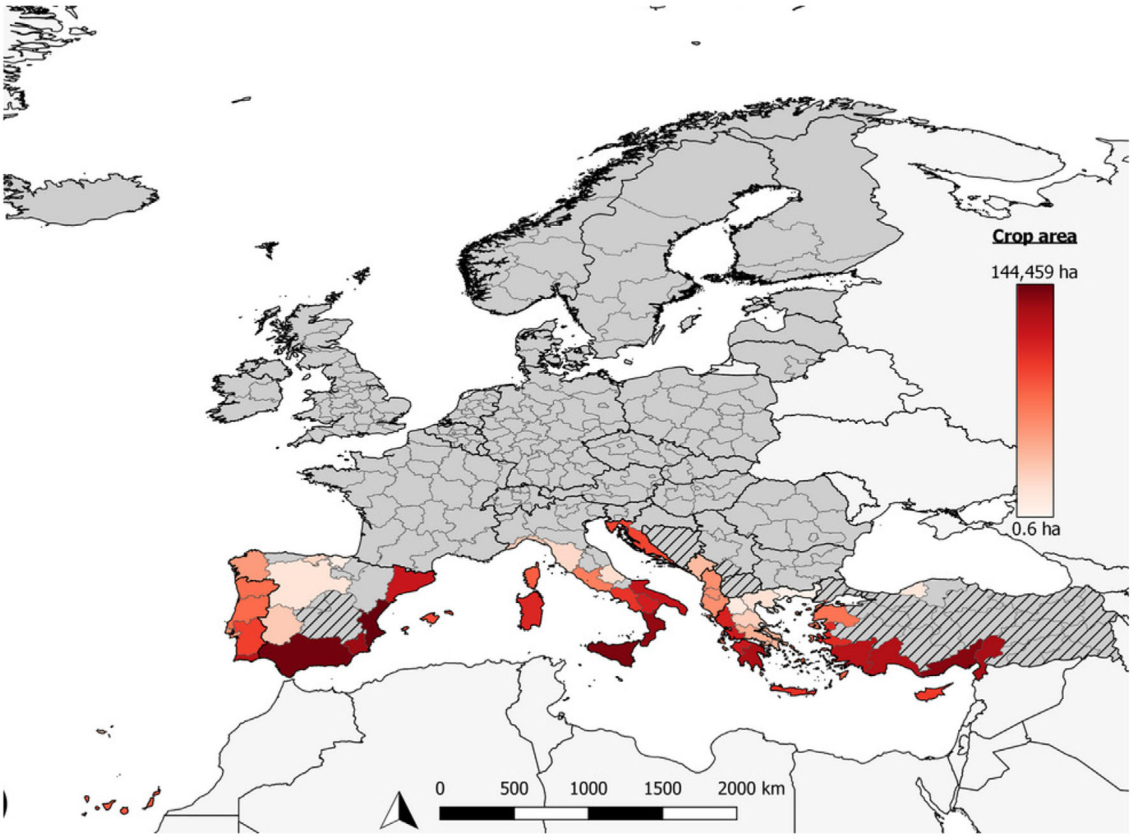

Figure 13: European citrus-growing areas based on data of crop area at NUTS 2 level (from EFSA PLH Panel et al., 2019). Areas with lines indicate areas with no data. Areas in light grey are neighbouring countries not included in the analysis.

4.2. Climate suitability

4.2.1. Climate suitability methodology

The number of confirmed *C. sagittiferella* presence locations is rather restricted. Therefore, the use of comprehensive modelling approaches such as species distribution models and niche models is not recommended here. Since the transferability in space and time of the above-mentioned models is often limited, their implementation could lead to unreliable projections in large parts of the risk assessment area.

4.2.2. Köppen–Geiger climate comparison

Building on the *C. sagittiferella* pest categorisation (EFSA PLH Panel, 2021a), a more refined Köppen–Geiger climate comparison was performed in this PRA. For this updated analysis, additional literature was evaluated and 31 pest report locations with coordinates were used. All these pest report locations with coordinates are in tropical climates not present in the EU. More details are available in the Zenodo report (Rossi and Maiorano, 2023). The available data suggest that the Cfb climate type (prevalent in central Europe) would be suitable to the establishment of *C. sagittiferella*. However, the areas in the EU with this climate type lack the presence of citrus, with the exception of Northern Spain (EFSA PLH Panel, 2021a) where citrus are present mostly as backyard/ornamental trees. Moreover, there is uncertainty about the suitability of the Cfb climate type for establishment of *C. sagittiferella*. This climate type was considered in the Köppen–Geiger climate comparison because it is present in a small area of the (i) Sabah province in Malaysia, and (ii) the Jawa Tengah province in Indonesia, where *C. sagittiferella* was reported. However, no report of pest presence was found in the specific area with Cfb climate type. It is also unclear whether citrus plants are present in that area.

Irrigation has been pointed out as a climate-modifying factor that may favour the establishment of some pests (Akrivou et al., 2021). Practically all the commercial citrus orchards existing in the EU are irrigated nowadays (Carr, 2012). Therefore, the Panel explored the possible effect of irrigation on the climate classification in the risk assessment area. Average monthly irrigation volumes for citrus in central-eastern Spain (Luís Bonet, pers. comm., September 2022) were added to the average monthly precipitation values used in the Köppen–Geiger climate classification. The results showed that a large proportion of citrus-growing areas in the EU with Mediterranean climate types (Csa and Csb) were classified as Cfa and Cfb when considering irrigation. Nevertheless, as indicated above, there is high uncertainty about the suitability of the Cfb climate type for establishment of *C. sagittiferella*. There are no reported occurrences of the pest in areas with Cfa climates, so the risk of establishment does not appear to be modified by including irrigation in the analysis.

4.2.3. Conclusions on climate suitability

Considering the little information on *C. sagittiferella* distribution and its thermal biology, the evaluation of climatic suitability of this pest is not straightforward and an EKE approach is thus required.

4.2.4. Probability of establishment

The parameter probability of establishment (p_{estab}) in the citrus-growing area in the EU is defined in Table 15.

