**EUROPEAN AND MEDITERRANEAN PLANT PROTECTION ORGANIZATION**
**ORGANISATION EUROPEENNE ET MEDITERRANEENNE POUR LA PROTECTION DES PLANTES**

20-25492

# Pest Risk Analysis for

# *Naupactus xanthographus* (Coleoptera: Curculionidae), South American fruit tree weevil

Image: Adult *Naupactus xanthographus* (R. Ripa Schaul)

September 2020

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The risk assessment follows EPPO standard PM 5/5(1) *Decision-Support Scheme for an Express Pest Risk Analysis* (available at http://archives.eppo.int/EPPOStandards/pra.htm), as recommended by the Panel on Phytosanitary Measures. Pest risk management (detailed in Annex 1) was conducted according to the EPPO Decision-support scheme for quarantine pests PM 5/3(5). The risk assessment uses the terminology defined in ISPM 5 *Glossary of Phytosanitary Terms* (available at https://www.ippc.int/index.php).

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**Based on this PRA, *Naupactus xanthographus* was added to the EPPO A1 List of pests recommended for regulation as quarantine pests in 2020. Measures for host plants for planting and host fruits are recommended.**

# Pest risk analysis for *Naupactus xanthographus* (Coleoptera: Curculionidae), South American fruit tree weevil

**PRA area:** EPPO region
**Prepared by:** Expert Working Group (EWG) on *Naupactus xanthographus*
**Date:** 26-29 March 2019. Further reviewed and amended by EPPO core members and Panel on Phytosanitary Measures (see below)

**Composition of the Expert Working Group (EWG)**


| | |
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The first draft of the PRA was prepared by the EPPO Secretariat.

Ratings of likelihoods and levels of uncertainties were made during the meeting. These ratings are based on evidence provided in the PRA and on discussions in the group. Each EWG member provided a rating and a level of uncertainty anonymously and proposals were then discussed together in order to reach a final decision.

Following the EWG, the PRA was further reviewed by the following core members: Björkdund N, Boberg J, Guitian Castrillon J M M (with the help of Fernández Gallego M M), Hannunen S and MacLeod A.

The PRA, in particular the section on risk management, was reviewed and amended by the EPPO Panel on Phytosanitary Measures on 2019-10-22/24 and 2020-03-24/26. The EPPO Working Party on Phytosanitary Regulations and Council agreed that *Naupactus xanthographus* should be added to the A1 List of pests recommended for regulation as quarantine pests in 2020.

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| **Summary of the Pest Risk Analysis for *Naupactus xanthographus* (Coleoptera: Curculionidae)** | | | |
|---|---|---|---|
| **PRA area:** EPPO region (Albania, Algeria, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Guernsey, Hungary, Ireland, Israel, Italy, Jersey, Jordan, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Luxembourg, the Republic of North Macedonia, Malta, Moldova, Montenegro, Morocco, Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tunisia, Turkey, Ukraine, United Kingdom, Uzbekistan) | | | |
| **Describe the endangered area:**<br>*Naupactus xanthographus* has the potential to establish in the warmer areas of the EPPO region, in particular the Mediterranean region. This mainly concerns host plants grown on a commercial basis in particular *Vitis vinifera* (grapevine), *Prunus persica* (peach) and *Prunus persica* var. *nucipersica*, (nectarine) and for other host plants there would be impact on export of fruit such as for *Citrus* spp. (*Citrus sinensis* and *Citrus limon*), *Actinidia deliciosa*, *Malus* spp., *Pyrus* spp., *Vaccinium*, and *Persea americana*.<br><br>There is an uncertainty on potential impact on hosts in other parts of the EPPO region, but even in the case of transient populations, there may be impact on exports due to *N. xanthographus* being a quarantine pest in some export destinations. | | | |
| **Main conclusions**<br>*Naupactus xanthographus* has had a high economic impact in Chile where the pest has been introduced. It is very polyphagous pest, with a number of fruit trees and bushes (including berries), and herbaceous hosts such as alfalfa. In Chile it is a major pest on grapevine, peach and nectarine.<br><br>The risk of *N. xanthographus* was assessed without the current specific phytosanitary requirements that are in place in (some) EPPO member states and reduces the risk of the pest (e.g. the EU import prohibition for several host plants and the EU-requirements for growing medium attached to plants were not taken into account). Import of fruit and its packaging material and plants for planting of host plants were considered major (potential) pathways and it was assumed that fruits and plants for planting are being imported from infested areas.<br><br>Different life stages of *N. xanthographus* are associated with different pathways. Adult weevils are the most likely stage to be associated with host fruit. The likelihood of entry on grapes and packaging material of grapes is considered to be moderate with high uncertainty, whereas the risk of other fruits and their packaging material is moderate to low with high uncertainty. The probability of entry on host plants for planting (except seeds, tissue culture, pollen) is higher with growing media attached due to the potential of larvae being associated with the roots: plants with growing media: high with moderate uncertainty; bare rooted plants: moderate with high uncertainty; rooted cuttings in small plugs: very low with moderate uncertainty; unrooted cutting: very low with low uncertainty.<br><br>When considering plants for planting with growing medium, the likelihood of establishment outdoors in the PRA area is high with low uncertainty and the likelihood of establishment in protected conditions is high with moderate uncertainty. The magnitude of spread within the EPPO region is moderate with moderate uncertainty.<br><br>Phytosanitary measures to reduce the probability of entry: Risk management options are considered for host fruit and plants for planting (except seeds, tissue culture, pollen) with or without growing media.<br><br>Overall the EWG considered the phytosanitary risk to the endangered area to be moderate with a moderate uncertainty. However, there was a minority opinion within the EWG that the phytosanitary risk to the endangered area is high with a moderate uncertainty. | | | |
| **Phytosanitary risk for the *endangered area*** *(Individual ratings for likelihood of entry and establishment, and for magnitude of spread and impact are provided in the document)* | High ☐ | Moderate X | Low ☐ |
| **Level of uncertainty of assessment**<br>*(see Section 17 for the justification of the rating. Individual ratings of uncertainty of entry, establishment, spread and impact are provided in the document)* | High ☐ | Moderate X | Low ☐ |
| ***Other recommendations:*** The EWG made recommendations (detailed in section 18) relating to the need for the development of control methods including studies on existing natural enemies in the EPPO region and the need for research into the viability/fertility of all life stages after transport on different commodities. The EWG also noted that early detection, contingency planning and awareness material would be essential to allow for eradication. | | | |

## Stage 1. Initiation

**Reason for performing the PRA:** *Naupactus xanthographus* (Coleoptera: Curculionidae) is a South American fruit tree weevil which is native in the area east of the Andes and has been introduced into Chile. It has been reported to cause economic damage on grapevine and fruit trees in South America with more damage reported from the area where it has been introduced. The pest is absent from the EPPO region, where several of its cultivated hosts are extensively grown for fruit production: grapevine (*Vitis vinifera*), and fruit trees such as apple (*Malus domestica*), stone fruit (*Prunus* spp.), lemon and orange (*Citrus lemon, C. sinensis)* and pear (*Pyrus communis*). Although no introduction is reported outside of South America, *N. xanthographus* has been intercepted in international trade of fruit from Chile, Argentina and Uruguay to various countries.

*N. xanthographus* was identified as a potential risk for fruit import in the DROPSA[1] EU project (Wistermann *et al.,* 2016, Suffert et al., 2018) *N. xanthographus* was added to the EPPO Alert List in 2018. In March 2018, the EPPO Panel on Phytosanitary Measures suggested *N. xanthographus* as one of the possible priorities for PRA in 2018 and following the Working Party on Phytosanitary Regulation selected the species for PRA in June 2018.

The EPPO standard PM 5/5 *Decision-Support Scheme for an Express Pest Risk Analysis* (EPPO, 2012) was used, as recommended by the Panel on Phytosanitary Measures. Pest risk management (detailed in Annex 1) was conducted according to the EPPO Decision-support scheme for quarantine pests PM 5/3(5).