Table 15: Definition of the parameter probability of establishment (p_{estab})

Name	Definition	Sources
p_{estab}	Probability that one founder population (from a successful entry) will establish. Once transfer occurs, the probability of establishment is the same for all founder populations	Expert knowledge (see justification below)

The elicited distribution of the probability of establishment is reported in Table 16 and Figure 14.

Table 16: Probability of establishment (p_{estab}) for citrus fruit (both scenarios)

Quantile:	1%	25%	Median	75%	99%
p_{estab}	0	0.4	0.7	0.9	1

Justification:

For the 1% quantile, the value was set considering that *C. sagittiferella* is not currently present in areas with Cfb climate and that the entire EU territory is considered unsuitable for pest establishment based on the Köppen–Geiger comparison. For the 99% quantile, it was assumed that wherever citrus is present in the EU (Figure 13), the pest can establish. The median was set closer to the 99% value, as other citrus pests (e.g. *A. aurantii*, *P. citrella*, *D. citri*; see Section 4.1) occurring in the same area of distribution of *C. sagittiferella* were able to establish in the Mediterranean Basin. Some natural enemies could hamper establishment, but in most cases, founder populations would be able to reproduce and establish. Establishment might not be similarly probable in different *Citrus* species and cultivars, as there is uncertainty about their different susceptibility to *C. sagittiferella*. However, this factor is likely to affect more impact and spread, rather than establishment.

No thermal studies and specific temperature thresholds are available for *C. sagittiferella*, so it is difficult to build appropriate maps of accumulated degrees. Frost-free day map could be suitable, but there is no evidence showing that the pest can survive a certain number of frost days. Irrigation-based Köppen–Geiger maps were explored, but there is high uncertainty on the climate type where the pest is reported, so this approach did not reduce the uncertainty of the elicitation on the probability of establishment.

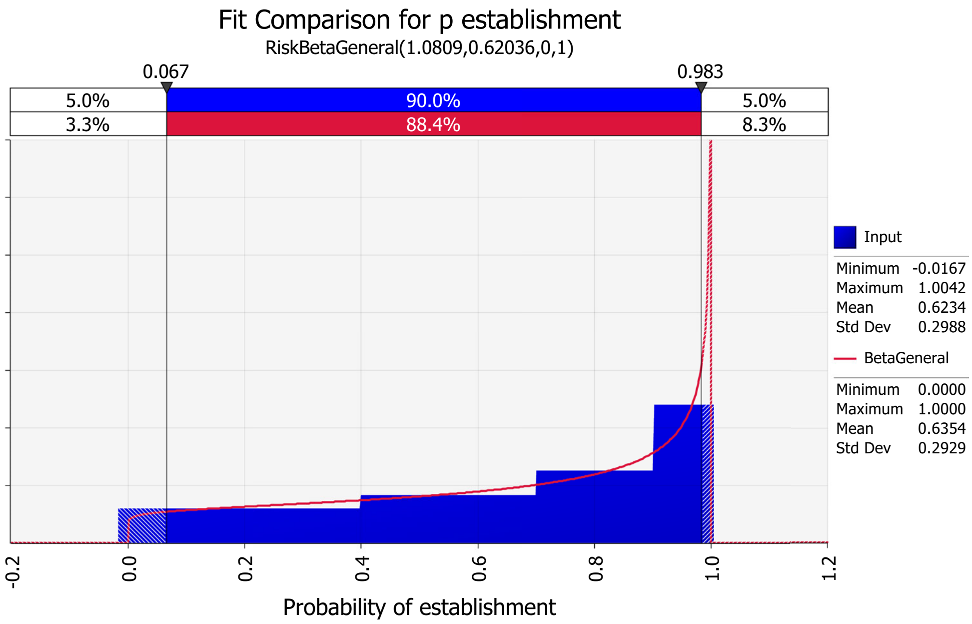

Figure 14: Fitted distribution for the probability of establishment (p_{estab}) for citrus fruit (both scenarios)

4.2.5. Number of established populations

The output variable (N_{est}) defined in Table 17 is obtained through the following equation:

$$N_{est} = N_{inf} \times p_{estab}.$$

Table 17: Definition of the output variable (N_{est})

Name	Definition	Units
N_{est}	Number of *C. sagittiferella* populations established in the EU	Number of established populations per year

Table 18 shows the outcome of the model calculations for N_{est} (number of established *C. sagittiferella* populations due to entries). The results are visualised in Figures 15 and 16.

According to the model results,

- Under scenario A0 (current practice), a median of about five established populations per year (90%-uncertainty range between about one established population every 400 years and about 800 established populations per year) is expected.
- Under scenario A2 (additional RROs) with cold treatment, a median of about one established population every 200 years (90%-uncertainty range between about one established populations every 5 million years and about 3 established populations every year) is expected.
- For both scenarios, the number of established populations is only slightly lower than the number of founder populations. In other words, establishment is not expected to be a major constraint for this pest.
- As is the case in the entry model, the risk of establishment is reduced under scenario A2 compared to scenario A0, but not eliminated, as cold treatment is not expected to be 100% effective.

Table 18: Outcome of the model calculation for the output variable N_{est} (the number of *Citripestis sagittiferella* established populations per year due to entries) under the considered scenarios A0 (current practice) and A2 (additional RROs), using 10,000 simulation runs

Scenario	Mean	St. dev.	1%	25%	Median	75%	99%
A0	1.4×10^3	4.1×10^4	1.7×10^{-5}	0.36	4.8	41	7,900
A2	9	324	5×10^{-10}	2×10^{-4}	5×10^{-3}	0.1	39