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

[1] Strategies to develop effective, innovative and practical approaches to protect major European fruit crops from pests and pathogens

## Stage 2. Pest risk assessment

### 1. Taxonomy

**Taxonomic classification.** Domain: Eukaryota; Kingdom: Metazoa; Phylum: Arthropoda; Class: Insecta; Order: Coleoptera; Family: Curculionidae; Tribe: Naupactini; Genus: *Naupactus*; Species: *Naupactus xanthographus* (Germar)

*Naupactus* (Dejean 1821) is a neotropical genus of broad-nosed weevils containing approximately 200 species distributed from southern Mexico to Argentina (del Río & Lanteri, 2019). *N. xanthographus* was first described by Germar in 1824, who previously classified the species as *Leptocerus xanthographus* (Elgueta & Marvaldi, 2006). Recently, Lanteri & del Río (2017) undertook a taxonomic revision of *N. xanthographus* and the putative related species *N. navicularis, N. dissimilis, N. mimicus, N. dissimulator* and *N. marvaldiae*.

**Synonyms.** *Leptocerus xanthographus* Germar, 1824. *Pantomorus xanthographus* Duran 1944

**EPPO Code:** NAUPXA

**English common names:** South American fruit tree weevil (EPPO, 2018), grape fruit weevil (Lanteri & del Río, 2017), grape snout beetle (Lanteri & del Río, 2017), grape weevil (Vera *et al*. 2016).

**Spanish common name**: mulita (CABI, 2006), mulita de la vid, burrito o mulita de los frutales de carozo y de la vid, gorgojo grande (in Argentina: Sinavimo, 2019); burrito de los frutales (local Chilean common name- Ripa, 1992).

### 2. Pest overview

#### 2.1 Morphology

- Eggs are oval (ellipsoidal and bluntly rounded at the ends) and yellow and between 1 to 1.2 mm in length) (Luppichini *et al.*, 2013). Eggs are often arranged in clusters of 25-45 eggs where they adhere to each other with a sticky residue (sticky at egg laying).
- Larvae are legless, white in colour with brown head capsule and mandibles. First instar larvae measure approximately. 1.5 mm and mature larvae can reach up to 20 mm before pupation in a cell made of soil. The last abdominal segment has four thin dark bands.
- Pupae are creamy white (or slightly yellowish) changing to brown before eclosion, they are 11 -22 mm in length (Loiácono & Diaz, 1992, citing others). However, 22 mm seemed to be rather long and this could be due to the elongation of the pupa at measurement; more normal maximum would be 15 mm (R. Ripa, Centro de Entomología Aplicada Ltda, Chile, pers. comm. 2019).
- Adults are brown or grey-brown with white or white/yellow stripes on pronotum and elytra. They can be dark brown when they are old. Adults show a high level of sexual dimorphism with female body length 12-16 mm and males being smaller 11-13 mm in length. Female rostrum is 1 – 1.5 x as long as wide at the apex. Males are also more slender than females with their rostrum being 1.25 x as long as wide (R. Ripa, pers. comm. 2019).

Details on morphology can be summarized as follows

Table 1: Morphological comparison of life stages of *Naupactus xanthographus*

| **Stage** | ***Colour/shape*** | **Size (length)** |
|---|---|---|
| Eggs | Yellow/oval | 1-1.2 mm in length |
| Larvae | White | 1.5 mm up to 20 mm at final stage |
| Pupae | Creamy white changing to brown | 11-22 mm |
| Adults | Brown or grey brown with white or white/yellow stripe on pronotum and elytra | Female: 12-16 mm<br>Male: 11-13 mm |

Additional pictures can be viewed in EPPO Global Database (https://gd.eppo.int/taxon/NAUPXA/photos).

**2.2 Life cycle**

*Naupactus xanthographus* reproduces sexually and the females lay eggs in clusters in the upper parts of the plants (normally in protected areas such as crevices, e.g. within cracks of bark) (Luppichini *et al.*, 2013). Egg clusters are not so easy to see. Females always look for crevices (adjoining surfaces) to lay eggs. On grapevine, eggs are usually laid on the upper part of the trunk or on branches in plant parts protected from the sun. Egg-laying in the field is mostly known from woody plants, although it may happen on some herbaceous plants such as alfalfa. Eggs may incidentally be laid in dried rolled leaves. It has only been observed on citrus leaves (R. Ripa, pers. comm. 2019) or where leaves have been rolled by mechanical damage or other pests (e.g. tortricids in tender leaves in peaches) (Ripa, 1992).

In Chile eggs are laid in summer and autumn (January to the end of March or the beginning of April) (González, 1989). Egg development time varies depending on the ambient temperatures. In laboratory experiments in Argentina, the incubation period ranges from 10 to 30 days (during March to April) and from 42 to 98 days (during May to July) in controlled experiments with larvae raised from eggs at ambient temperature from adults collected in the Buenos Aires area; Loiácono & Díaz, 1992. In the field, egg development probably takes at least 30 days in the summer (pers. comm. R. Ripa, A. Lanteri, Museo de La Plata, Argentina, 2019). Newly hatched larvae fall to the ground, enter the soil and start to feed on the rootlets of the host plants and weeds. Developed larvae can also produce feeding grooves at the surface of older roots. The larvae can live in the soil at depths of 20 – 60 cm and rarely below that, though they have been recorded up to 120 cm depending on the texture of the soil (Ripa 1992; R. Ripa, pers. comm. 2019). However, larvae can be present in potted plants and would be restricted to the depth of the pot. The development of the larval stage takes on average 9 months with five instars in total (R. Ripa, pers. comm. 2019). According to Ripa (1992), in Chile, there are larvae in the soil throughout the year.

Pupation occurs within the soil in a pupal cell which is lined with body secretions. The development of the pupal cell and pupation occurs at depths of 20-30 cm below the surface (R. Ripa, pers. comm. 2019; Vicchi, 2014). The pupal stage requires about 30 days before the adult starts to emerge. Upon emergence, the adult requires at least 30 days in the soil to mature and harden the exoskeleton before it can bore an exit gallery to the surface of the soil (pers comm Ripa, 2019). The teneral adults have mandibles with hook-like mandibular processes which they use to exit the pupal chamber and crawl up through the soil. They lose these processes after emerging from the soil.

Adults emerge usually within the spring and summer months (see section 2.3 for temperature requirements). There are two main peaks of emergence where the first is in late spring (starting in September), the second in early summer (starting in December); a third may occur in late summer to early autumn [March to April in Chile (Valparaiso region)] (Ripa 1986a). According to Caballero (1972), adults can live for 8 months in laboratory conditions. However, other observations under laboratory conditions have observed a maximum period of four months for adults (A. Lanteri, R. Ripa, pers. comm. 2019). Adults feed on the aerial parts of host plants (leaves - in particular young leaves, Vera *et al*. (2016) - flower buds and leaf buds are mentioned in the literature). Feeding on fruit has been reported in the literature (see section 2.5) but the EWG considers this highly unlikely (see section 2.5). Following mating, females can oviposit 30 to 35 days after emergence from the soil. Adults have been observed to survive for 1 week without food in vials; at low temperature with sufficient humidity, they are expected to survive longer (R. Ripa, pers. comm. 2019). Guzman *et al.* (2012)

citing Gonzalez (1983) detail that females can store viable sperm in the spermatheca for at least 3 months. A female can lay between 200 and 600 eggs during her lifetime (R. Ripa, pers. comm. 2019).

The species is generally univoltine (i.e. has one generation per year), though this may be prolonged according to climatic conditions. Luppichini *et al.* (2013) detail that the life cycle can take between 12 and 14 months whereas Lanteri & del Río (2017), citing González (1983) and Ripa (1986a), and Ripa (1992) detail that the life cycle can last between 12-16 months. In dry areas and during very dry summers, the larval development is longer and will continue until the next spring or summer. In this case the life cycle lasts 16-18 months (A Lanteri, pers. comm. 2019). Some life stages (larvae, pupae, adults) are present in the soil throughout the year. For the purpose of this PRA the 12-16 month life cycle period has been used as this is based on scientific publications.

*N. xanthographus* has a bisexual reproductive mode (Guzman *et al.*, 2012). This is unlike several other *Naupactus* species, for which parthenogenicity is considered to contribute to the success of introduction and spread into new locations, including *N. leucoloma* for which only parthenogenic females have been found outside South America, and *N. cervinus* (EPPO, 1999; Guzman *et al.*, 2012; Germann, 2016). See Annex 2 for images of all life stages.

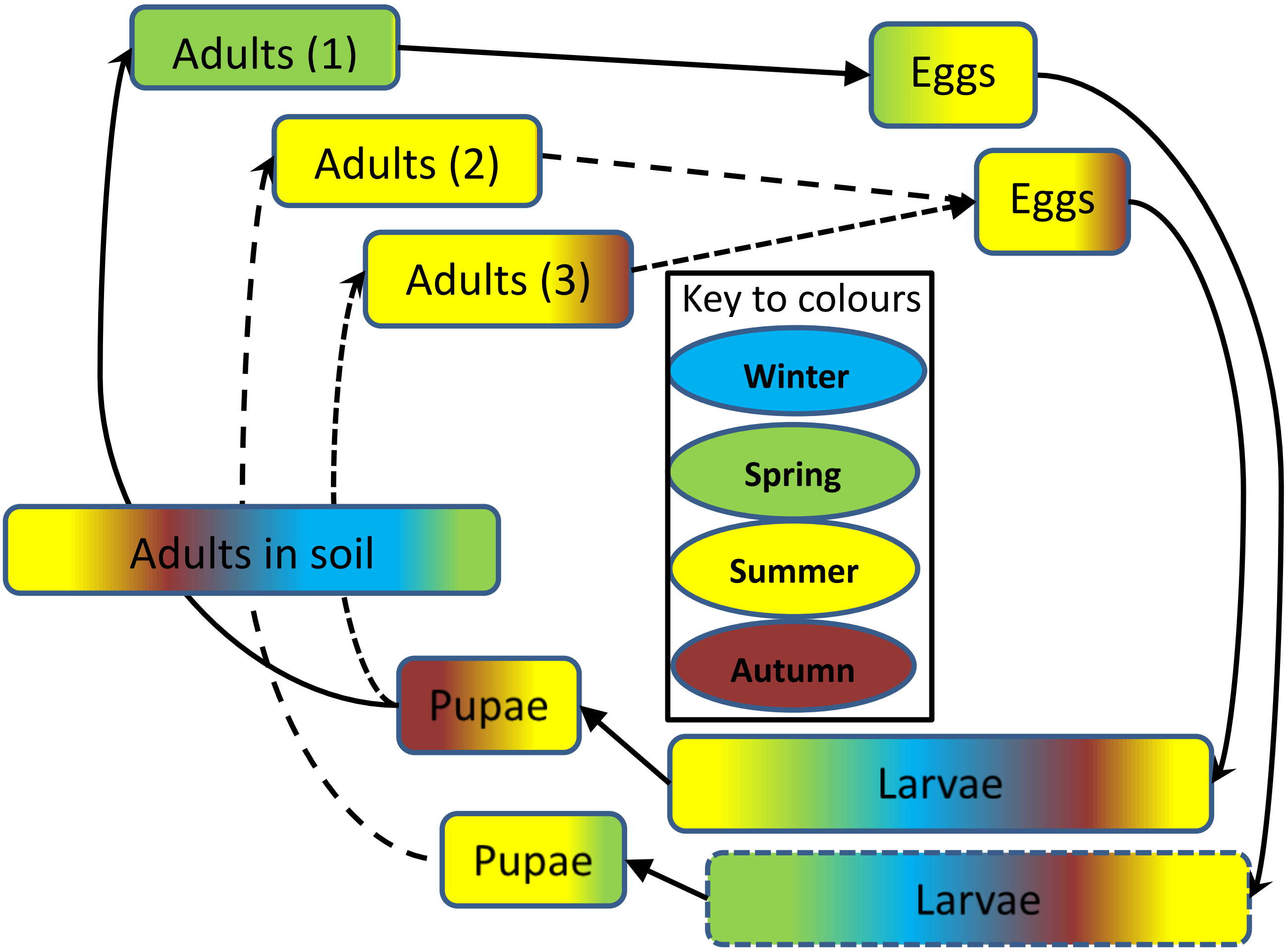


Fig 1. Diagram of the life cycle of *Naupactus xanthographus* (adapted from Ripa (1992). Adult (1) emerge in spring, lay eggs and larvae develop in soil, pupate and emerge the following summer (adult 2). Adult 2 lay eggs in the summer/autumn, larvae develop in the soil, pupate and either emerge late in the summer of the next year (adult 3) or if the temperature is below 13.5 ºC remain in the soil and emerge the following spring (adults 1).

## 2.3 Temperature and humidity requirements

Adults are generally seen above-ground when temperatures are between 15-40°C, but they are more frequent over 25°C. At low temperatures (5-10 °C) adults become very slow. Below 1-2°C, they are completely immobile. There are no data on survival below 0°C but it is expected that they may survive for short periods (24-48 hours) at temperatures below 0°C (R. Ripa pers comm. 2019). Adults stop emerging from the soil in the autumn months when the temperatures in the soil fall below 13.5ºC (in Chile around the month of May until September to October) (Ripa, 1992).

Humidity is very important for the survival of eggs and larvae and is essential for the emergence of adults (they usually emerge after rain or irrigation). In South America, the distribution of *N. xanthographus* is limited by minimum and maximum precipitation levels, except when crops are irrigated. *N. xanthographus* naturally occurs in areas with 1 000 - 2 000 mm maximum annual precipitation, but it can survive in much drier environments with artificial irrigation (A. Lanteri, pers. comm. 2019). In dry areas and during very dry summers, the larval development is longer than in optimal conditions and will continue until the next spring or summer (can be between 16-18 months). Artificial irrigation is essential for the survival of *N. xanthographus* in Mendoza province (Argentina) and the central area of Chile, where the environment is very dry (A. Lanteri, pers. comm. 2019).

## 2.4 Dispersal capacity of adults

Adults are flightless and therefore dispersal capacity is restricted. However, they can move within a field or to neighbouring fields. When adults emerge from the soil, they climb the trunks of host plants. No specific information on the spread capacity was found (see section 11).

## 2.5 Nature of the damage

Neonatal larvae first feed on rootlets of plants. The larval stage is the most damaging stage as the larva feed on the root system which can have an impact on the development of the affected plant by reducing the absorption of water and nutrients by the roots. Severe larval damage on the roots produce wilting of the foliage and may kill the plants (González 1989; Ripa, 1992). Feeding of adults can also cause direct damage to the aerial parts of the plants. In grapevine, the most obvious damage is caused by adults, which feed on grapevine leaves and buds when no leaves are available, being particularly injurious to young plants and sprouting of plants in September. This feeding behaviour produces "notching" on the leaf margins (González 1989; Ripa, 1992).

Quality losses of fruits have been reported due to contamination with faeces (Guzmán *et al.* 2010). Although feeding on fruit is mentioned in the literature, at least for grapevine (Lanteri & del Río, 2017 based on previous publications) and peach (Sinavimo, 2019, without reference), the Expert Working Group (EWG) considers this is highly unlikely as the mouthparts of the adult are not suited to this (mandibles are lost following emergence from the soil).

All *Naupactus* species cause more damage in seedlings (young plants with small roots) than in adult or old plants. In Argentina, the damage is observed to be more severe if there is drought and if larvae of other weevil species are present (A. Lanteri, pers. comm. 2019).

For a number of plants that have been recorded as hosts, the association is occasional when those plants are grown in soil infested by the weevil (Section 7).