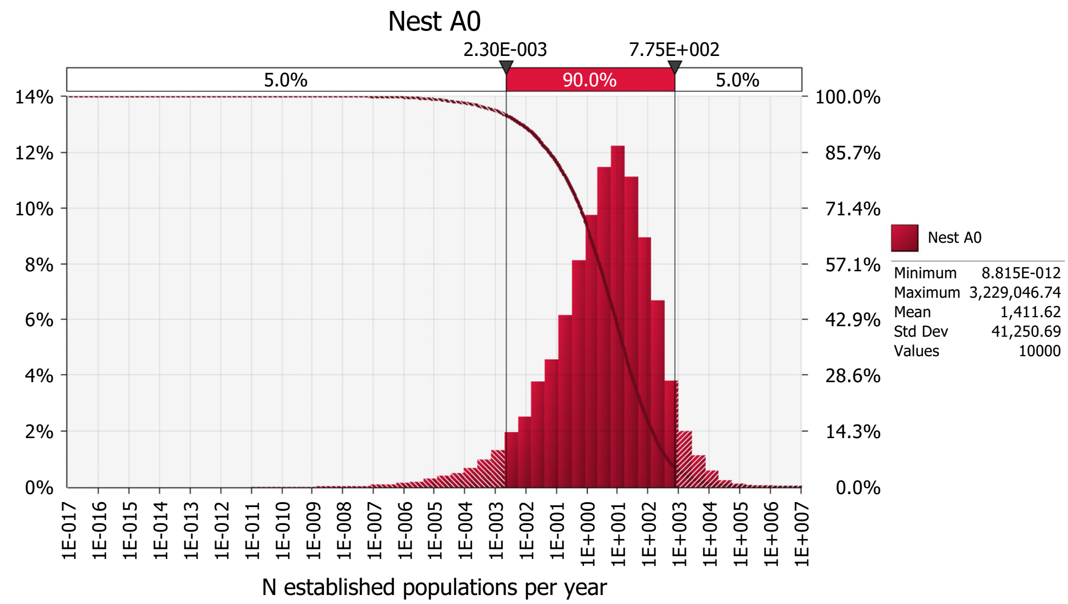

Figure 15: Outcome of the model simulations for scenario A0 (current practice) showing the relative frequency and cumulative descending probability; log-scale x-axis (same x-scale as in Figure 16). The number of established *Citripestis sagittiferella* populations per year is estimated between about 2 x 10^{-3} and 770 with a 90% probability

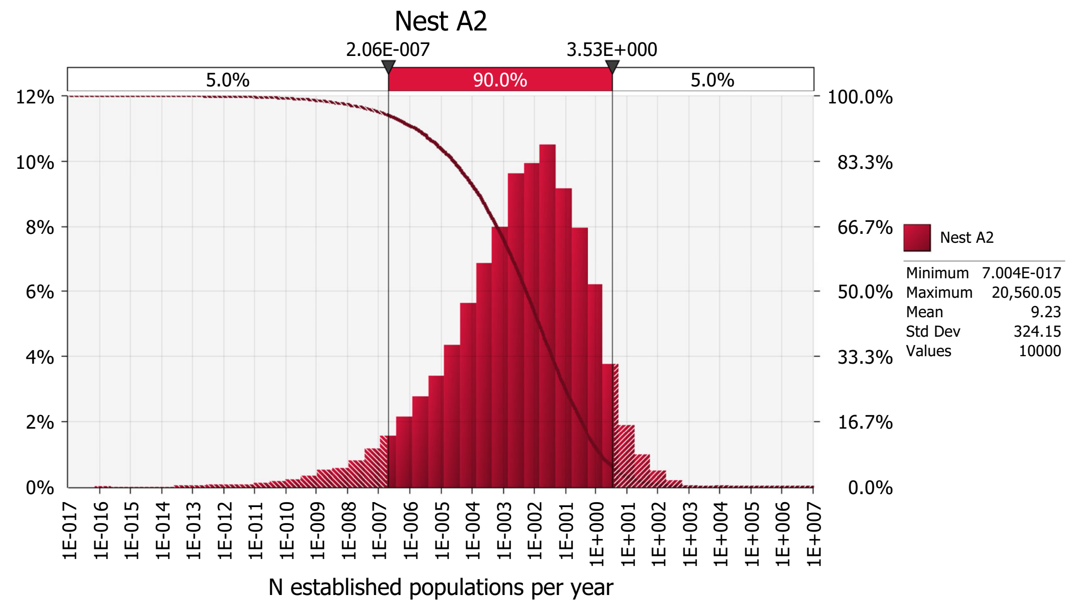

Figure 16: Outcome of the model simulations for scenario A2 (additional RROs) showing the relative frequency and cumulative descending probability; log-scale x-axis (same x-scale as in Figure 15). The number of established *Citripestis sagittiferella* populations per year is between about 2 x 10^{-7} and 3.5 with a 90% probability

4.3. Sensitivity analysis of the number of established populations

Based on the sensitivity analysis (Figures 17 and 18), the output variable N_{est} is mainly correlated with the probability of transfer, the disaggregation factor and sorting. For scenario A2, N_{est}. is also strongly correlated with the effectiveness of the RROs. In both scenarios, the probability of establishment is weakly correlated with the output variable N_{est}.

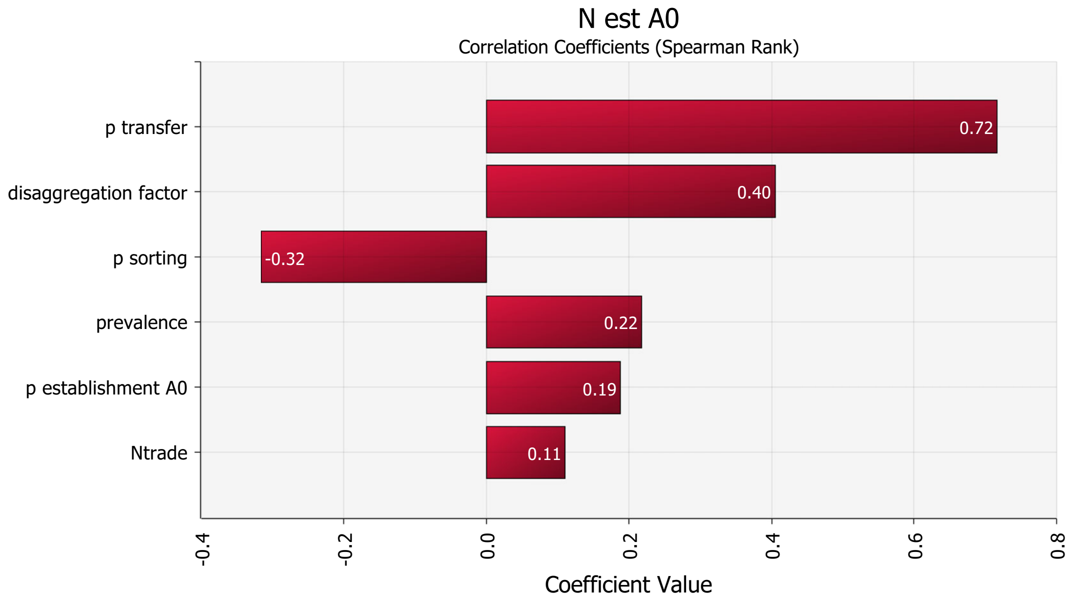

Figure 17: Correlation with the output variable (N_{est}) of the model parameters for scenario A0 (current practice)

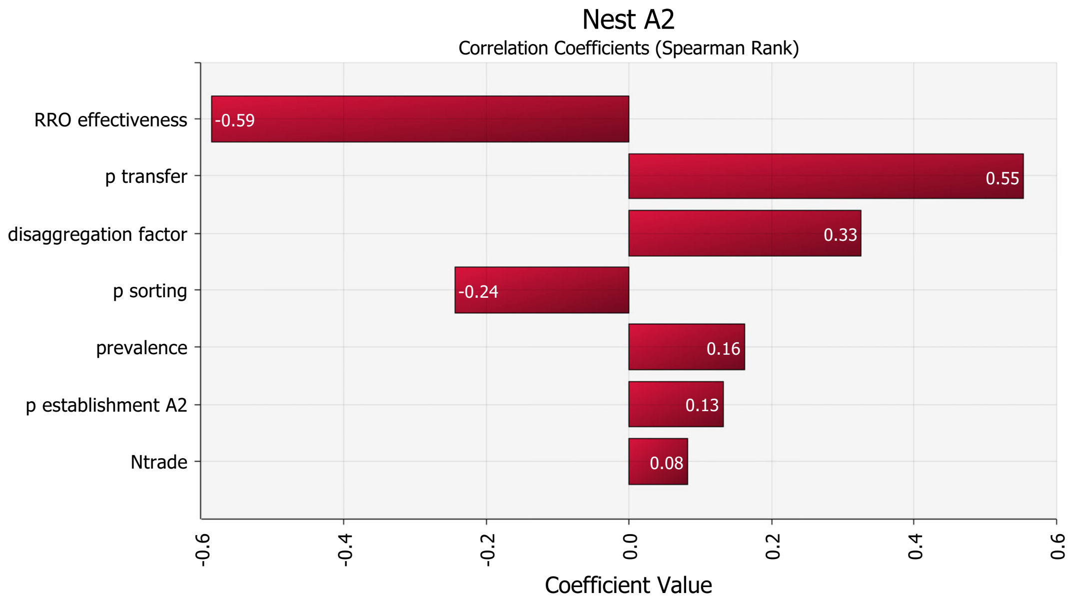

Figure 18: Correlation with the output variable (N_{est}) of the model parameters for scenario A2 (additional RROs)

4.4. Additional uncertainties

Unquantified uncertainties in the establishment assessment include:

- The role of irrigation in making the microclimate of citrus orchards more suitable for establishment
- The role of occasional frost in making the microclimate of citrus orchards less suitable for establishment

The Panel expects the conclusions of the assessment model not to be modified substantially by the additional uncertainties not quantified in this assessment.

4.5. Dependencies between parameters

There is a possible dependency between the probability of transfer and the probability of establishment, as locations more suitable to transfer might tend to be also more suitable to establishment.

However, the Panel expects the conclusions of the assessment model not to be modified substantially by this dependency between parameters.

4.6. Conclusions on establishment

Under scenario A0 (current practice), model simulations lead to a median of about five established populations per year (90%-uncertainty range between about one established population every 400 years and about 800 established populations per year).

Under scenario A2 (additional RROs) with a cold treatment, the median is reduced to about one established population every 200 years (90%-uncertainty range between about one established populations every five million years and about three established populations every year).

For both scenarios, the number of established populations is only slightly lower than the number of founder populations. Establishment is thus not expected to be a major limiting factor for this pest.

As is the case in the entry model, the risk of establishment is reduced under scenario A2 compared to scenario A0, but not eliminated, as cold treatment is not expected to be 100% effective.

The main uncertainties in the establishment assessment are the probability of transfer, the disaggregation factor, sorting and, for scenario A2, the effectiveness of the RROs. The probability of establishment is instead weakly correlated with the output variable N_{est}.

5. Spread

In the assessment of potential spread, the Panel assumed that the founder population of *C. sagittiferella* occupies a limited proportion of available habitat (citrus plants or orchards located in a restricted area) with a small local population size (i.e. a fraction of the habitat's carrying capacity), consistently with previous spread assessments (EFSA PLH Panel et al., 2022). Similarly, it is assumed that the initial increase in population size and the initial dispersal rate of *C. sagittiferella* are limited due to:

a) (epi)-genetic factors (lack of fitness of the species in a new environment),
b) suboptimal environmental conditions reducing the fitness of the pest.

During the lag period, spread is limited and haphazard (it can differ in different directions). At the end of this phase, the pest is expected to be better adapted to local conditions allowing it to survive, reproduce and infest enough plants to spread between orchards by natural means (flight). In the specific case of *C. sagittiferella*, an important role in the spread is likely to be played by the agricultural practices, in particular by harvesting and transport of citrus fruit to packinghouses (part of common agricultural practices, and thus considered in the estimations here).

5.1. Assessment of spread

The lag period between establishment and spread is defined as the time needed for a founder population to build up to a density enabling the colonisation of a neighbouring orchard. For *C. sagittiferella*, the median lag period is estimated to be slightly more than 1 year (90%-uncertainty interval between about 2 months and 33 months).

After the lag period, the median spread rate by natural means (flying) and due to transport of harvested citrus fruit from orchards to packinghouses (part of common agricultural practices) is estimated at about 100 km/yr (90%-uncertainty interval between about 40 and 500 km/year).

More details are provided in Appendix A.

5.2. Uncertainties

The main uncertainties affecting the assessment of the lag period include:

- The extent to which natural enemies (other arthropods, entomopathogens, birds, etc.) could hamper the build-up of the population, as adaptation to a new host can take time.
- Climatic conditions disrupting or delaying establishment in new areas.