## 2.6 Detection and identification

*Detection*

Adult *N. xanthographus* can leave obvious exit holes in the soil around host plants (Luppichini *et al.*, 2013). Above-ground foliage can show feeding damage where the adults feed from the margins of the leaves and create semicircle indentations (Fig. 2: R. Ripa pers comm. 2019). This damage could be mistaken for other weevil species, particularly broad-nosed weevils. On grapevine, infestation may cause smaller shoots, leaves or bunches, as well as signs similar to potassium deficiency (R. Ripa, pers. comm. 2019).

Fig. 2 Adult damage of *N. xanthographus* on vine leaves (Image R. Ripa).

Feeding damage to roots may be visible on the thicker roots (grooves) along with an absence of small roots if the host plant is uprooted. Feeding on the roots may also be expressed as symptoms above-ground resulting in reduced foliage and growth.

A low abundance of the species (all life stages) is difficult to detect.

*Identification*

Morphological characters of *N. xanthographus* adults are given in several publications with the most recent being Lanteri & del Río (2017). Morphologically, adults *N. xanthographus* can be confused with other species of the same genus, e.g. *N. dissimilis*, *N. mimicus* and *N. navicularis* (Lanteri & del Río, 2017), but it is very easy to distinguish from *N. leucoloma* and *N. cervinus*.

Morphological identification of larvae is difficult, even by specialists, and therefore larvae should be reared to adults to aid identification. Alternatively, molecular identification methods can be used (see below).

A number of publications detail molecular identification of the species (for example del Río *et al.*, (2018). There are over 160 accessions entered in the GenBank database (2019) and barcodes based on Cytochrome oxidase 1 (COI) are available (for example see http://boldsystems.org). There is a single haplotype of COI around the edges of the distribution range of *N. xanthographus* in Argentina.

A PCR method was developed to differentiate *N. xanthographus* from *N. cervinus* (aiming at distinguishing eggs in traded commodities; Aguirre *et al.*, 2015). This may be relevant for detection of introductions in the EPPO region because *N. cervinus* has already been introduced in a number of countries (e.g. Switzerland) and is spreading (Germann, 2016).

Annex 2 contains images of the various life stages of the species.

**3. Is the pest a vector?**

**Yes** ☐ **No** ✓

**4. Is a vector needed for pest entry or spread?**

**Yes** ☐ **No** ✓

## 5. Regulatory status of the pest

*Naupactus xanthographus* is not listed as a quarantine pest in any of the EPPO countries (based on the lists of regulated pests on the International Phytosanitary Portal – IPP, (IPPC, 2019) and EPPO Global Database[2] - EPPO, 2019). It was added to the EPPO Alert List in 2018 (EPPO, 2018).

Regarding non-EPPO countries, *N. xanthographus* is a quarantine pest for Canada, the USA, Mexico, Panama, Costa Rica, Ecuador, Peru, India, Japan, Republic of Korea (from the lists of regulated pests on the IPP), Thailand (Thailand, 2013 at least for apples from Chile) and New Zealand (New Zealand Government, 2019). This list is probably not exhaustive as not all national lists of regulated pests were checked.

The related species *N. leucoloma* (also from South America) is a quarantine pest in many EPPO countries, such as: Azerbaijan, the EU, Georgia (from current list on the IPP), Jordan, Montenegro, Morocco, Switzerland, Turkey, Ukraine, as well as Belarus, Moldova[3], Kazakhstan, Uzbekistan, Russia (EPPO, 2019).

## 6. Pest distribution

*N. xanthographus* is native to South America, East of the Andes, especially from the Pampean biogeographic provinces. The native range includes southern Brazil, Paraguay, Uruguay and central- northeastern Argentina (pers. comm. A Lanteri, 2019). The species is non-native to Chile, where it was first introduced in 1920s-1930s (Gonzalez, 1983). It has also been introduced to Juan Fernandez and Easter Islands (Lanteri & del Río, 2017; Guzmán *et al.*, 2012). The species is not known to be established anywhere outside of South America.

Table 2. Global distribution of *N. xanthographus*

| Region | Distribution | Additional details, references and uncertainties |
|---|---|---|
| **South America** | Argentina | Native: recorded from: Buenos Aires, Catamarca, Chaco, Córdoba, Corrientes, Entre Ríos, La Pampa, La Rioja, Mendoza, Misiones, Neuquén, San Juan, San Luis, Santa Fe, Santiago del Estero, Tucumán (del Río & Lanteri, 2019), Salta (del Río *et al.*, 2010), Jujuy (Lanteri & del Río, in press)<br><br>*Uncertain records*: Chubut. Bado (2007, 2013) reports *N. xanthographus* in Chubut but its presence needs confirmation as it may have been confused with other species. |
| | Brazil | Native to Southern Brazil: Rio Grande do Sul and Santa Catarina (Lanteri & del Río, 2017).<br>*Uncertain records*. The species has been cited as Paraná and São Paulo (D'Araujo e Silva *et al.*, 1968) though Lanteri & del Río (2017) consider this reference could be a misidentification with either *N. navicularis* or *N. mimicus*. |
| | Chile | Non-native to Chile: Atacama, Region Metropolitana, Valparaiso, Juan Fernandez Island (Lanteri & del Río, 2017), Coquimbo, Easter Island (Guzmán *et al.*, 2012), Biobio, Libertador General Bernardo O'Higgins (Elgueta & Malvardi, 2006).<br>*Uncertain record*: Temuco. Klein & Waterhouse (2000) reports *N. xanthographus* in Temuco but its presence needs confirmation as it may have been confused with other species. |
| | Paraguay | Native to Paraguay: Itapúa and Paraguarí (Lanteri & del Río, 2017). |
| | Uruguay | Native to Uruguay: Artigas, Colonia, Montevideo, Soriano and Treinta y Tres (Lanteri & del Río, 2017). |

[2] *N. xanthographus* was on the list of regulated pests of Jordan in 2007 but is not on the 2013 list (EPPO, 2019).
[3] *N. leucoloma* was on the list of quarantine pests of Belarus (1994) and Moldova (2006) but no longer according to the lists on the IPP (www.ippc.int).

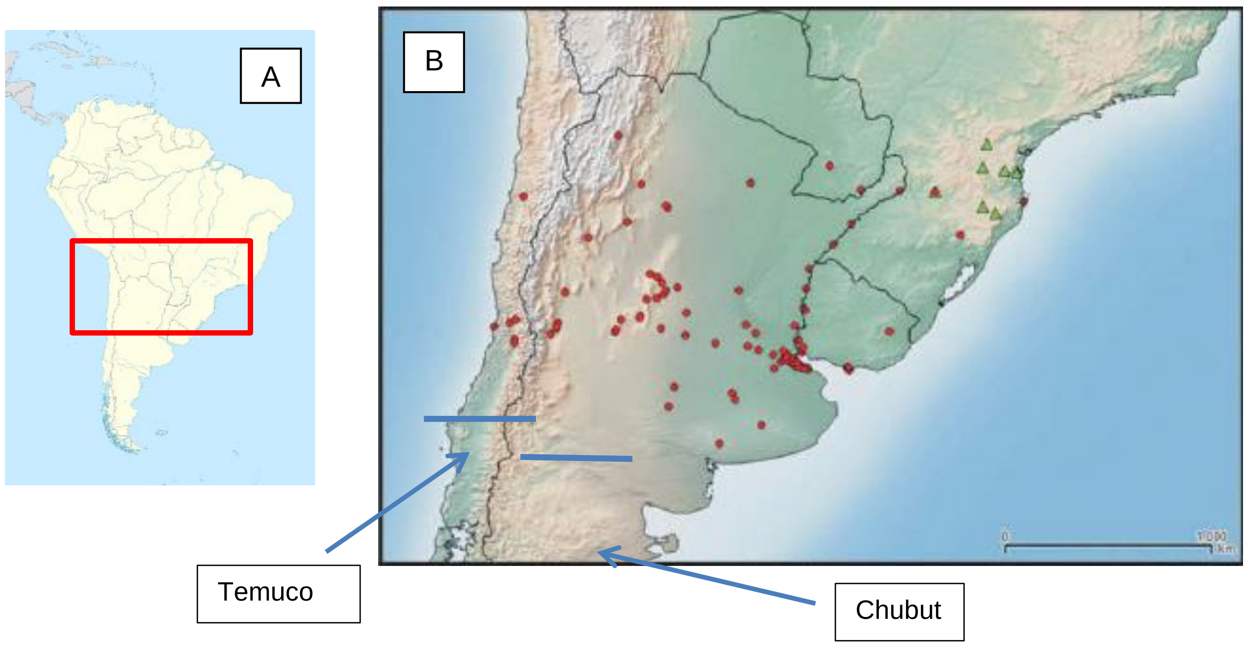


Figure 3. Geographic distribution of *N. xanthographus* in South America. Figure A shows the area in South America of figure B. Figure B modified from Lanteri & del Río (2017) and completed. Red circles indicate the sites where *N. xanthographus* was found in the study by Lanteri & del Río (2017). Note: green triangles on the map are not relevant to this PRA. For Chile, Easter Island and Juan Fernandez Island, where *N. xanthographus* is present, are not shown on the map. The blue lines indicate the approximate southernmost records (for Chile, Biobio records in Elgueta & Malvardi, 2006; for Argentina, Neuquén, in del Río & Lanteri, 2019). The arrows depict uncertain locations of *N. xanthographus* in Chile (Temuco) and Argentina (Chubut).

## 7. Host plants and their distribution in the PRA area

Lanteri and del Río (2017) and others (e.g. Olivares *et al.* (2014)) detail that one of the main native hosts of *N. xanthographus* is *Erythrina crista-galli* (Fabaceae), a tree species native from north-eastern and central-western Argentina, eastern Bolivia, southern Brazil and a great part of Paraguay. The weevil's range in South America matches approximately the range of *E. crista-galli* (EPPO, 2018). *E. crista-galli* is present within the EPPO region as an ornamental tree species though often, in this region, the species grows in the form of a shrub rather than a tree.

It is noted that all *Naupactus* species are polyphagous, but that they show host preferences. If the preferred hosts are available in large quantities and the climatic conditions are favourable, populations will be high, if not, some specimens will survive feeding on alternative hosts.

In South America, one of the most favourable host plant is *Vitis vinifera* (Lanteri & del Río, 2017). High egg densities have been recorded on *V. vinifera* compared to other species (R. Ripa, pers. comm. 2019).

*Naupactus xanthographus* has been recorded on many woody plants, but also on some herbaceous hosts, including field crops such as *Medicago sativa* and weeds. Caballero (1972) lists a number of weed species as hosts, and Ripa (1992;1986b) also detail a number of weed species which are hosts of *N. xanthographus* based on glasshouse no-choice experiments. Sinavimo (2019) mentions that populations (in the field) may be very high in the presence of weeds. A strong association between *N. xanthographus* and several weed species has been recorded in Chile (Ripa,1992; Ripa, 1986b).

Adults can feed on many plants, but the number of species on which the pest is known to complete its life cycle is narrower. For the purpose of this PRA, the host list has been divided into three sections where:

- Section **A** details species recorded as hosts of *N. xanthographus* through field observations (where various life stages (adults and larvae) have been recorded). It is assumed that eggs have been laid on hosts where larvae have been described on the plants. These hosts are covered in detail in the PRA. Even if larval development has been described on a host, it is noted that the neonatal larvae require small rootlets to start their development, which they may not find on their host but on weeds. Historically in Chilean orchards, there was a high association between high abundance of *N. xanthographus* and the presence of weeds.
- Section **B** details other species where adults were observed feeding on, or information is lacking about specific life stages associated with these species in the literature. For these plant species, evidence is lacking to list them as true hosts and the species were, therefore, not studied in detail.
- Section **C** contains experimental hosts on which the weevil completed its life cycle., as shown in no-choice experiments. Because of this, they are not studied in detail further in this PRA.

Many hosts are widespread in the EPPO region. The fruit tree hosts are grown commercially and in gardens or as ornamentals (see section 9.1).

Many known hosts are exotic to South America, i.e. showing the ability of the species to pass onto new host plants (including recent commercial crops in that continent, such as blueberries). The known host range includes mostly crops, but given the diversity and number of hosts, the host list is probably not complete, and the pest may pass onto new species when introduced into new locations.

**Table 3(A)[4] Confirmed hosts of *N. xanthographus***

| Host | Presence in PRA area (Yes/No/Not known) | Where available information on development | General references for host status |
|---|---|---|---|
| Species recorded as hosts of *N. xanthographus* through field observations (where varying levels of development have been recorded). | | | |
| *Actinidia deliciosa* (kiwifruit) | **Yes**: Cultivated for fruit production in warm climatic regions in the EPPO region. Widely grown as a garden ornamental. | Larval development and adult feeding (González, 1989) | Ripa (1992); Ripa & Rodríguez& Rodríguez (1999) |
| *Annona cherimola* (cherimoya) | **Yes:** Cultivated for fruit production in warm climatic regions in the EPPO region (e.g. Spain). CABI (2019) details the species is introduced into Egypt and the Canary Islands (ES). | Reported in the field and demonstrated to supported complete development in no-choice experiments (Ripa, 1992). | Ripa (1992); Ripa & Rodríguez (1999) |
| *Citrus limon* (lemon) | **Yes:** Cultivated for fruit production in warm climatic regions in the EPPO region. | Larvae develop on species (Ripa, 1992) | Olivares *et al.* (2014); Ripa (1992); Ripa & Rodríguez (1999) |
| *Citrus sinensis* (orange) | **Yes**: Cultivated for fruit production in warm climatic regions in the EPPO region. | Larvae develop on species (Ripa, 1992) | Olivares *et al.* (2014); Lanteri & del Río (2017); Ripa (1992); Ripa & Rodríguez (1999) |
| *Diospyros kaki* (persimmon) | **Yes:** Cultivated for fruit production in warm climatic regions in the EPPO region (e.g. Spain). | Larval development and adult feeding (González, 1989) | Ripa & Rodríguez (1999) |
| *Erythrina crista-galli* (cockspur coral tree) | **Yes**: sold in horticulture trade (for example the Royal Horticultural Society (2019) of the UK lists 13 suppliers). | No evidence was found of recorded larvae feeding on *Erythrina crista-galli*. However, the species is classified as a major host and the main native host (Lanteri & del Río, 2017). | Lanteri & del Río (2017); Olivares *et al.* (2014) |
| *Eriobotrya japonica* (loquat) | **Yes:** Cultivated for fruit production in warm climatic regions in the EPPO region (e.g. Spain). Sold in horticulture trade (for example the Royal Horticultural Society (2019) of the UK lists 27 suppliers). | Larval development and adult feeding (González, 1989). Referred to as níspero in the reference. | Ripa (1992); Ripa & Rodríguez (1999) |
| *Glycine max** (soybean) | **Yes**: increasingly cultivated in the EPPO region. | Larvae feed on roots (A. Lanteri pers comm. 2019). | del Río *et al.* (2010); Lanteri & del Río (2017) |
| *Juglans regia** (walnut) | **Yes:** Thought to be native and a long history of being grown within the EPPO region (Rigo *et al.*, 2016) | Larval feeding (Ripa, 1992) | Lanteri & del Río (2017); Olivares *et al.* (2014). Buds, leaves, roots, leaf buds (Sinavimo, 2019) |
| *Malus domestica* (apple) | **Yes:** Widely cultivated for fruit production within the EPPO region. | Larval development and adult feeding (González, 1989). Referred to as manzano in the reference. | Lanteri & del Río (2017); On leaves, shoots, roots (Sinavimo, 2019); Caballero (1972) Interception on fruit. |

[4] In the absence of confirmed larval development, when larvae are reported as feeding on roots of a host, this is a strong indication that it is a host (these species are marked with a * in the table).