- Unknown effect of pesticide applications in the orchard – these would decrease the speed of population build-up.
- Unknown differences in susceptibility of different *Citrus* species and cultivars.

The main uncertainties affecting the assessment of the spread rate include:

- The pest is spreading in Vietnam, but quantitative data about the spread rate in that country are lacking.
- Whether gaps in the distribution of citrus orchards in the landscape would affect the natural spread of the pest.
- The climate suitability of the initial spread focus.

5.3. Conclusions

The median lag period between establishment and spread, defined as the time needed for a founder population to build up to a density enabling the colonisation of a neighbouring orchard, is estimated for *C. sagittiferella* to be slightly more than 1 year (90%-uncertainty interval between about 2 months and 33 months).

After the lag period, the median spread rate by natural means (flying) and due to transport of harvested citrus fruit from orchards to packinghouses (part of common agricultural practices) is estimated at about 100 km/yr (90%-uncertainty interval between about 40 and 500 km/year).

6. Impact

Eggs of *C. sagittiferella* are deposited on fruit, scattered or in clusters of 2–16 eggs. The rate of egg hatching is estimated to be above 87% and larval development time is of about 12–17.5 days. Newly hatched larvae bore into the fruit rind and then burrow into fruit albedo and consume the interior of the fruit. Entrance holes are about 2–3 mm in width and, upon larval feeding, large amounts of drying sap and excrements can be visually detected from these holes. Larvae damage the fruit from 2 weeks old to harvest and 5.2 larvae can be found per fruit on average (Bali, Indonesia; Rahayu et al., 2018).

The pest is considered as destructive – when left uncontrolled, it can cause major fruit losses and accelerate spoilage through secondary fungal/bacterial pathogens. There is no economic impact assessment available, but the pest is oligophagous and has impacts on various species of the genus *Citrus*, including pomelo (*C. maxima*), King mandarin (*C. reticulata*) and lemon (*C. limon*) in Vietnam, *C. amblycarpa* in Tarakan, Indonesia, and *C. nobilis* in Sumatra, Indonesia. There are limited data on cultivar/species susceptibility.

6.1. Assessment of impact

Estimation of yield losses is performed in terms of the proportion of infested fruits among total fruits produced within the EU citrus-growing regions. Infested fruit may not be harvested, so the total produced fruits in the estimation include also the potentially harvestable fruit that are not harvested due to pest infestation. The estimation is done for citrus in general, without differentiating between *Citrus* species or production for fresh consumption and juice.

RROs already in place are taken into account and also possible additional RROs for this pest (e.g. those applied in the countries of origin that could be applied in the EU).

The elicited median impact of *C. sagittiferella* in the EU citrus-growing area (proportion of infested citrus fruit among the harvested citrus fruit) is estimated at about 10% (90%-uncertainty range between about 2% and 25%).

More details are provided in Appendix A.

6.2. Uncertainties

Uncertainties affecting the impact assessment include:

- the susceptibility of different *Citrus* species and cultivars.
- differences in potential yield loss between fresh fruit and juice production.
- the effect of the citrus fruit harvesting season in the EU (mainly winter, which is most probably the less suitable season for the pest).

Most factors affecting the impact assessment are fraught with uncertainty. Further uncertainties are listed in Appendix A.

6.3. Conclusions on impact

The median impact of *C. sagittiferella* in the EU citrus-growing area (proportion of infested citrus fruit out of the harvested citrus fruit) is estimated at about 10% (90%-uncertainty interval between about 2% and 25%).

7. Conclusions of the PRA

In a study of new pests likely to be introduced into Europe with the fruit trade, *C. sagittiferella* was assessed as a pest with high economic importance, more likely to transfer and emerging/spreading (Suffert et al., 2018). This PRA confirms the potential for entry, establishment, spread and impact of the pest.

Based on the outputs of the entry model obtained in scenario A0, the median number of founder populations in the EU citrus-growing area is estimated to be slightly less than 10 per year, with an uncertainty spanning several orders of magnitude (90%-uncertainty interval between about one entry per 180 years and 1,300 founder populations per year).

The risk of entry and the simulated numbers of founder populations are orders of magnitude lower for scenario A2 with post-harvest cold treatment compared to scenario A0, but the uncertainty is larger for scenario A2 compared to scenario A0 (median estimated at about one founder population per 100 years; 90%-uncertainty interval between one founder population per about two million years and about six founder populations per year).

The main uncertainties in the entry assessment are the probability of transfer, the RRO effectiveness (for scenario A2), the disaggregation factor and sorting.

When including the probability of establishment, model simulations lead to a median of about five established populations per year under current practice (90%-uncertainty interval between about one established population every 400 years and 800 established populations per year).

Adding post-harvest cold treatment (scenario A2), the median number of established population is reduced to about one established population every 200 years (90%-uncertainty interval between about one established populations every five million years and about three established populations every year).

For both scenarios, the number of established populations is only slightly lower than the number of founder populations, revealing that establishment is not expected to be a major limiting factor for this pest.

As already noted for the entry risk, the risk of establishment is reduced under scenario A2 compared to scenario A0, but not eliminated, as post-harvest cold treatment is not expected to be 100% effective.

The main sources of uncertainty in the establishment assessment are the probability of transfer, the disaggregation factor, sorting and, for scenario A2, the effectiveness of the RROs. The probability of establishment is instead weakly correlated with the output variable.

The median lag period between establishment and spread, expressed as the time needed for a founder population to build up to a density enabling the colonisation of a neighbouring orchard, is estimated to be slightly more than 1 year (90%-uncertainty interval between about 2 months and 33 months).

After the lag period, the median spread rate by natural means (flying) and due to transport of harvested citrus fruit from orchards to packinghouses (part of common agricultural practices) is estimated at about 100 km/yr (90%-uncertainty interval between about 40 and 500 km/yr).

The main uncertainties affecting the assessment of the lag period include the extent to which natural enemies, differences in susceptibility of *Citrus* species and cultivars, and other environmental factors could hamper the build-up of the population.

The main uncertainties affecting the assessment of the spread rate include the lack of data at the origin and the climate suitability of the initial spread focus.