| Host | Presence in PRA area (Yes/No/Not known) | Where available information on development | General references for host status |
|---|---|---|---|
| Species recorded as hosts of *N. xanthographus* through field observations (where varying levels of development have been recorded). | | | |
| *Medicago sativa* (alfalfa) | **Yes**: grown within the EPPO region for fodder | Larval development and adult feeding (González, 1989) | Lanteri & del Río (2017), On buds and leaves (Sinavimo, 2019) |
| *Persea americana* (avocado) | **Yes:** Cultivated in Mediterranean region | Larval development and adult feeding (González, 1989). Referred to as palto in the reference. Supported complete development in no-choice experiments (Ripa, 1992). | Lanteri & del Río (2017); Luppichini *et al*. (2013); Ripa (1992). |
| *Prunus armeniaca** (apricot) | **Yes:** Cultivated for fruit in the EPPO region. | | Lanteri & del Río (2017); Olivares *et al.* (2014) citing others; Ripa (1992). On buds, flowers, leaves, shoots, roots, leaf buds (Sinavimo (2019); Caballero (1972) |
| *Prunus avium** (sweet cherry) | **Yes:** Widely cultivated for fruit in the EPPO region. | | del Río *et al.* (2010) Ripa (1992); On buds, flowers, leaves, shoots, roots, leaf buds (Sinavimo (2019), Caballero (1972)). |
| *Prunus cerasus* (sour cherry) | **Yes:** Widely cultivated for fruit in the EPPO region. | Larval development and adult feeding (González, 1989). Referred to as guindo in the reference. | del Río *et al.* (2010) |
| *Prunus domestica* (plum) | **Yes:** Widely cultivated for fruit in the EPPO region. | Larval development and adult feeding (González, 1989). Referred to as ciruelo in the reference | Ripa (1992). |
| *Prunus persica* (peach) | **Yes:** Cultivated in Mediterranean region | Larval development and adult feeding (González, 1989) | Lanteri & del Río (2017); Ripa (1992); On buds, flowers, fruit, leaves, shoots, roots, leaf buds (Sinavimo, 2019); Caballero (1972)). |
| *Prunus persica* var. *nucipersica* (nectarine) | **Yes:** Cultivated in Mediterranean region | | Caballero (1972; Lanteri & del Río (2017) |
| *Prunus dulcis** (almond) | **Yes:** Cultivated in Mediterranean region | | Ripa (1992); On buds, flowers, fruit, leaves, roots, leaf buds (Sinavimo, 2019) |
| *Pyrus communis* (pear) | **Yes**: Widely cultivated for fruit in the EPPO region. | Larval development and adult feeding (González, 1989). Referred to as peral in the reference. | del Río *et al.* (2010); Lanteri & del Río (2017); On leaves, shoots, roots (Sinavimo, 2019); Caballero (1972). |
| *Vaccinium* sect. *cyanococcus** (blueberry) | **Yes**: Cultivated for fruit in the EPPO region. | | Rocca & Greco (2011); On leaves and roots (Sinavimo, 2019) |

| Host | Presence in PRA area (Yes/No/Not known) | Where available information on development | General references for host status |
|---|---|---|---|
| Species recorded as hosts of *N. xanthographus* through field observations (where varying levels of development have been recorded). | | | |
| *Vitis vinifera* (grape) | **Yes:** Widely cultivated for fruit and wine making in the EPPO region. | Larval development and adult feeding (González, 1989) | del Río *et al.* (2011); Lanteri & del Río (2017); Ripa (1992); Ripa and Luppichini (2010); On buds, leaves, roots and leaf buds (Sinavimo (2019); Caballero (1972)). |
| **Weeds** *Conium maculatum* *Sorghum halepense*, | **Yes**, as weeds | | Experiments Ripa (1986; 1992). |
| | | | |

**Table 3 (B) Other species reported as hosts but for which evidence is lacking that they are true hosts (i.e. support completion of full life cycle).**

| Host | Presence in PRA area (Yes/No/Not known) | Where available information on development | General references for host status |
|---|---|---|---|
| Other species reported as hosts or damaged by *N. xanthographus* | | | |
| *Acacia* | **Yes.** | | Lanteri *et al.* (2002) citing Artigas *et al.* (1994) |
| *Asparagus* | **Yes:** Genus includes both spontaneous and cultivated plants in the EPPO region | | Lanteri *et al.* (2002) citing Artigas *et al.* (1994) |
| *Beta vulgaris* (beetroot) | **Yes:** cultivated throughout the EPPO region | Adult feeding (A. Lanteri, pers. comm. 2019) | INIA (2008); Lanteri *et al.* (2002) citing Artigas (1994); Ripa & Rodríguez (1999) |
| *Brassica campestris* | **Yes**: grown in Europe | Adult feeding only | Caballero (1972) |
| *Cichorium intybus* (as 'achicoria') | **Yes:** cultivated and naturally occurring in the EPPO region | | Luppichini *et al.* (2013) |
| *Fragaria* (strawberry) | **Yes:** cultivated for fruit in the EPPO region | Considering several weevil species together | Cisternas (2013a) |
| *Helianthus annuus* (sunflower) | **Yes:** grown as an agricultural plant in the EPPO region | | On leaves and seedlings Sinavimo, 2019 |
| *Ilex paraguariensis* | Not known | Adult feeding only | Caballero (1972) |
| *Ligustrum* spp. | **Yes**, ornamental (at least *L. lucidum* - EPPO PRA on *Lycorma delicatula*) | | Lanteri & del Río (2017) |
| *Mespilus germanica* | **Yes:** Native to the EPPO region | | Biosecurity Australia (2005) |

| Host | Presence in PRA area (Yes/No/Not known) | Where available information on development | General references for host status |
|---|---|---|---|
| Other species reported as hosts or damaged by *N. xanthographus* | | | |
| (common medlar) | | | |
| *Olea europaea* (olive) | **Yes:** Cultivated throughout Mediterranean region | | Sinavimo (2019 citing Saini 2007); Biosecurity Australia (2005 citing others); Quiroz & Larrain, (2003) |
| *Phaseolus vulgaris* (green bean) | **Yes:** widely grown as a crop plant in the EPPO region | | Ripa & Luppichini (2010); Lanteri *et al.* (2002) citing Artigas (1994). |
| *Populus nigra* (black poplar) | **Yes**: Native to the EPPO region | | On buds, fruit, leaves, shoots, roots, leaf buds (Sinavimo, 2019). |
| *Prunus salicina* (Japanese plum) | Yes: Cultivated for fruit in warm climatic regions in the EPPO region | | Biosecurity Australia (2005), probably citing Gonzalez (1983). |
| *Raphanus sativus* | **Yes:** Grown as a vegetable throughout the EPPO region. | Adult feeding only | Caballero (1972) |
| *Robinia pseudoacacia* | **Yes:** Present within the EPPO region, in some countries considered invasive (Sitzia *et al.*, 2016) | Adult feeding only | González (1989) |
| *Rubus idaeus* (raspberry) | **Yes**: native to the EPPO region. Grown for its fruit | Cisternas (2013b) writes about adults and larvae in crops (but treating several weevil species together) | del Río *et al.* (2010); Ripa & Luppichini (2010); Cisternas (2013b) |
| *Salix babylonica* | **Yes:** Ornamental species in EPPO region | Adult feeding only | Caballero (1972) |
| *Salix viminalis* | **Yes:** Native to EPPO region | Adult feeding only | Caballero (1972) |
| *Solanum lycopersicum* (tomato) | **Yes:** Widely cultivated for fruit in the EPPO region. | | Lanteri *et al.* (2002) citing Artigas (1994). |
| *Solanum tuberosum* (potato) | **Yes:** A very widely grown staple crop grown throughout the EPPO region. | | del Río *et al.* (2010); Lanteri & del Río (2017); INIA (2008), Olivares *et al.* (2014) citing others; On flowers, leaves and roots (Sinavimo (2019); Lanteri *et al.* (2002) citing Artigas (1994)). |
| *Trifolium* | **Yes**: Genus includes both spontaneous and cultivated plants in the EPPO region | | Lanteri *et al.* (2002) citing Artigas *et al.* (1994) |
| *Triticum aestivum* | **Yes:** A very widely grown staple crop grown throughout the EPPO region. | Adult feeding only | Caballero (1972) |
| *Zea mays* | **Yes:** A very widely grown staple crop grown throughout the EPPO region. | Adult feeding only | Caballero (1972) |

| Host | Presence in PRA area (Yes/No/Not known) | Where available information on development | General references for host status |
|---|---|---|---|
| Other species reported as hosts or damaged by *N. xanthographus* | | | |
| **Weeds:** *Amaranthus deflexus, Chenopodium album; Datura stramonium; Polygonum aviculare; Rumex pulcher;* | **Yes**, as weeds | Adult feeding only | Caballero (1972) |