The median impact of *C. sagittiferella* in the EU citrus-growing area is estimated at about 10% of infested fruits among the harvested citrus fruits (90%-uncertainty interval between about 2% and 25%).

Uncertainties affecting the impact assessment include the susceptibility of different *Citrus* species and cultivars.

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Abbreviations

A0	Scenario reflecting current requirements
A1	Scenario reflecting deregulation (not considered in this assessment)
A2	Scenario with risk reduction options
EPPO	European and Mediterranean Plant Protection Organisation
FAO	Food and Agriculture Organisation of the United Nations
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
MS	Member State
N_{est}	Number of established populations
N_{inf}	Number of founder populations
N_{trade}	Trade flow
pers. comm.	Personal communication
$P_{prevalence}$	Prevalence at the origin
$p_{sorting}$	Sorting
$p_{transfer}$	Probability of transfer
PLH	Plant Health
RRO	Risk reduction option
ToR	Terms of Reference

Appendix A – Overview of the evaluation of spread and impact

SPREAD

Overview of the results of the Expert Knowledge Elicitation (1st EKE question)															
Parameter	**Duration of the lag period (months)**														
Stratification	Citrus-growing area in the EU (see Figure 13)														
Question	How long is the average duration of the lag period, i.e. the time from the first infested plant(s) present in a citrus orchard to the spread between orchards by natural means, e.g. by flight of the pest? [months]														
Results	P1%	P5%	P10%	P15%	P20%	P25%	P35%	P50%	P65%	P75%	P80%	P85%	P90%	P95%	P99%
Elicited values	1					7		12		22					36
EKE results	0.48	1.73	3.0	4.3	5.4	6.6	9.0	12.9	17.3	20.9	23.1	25.5	28.6	32.9	39.9
Fitted distribution	BetaGeneral (1.2897, 3.1301, 0, 49.785)														

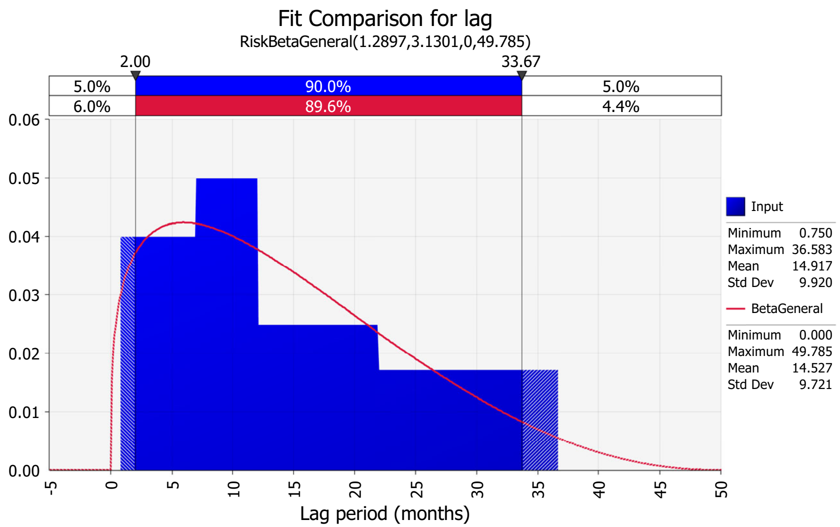

Figure (A.1a): Comparison of elicited and fitted values/density function to describe the remaining uncertainties of the parameter

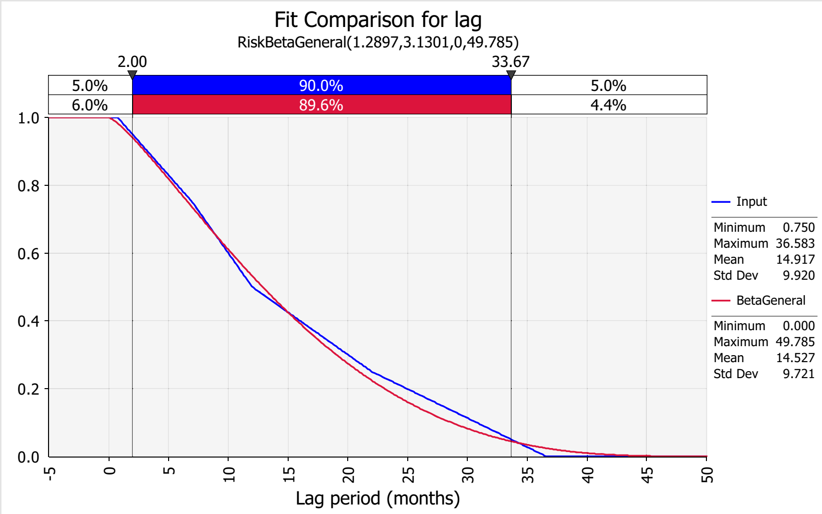

Figure (A.1b): Cumulative distribution function (CDF) of the likelihood of the parameter

Table A.1: Lag period

Summary of the evidence used for the evaluation	
The experts considered several factors influencing the presence and the length of a lag period, in particular • Size of the founder population • Size of the orchard • Generation time needed for descendants to be able to spread • As the population has established, temperature would be suitable for establishment, but it could still be more or less suitable for the spread to begin (e.g. due to presence of fruit) • Timing of the process start (winter arrival would delay the process, whereas summer arrival would proceed immediately)	
Main uncertainties	
• The extent to which natural enemies (other insects, entomopathogens, birds, etc.) could hamper the build-up of the population as adaptation to a new pest can take time • Climatic conditions could disrupt or delay the development but no data are available • Unknown effect of pesticide applications in the orchard would decrease the speed of population build-up • Unknown differences in susceptibility of *Citrus* spp. and cultivars	
Reasoning for a scenario which would lead to a reasonable high duration	The judgement on the upper limit considers that • Several generations are needed to produce a population able to spread beyond the limits of the orchard • Colonisation of the initial focus, particularly for large citrus orchards, could take several years
Reasoning for a scenario which would lead to a reasonable low duration	The judgement on the lower limit considers that • If a lot of individuals arrive, they could spread immediately, i.e. in a matter of weeks • This is the case particularly for small orchards
Fair estimate as judgement on the weighted evidence	The judgement on the median considers that • The most frequent situation would be a few individuals, which have to reproduce before spreading, which will take one season (= year)
Precision of the judgement as description of remaining uncertainties	The judgement on the interquartile range considers that • After 1 year, a suitable season is likely to have occurred • Lack of knowledge of susceptibility of different *Citrus* species and cultivars • It could take time for the pest to adapt to the EU conditions and *Citrus* species and cultivars

Overview of the results of the Expert Knowledge Elicitation (2nd EKE question)															
Parameter	Spread rate after the lag period (km/year)														
Stratification	Citrus-growing area in the EU (see Figure 12)														
Question	Assuming that human-assisted spread between citrus orchards is excluded by perfect sanitary measures or prohibited exchange of tools, but taking into account the possible movement of harvested citrus fruit from orchards to packinghouses (as this is part of common agricultural practices), what is the 95th percentile of the distance newly infested orchards have to the nearest existing one already infested 1 year before? [km/year]														
Results	P1%	P5%	P10%	P15%	P20%	P25%	P35%	P50%	P65%	P75%	P80%	P85%	P90%	P95%	P99%
Elicited values	1					70		100		200					1,000
EKE results	26.7	37.4	45.7	52.9	59.6	66.4	73.4	107.2	146.3	189	221	267	345	520	1,268
Fitted distribution	Pearson5 (1.9505, 174.66)														

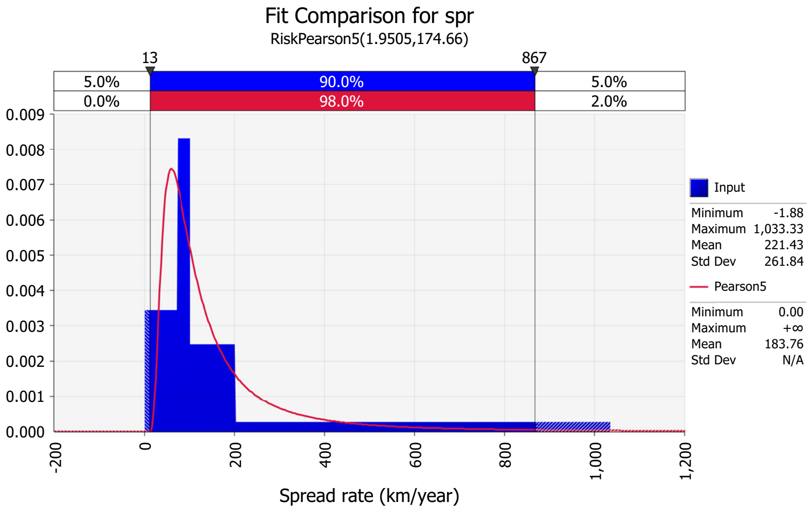

Figure (A.2a): Comparison of elicited and fitted values/density function to describe the remaining uncertainties of the parameter

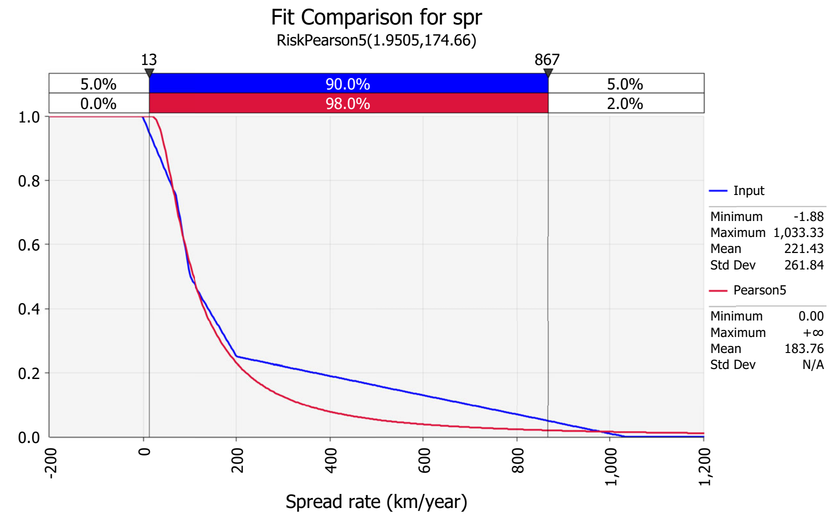

Figure (A.2b): Cumulative distribution function (CDF) of the likelihood of the parameter

Table A.2: Spread rate after lag period

Summary of the evidence used for the evaluation	
The experts considered several factors influencing the rate of spread, in particular • *C. sagittiferella* is a strong flier • Spread rates of other citrus pests (e.g. *Thaumatotibia leucotreta*) • The values in the literature for other citrus pests (e.g. *P. citrella*) may not be due only to natural spread. • It takes years only for wingless mites. If citrus pests can fly, then it is normally a fast process. • *C. sagittiferella* is a pest of fruits, not of plants. Fruit movement is part of common agricultural practices, so it is considered here. • Australia fears a natural entry over the strait of Torres, as the pest is a good flyer (Anonymous, 2015) • Continuity of citrus orchards in the landscape	
Main uncertainties • *C. sagittiferella* is spreading in Vietnam, where it has recently become a pest, but quantitative data of the spread there are lacking. • Whether gaps in the distribution of citrus orchards in the landscape would affect the natural spread of the pest • Climate suitability of initial spread focus	
Reasoning for a scenario which would lead to a reasonable high duration	The judgement on the upper limit considers that • Considering fruit movement, the spread rate would be increased by jumps between far-away locations • A jump from e.g. Huelva to Valencia provinces (Spain) due to movement of fruit boxes before processing at packinghouse would not be surprising in 1 year • Even after processing at the packinghouse, there could still be viable eggs and larvae in the traded fruit
Reasoning for a scenario which would lead to a reasonable low duration	The judgement on the lower limit considers that • In 1 year, there can be several generations, each would fly at least 3 km (*C. sagittiferella* is a strong flyer) • However, in case of an isolated citrus orchard, or under protected cultivation, then the pest would not spread and the outbreak could remain localised
Fair estimate as judgement on the weighted evidence	The judgement on the median considers that • If the judgement was just on natural spread, then about 30 km would be a suitable median • But here we consider fruit movement, so hundreds of km is realistic • To reduce transport costs, harvested fruit mostly goes to the nearest packinghouses
Precision of the judgement as description of remaining uncertainties	The judgement on the interquartile range considers that • A peak around 100 km is likely because the pest is a strong flyer, several generations are possible per year, and fruit movement is an efficient means of spread, but most of the times not over extremely long distances • Juice processing facilities are not so many, thus extending the possible spread rate, but even in that case distance travelled by the harvested fruit will be kept as low as possible for cost reasons. Juice is anyway a side-product, at least in Spain, where production is oriented towards fresh consumption