**TABLE 3(C) Experimental hosts**

| Host | Presence in PRA area (Yes/No/Not known) | Available information on development | General references for host status |
|---|---|---|---|
| *Foeniculum vulgare* (fennel) | **Yes**: grow as a vegetable in the EPPO region | Supported complete development in no-choice experiments (Ripa, 1992). | Ripa (1992) |
| **Weeds** *Taraxacum officinale, Plantago major, Rumex* spp. | **Yes**, as weeds | Supported complete development in no-choice experiments (Ripa, 1992). | Ripa (1986; 1992) |

**Note: Not included as host.** *Ribes*. Lanteri & del Río (2017) refer to del Río *et al.* (2010), which does not mention *Ribes*.

## 8. Pathways for entry

*Naupactus xanthographus* has been shown to move on certain pathways. *N. xanthographus* has been reported as travelling on fruit (e.g. CABI, 2006; USDA 2015; USDA, 2008 citing AQAS, 2007; USDA, 2007; Biosecurity Australia 2005), with numerous interceptions (see Fruit pathway, Table 4). However, plants for planting with growing medium are thought to be the pathway of introduction into Chile and Easter Island and Juan Fernandez Island (R. Ripa, pers comm. 2019).

Adults of the related species *N. leucoloma*, were recorded as being associated with hay and other crops, and with vehicles and agricultural equipment being transported. Soil attached to plants for planting or turf was also considered as a possible pathway for *N. leucoloma* (EPPO, 1999). These pathways for the related species *N. leucoloma* were considered when assessing pathways for *N. xanthographus.*

For the purpose of assessing the entry pathways only hosts that are cultivated in the countries where the pest occurs are considered. (see table in section 7). Information on the life-cycle of the pest which is relevant to the pathways assessed are detailed in section 2.2.

In this section, host is considered in the broad sense, and covers all hosts recorded in section 7 (Table 3A and 3B). There is more uncertainty on the host status of the plants in Table 3 (B) than in Table 3 (A).

The following pathways for entry of *N. xanthographus* are discussed in this PRA. Pathways in bold are described in detail in section 8.1; other pathways were briefly assessed at the end of section 8.1. Pathways with a very low likelihood of entry for reasons stated in section 8.2.

- **Host fruit and fruit packaging material,**
- **Host plants for planting (except seeds, tissue culture, pollen) with or without growing media,**
- **Travellers carrying fruit or plants for planting of main hosts from where the pest occurs,**
- **Soil and other growing medium (on its own or associated with plants for planting of non-hosts),**
- **Contaminant of soil attached to used vehicles, machinery and equipment,**
- **Contamination of containers used to transport host plants and fruits.**

Pathways with a very low likelihood of entry (detailed in section 8.2)

- Tubers or root commodities with growing media attached,
- Leafy vegetables,
- Wood and bark of hosts,
- Tissue culture of hosts,
- Cut flowers (sunflower) and cut branches of hosts,
- Processed commodities made from fruit of the hosts (e.g. dried fruit, pulp, canned preparations etc.),

- Sun dried/dehydrated bales of alfalfa,
- Seeds of host plants, grain (Glycine max),
- Weed hosts,
- Other hitch-hiking (contaminant),
- Natural spread,
- Intentional human-assisted movement of individuals.

### 8.1 Pathways studied

Examples of prohibition or inspection are given only for some EPPO countries (in this express PRA the regulations of all EPPO countries was not fully analysed). Similarly, the current phytosanitary requirements of EPPO countries in place on the different pathways are not detailed in this PRA (although some were taken into account when looking at management options). EPPO countries would have to check whether their current requirements are appropriate to help prevent the introduction of the pest.

Although specific requirements are currently in place for certain commodities in certain EPPO countries, each pathway was assessed without such requirements in place, and assuming that fruits and plants for planting are being imported from infested areas.

*8.1.1 Host fruits from where the pest occurs*

Table 4

| Pathway | Host fruit |
|---|---|
| **Coverage** | Fruit commodities moving in trade from host species where the pest occurs. Commodities include fruits of species listed in the section 'Plants concerned' further down in this table. This pathway includes fruit with or without other plants parts, e.g. peduncles, leaves associated.<br>This pathway also covers crates or boxes used for packing of host fruit. |
| **Pathway prohibited in the PRA area?** | No.<br>In the EU, the importation of citrus fruit from the countries where the pest is present is prohibited if they are with peduncles and leaves. |
| **Pathway subject to a plant health inspection at import?** | Partly, e.g. in the EU for *Annona*, *Diospyros*, *Malus*, *Prunus*, *Pyrus*, *Vaccinium*, *Vitis* for certain protected zones.<br>In the EU, consignments are inspected randomly to check for compliance with phytosanitary requirements. Inspections of consignments in the importing country may be carried out at the point of entry or at the place of destination, depending on the possibilities of carrying out efficient inspections and provided that the fruits remain under official control.<br><br>Depending on the species of fruit commodity, and its origin, and according to certain quarantine pests, some EPPO member countries (e.g. EU countries) have requirements for fruit commodities. These can include fruit originates from areas known to be free from certain pests, the commodity includes an official statement (documentation) that the fruits originate from areas known to be free from certain pests; inspections are conducted for pests at the site of production during the growing season; appropriate treatments are applied in the field against pests, or inspections of consignments prior to export.<br><br>Note: As of 14th December 2019, all fruit entering the EU will require a phytosanitary certificate with the exception of: *Ananas comosus*, *Cocos nucifera*, *Durio zibethinus*, *Musa* and *Phoenix dactylifera* (Regulation (EU) 2016/2031).<br><br>Regarding packaging material, in the EPPO region, countries would conduct random inspections to check compliance with phytosanitary requirements, if any. |
| **Pest already intercepted?** | Yes: Adults of *N. xanthographus* have been intercepted on table grapes from Chile in the USA and Peru (Biosecurity Australia 2005). One adult of the species was intercepted on apples (*Malus domestica*) from Uruguay into France in 2017 (Marseille) (EPPO, 2018). The individual was found in a wooden bin containing apples and in the same container a number of *Conoderus rufangulus* were also found (Pascal Reynaud, pers comm. Inspecteur Phytosanitaire PEC de Fos, Marignane et Marseille, 2019). The individual was alive but in a weakened condition. Two interceptions have been recorded in the United Kingdom (GB) from grapes (*Vitis*) from Chile (early 1990s) and from cherries (*Prunus avium*) from Argentina (Fera Science Ltd., Unpublished data/internal database). *Naupactus xanthographus* adults have been intercepted twice in commercial blueberry (shipments in the USA from Chile) (USDA 2008).<br><br>In addition, USDA (2008) detail that *N. xanthographus* has been intercepted by US port inspectors 112 times on fruits of various species. In old interceptions (from the 1930s to 1980s), fruits of *Vitis*, *Cucumis melo* (note that this species is not recorded as host), *Pyrus communis*, *Malus* and packing for grapes are mentioned (Biodiversity Heritage library). No data was found on recent interceptions (it is noted that the current practices in exporting countries may have reduced interceptions) (see Important factors for associations with the pathway). |
| **Plants concerned** | Association is considered more likely for fruit of hosts listed in Table A than for fruit of hosts listed in Table B (section 7): |