IMPACT

Overview of the results of the Expert Knowledge Elicitation (3rd EKE question)															
Parameter	**Incidence in citrus fruit (proportion)**														
Stratification	Citrus-growing area in the EU (see Figure 12)														
Question	What is the proportion of infested fruits out of harvested fruits within the EU citrus production regions (i) once the pest has spread to the entire citrus-growing area in the EU, (ii) for citrus in general, without differentiating between *Citrus* species of production for fresh consumption and juice and (iii) taking into account RROs already in place as well as possible additional RROs for this pest (e.g. those applied in the countries of origin that could be applied in the EU)?														
Results	P1%	P5%	P10%	P15%	P20%	P25%	P35%	P50%	P65%	P75%	P80%	P85%	P90%	P95%	P99%
Elicited values	0					0.05		0.10		0.15					0.25
EKE results	0.001	0.019	0.029	0.038	0.046	0.054	0.069	0.094	0.124	0.149	0.165	0.185	0.211	0.252	0.336
Fitted distribution															

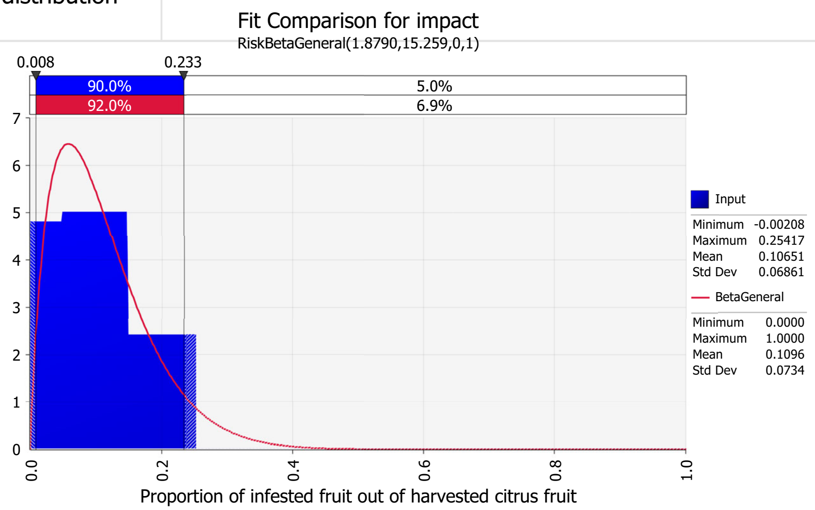

Figure (A.2a): Comparison of elicited and fitted values/density function to describe the remaining uncertainties of the parameter

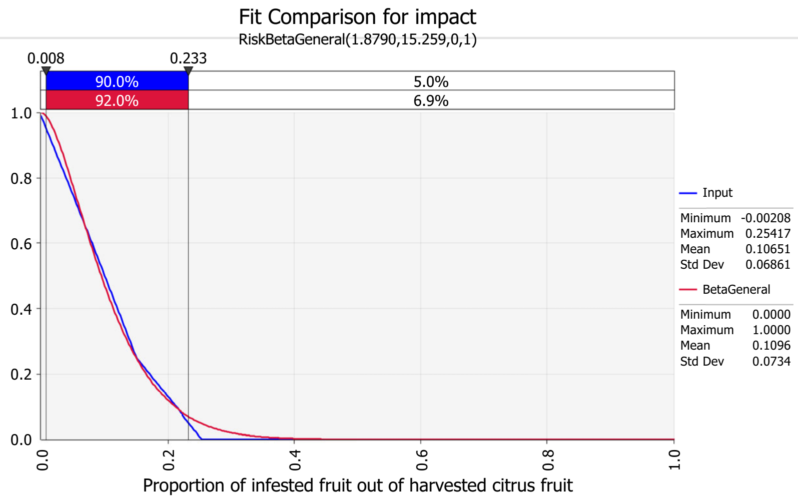

Figure (A.2b): Cumulative distribution function (CDF) of the likelihood of the parameter

Table A.3: Yield loss

Summary of the evidence used for the evaluation	
The experts considered several factors influencing the yield loss, in particular • Susceptibility of different *Citrus* species and cultivars • Environmental conditions (e.g. presence of frost, low relative humidity) • Control measures applied against other pests • Natural enemies (generalists) already present in the EU • Number of generations (voltinism may be lower than at the origin) • Number of larvae per fruit (it may be lower than at the origin)	
Main uncertainties • A potential mismatch between host phenology and pest development (although citrus fruit is available most of the year also in the EU) • Susceptibility of different *Citrus* species and cultivars • Differences in crop value between fresh fruit and juice production • Effect of the harvesting season in the EU (mainly winter, which is likely the less suitable season for the pest)	
Reasoning for a scenario which would lead to a reasonable high duration	The judgement on the upper limit considers that • Considering the limitations listed above (e.g. unfavourable environment, natural enemies, host susceptibility)
Reasoning for a scenario which would lead to a reasonable low duration	The judgement on the lower limit considers that • If conditions are unsuitable for the pest, yield loss would be zero or close to zero
Fair estimate as judgement on the weighted evidence	The judgement on the median considers that • The skew towards the left of the distribution reflects the elicited distribution for the prevalence at the origin (see Section 3.2.2.1)
Precision of the judgement as description of remaining uncertainties	The judgement on the interquartile range considers that • The microclimatic conditions will not be similarly suitable for the pest in all citrus orchards • One single larva in the fruit makes the fruit unsuitable for both juice and fresh fruit marketing • The values elicited for the prevalence at the origin were halved