| Pathway | Host fruit |
|---|---|
| | From Table A: *Actinidia deliciosa* (kiwifruit), *Annona cherimola* (chirimoya), *Citrus sinensis* (orange), *Citrus limon* (lemon), *Diospyros kaki* (persimmon), *Eriobotrya japonica* (loquat), *Juglans regia** (walnut), *Malus domestica* (apple), *Persea americana* (avocado), *Prunus armeniaca* (apricot), *Prunus avium* (sweet cherry), *Prunus cerasus* (sour cherry), *Prunus domestica* (plum), *Prunus persica* (peach), *Prunus persica* var. *nucipersica* (nectarine), *Prunus dulcis* (almond)*, *Pyrus communis* (pear), *Vaccinium* sect. *cyanococcus* (blueberry), *Vitis vinifera* (grape).<br><br>There is more uncertainty for Table B hosts, but because adults were recorded feeding on plants, it is considered that they may be associated with the following fruit: *Fragaria* (strawberry), *Mespilus germanica* (common medlar), *Olea europaea* (olive), *Prunus salicina* (Japanese plum), *Rubus idaeus* (raspberry), *Solanum lycopersicum* (tomato).<br><br>In addition, it has been intercepted on *Cucumis melo,* for which no association has been recorded in the field.<br><br>*It is considered unlikely that *N. xanthographus* will be associated with nut commodities when they are shipped dry without any green parts attached (*Juglans regia*, *Prunus dulcis*). However, at least almonds can be traded green with shells, and the association in that case may be the same as for other fruit. |
| **Most likely stages that may be associated** | Adult weevils are the most likely stage to be associated with this pathway. Adults are unlikely to feed on fruit (see 2.5). However, adults can be present feeding on the aboveground foliage of host plants and can become associated with fruit at harvest and packing (USDA, 2008). There have been many interceptions on fruit (USDA, 2008).<br><br>Eggs may potentially be associated with fruit if a gravid female is present in the commodity. Olivares *et al.* (2014) showed that females can lay eggs on the fruit of *Citrus sinensis* (in a controlled experiment on oviposition preferences). Egg masses were not laid on an unprotected area of the fruit surface. However, eggs were oviposited mostly on leaves (52%), the fruit surface (6%) or on the cage surface (40%). In fruit consignments, they may therefore be mostly on the packaging (see Table 5). However, such association seems very unlikely as most fruit would be transported cooled.<br><br>Larvae and pupae are very unlikely to be associated with the fruit at harvesting or packing as these life stages occur below ground. |
| **Important factors for association with the pathway** | At least in Chile, *N. xanthographus* occurs more often in grapes, and there is less handling of grapes (e.g. washing) compared to other fruit. Adults may be concealed in the bunches of table grape. On other fruit commodities, it is less clear how they become and remain associated (as they are flightless).<br><br>Adults and eggs may be removed from the consignment before dispatch if the fruit is cleaned or during the packing process. However, interceptions show that adults may remain associated with fruit consignments in trade.<br><br>In Chile and Argentina, practices are in place to limit the association of the pest with fruit consignments at export, because *N. xanthographus* is a quarantine pest for several trading partners, and studies are ongoing to improve control methods (R. Ripa, A. Lanteri, pers. comm. 2019). However, no information was available on the situation in other countries where the pest occurs.<br><br>If an adult is present, the probability that it concerns a gravid female or a female that carries viable sperm arrives seems fairly high (ie. more than 30%). The male to female ratio is about 1:1. Thus in about 50% of the case the adult is expected to be a female. Females mate |

| Pathway | Host fruit |
|---|---|
| | about 1 week after emergence from the soil and they can store viable sperm in the spermatheca for at least 3 months (see above '2.2 Life cycle'). Assuming that females live for 4 months (see 2.2), the probability that the female is gravid or carries viable sperm may be about 0.75 and the probability that the adult is a gravid female or a female that carries viable sperm is about 0.75 x 0.5 = 0.375.<br><br>The absence of green parts with the fruit does not significantly affect the likelihood of association of the pest.<br><br>It is unlikely that *N. xanthographus* adults will be associated with fruits harvested in winter from areas with cooler winters (in particular citrus) because adults are overwintering in soil.<br><br>*N. xanthographus* has been shown to be associated with packaging material of fruit.<br><br>Adults are conspicuous and the numerous interception records show that it is possible to detect the pest at import. However, host fruit is not subject to specific phytosanitary import requirements against *N. xanthographus* in most EPPO countries and may be at most subject to some general inspection or targeted inspections against other pests, therefore it is not certain that *N. xanthographus* would be detected. |
| **Survival during transport and storage** | Fruit in international trade is commonly transported under controlled conditions (lower temperature and/or controlled atmosphere). However, the interception of live adult specimens on various fruit commodities shows that the pest is able to survive confinement in the packaged commodity and subsequent transport of the commodity through international travel. Adults can live for at least 4 months; there is no information about the fitness of adults after transport, except for one case. In that case, the intercepted individual was alive but weakened or dying (P. Reynaud, pers comm. 2019).<br><br>It is not known if they would be able to feed and survive on the different fruit (only feeding on grapes and peach are mentioned in the literature). Adults have been observed to survive for 1 week without food in vials; they are expected to survive longer at low temperature with sufficient humidity.<br><br>However, there is an uncertainty on whether adults are still fit enough to initiate a population after arrival on the fruit commodity. There is a lack of information on how the commodities are transported (i.e. transport time and specific conditions) and how this affects the viability of the adults. |
| **Trade** | There is a large volume of trade in fruit commodities from South American countries where the pest occurs into the EPPO region (e.g. grape). This trade includes fruits of known host species. Annex 3 indicates import volumes of a number of fruit commodities from countries where the pest occurs (Argentina, Brazil, Chile, Paraguay and Uruguay).<br>The peak of harvest for grapes is usually in February (although imports may continue through to June), but some other fruit may be imported during the summer months in the EPPO region (e.g. kiwifruits, *Citrus*). |
| **Transfer to a host** | Hosts are widespread in the EPPO region. However, as host fruit are imported for consumption or processing, transfer with fruit directly provided to the consumer or used for processing is generally considered unlikely (the pest will be destroyed during processing or discarded by the final consumer in a closed waste bin). Transfer seems more likely if fruit arrives in areas close to production facilities, where damaged fruit may also be discarded in open bins close to host plants. The risk is therefore higher where imported fruit is stored or repacked close to production facilities but would still remain low due to the weevil not being able to fly, because of their possibly low fitness at arrival, because fruit may be packed and sorted under cool conditions. |

| Pathway | Host fruit |
|---|---|
| | The peak import of grapes and other fruit from South America would occur in February, when the temperatures are not favourable in the Northern part of the EPPO region. However, temperatures may be favourable for adult movement in part of the EPPO region (e.g. the Mediterranean). |
| **Likelihood of entry and uncertainty** | There are no detailed interception data at a global scale, and there are not enough data to assess the different fruit separately. However, grape was rated separately because the probability of association with the pest was rated higher. Grapes are a preferred host and adults can be hidden in bunches.<br><br>**Grapes and packaging material of grapes. Moderate with high uncertainty** (seasonality of imports, whether adults are viable on arrival, whether situations exist where adults could transfer to a host, association [few interceptions, but no regular inspection], management practices in countries other than Chile and Argentina, as well as abundance of the pest in fruit crops).<br><br>**Other fruits and their packaging material**. Moderate to **Low with high uncertainty** (explanation for uncertainty is the same as for grapes above. |

*8.1.2 Host plants for planting (except seeds, tissue culture, pollen) with or without growing media from where the pest occurs*

Table 5

| Pathway | Host plants for planting (except seeds, tissue culture, pollen) with or without growing media |
|---|---|
| **Coverage** | • Plants for planting in pots or similar (including bonsais), plants with bare roots, cuttings.<br>• Seeds, tissue culture, pollen are excluded because the pest is not associated with these pathways |
| **Pathway prohibited in the PRA area?** | Yes, in part, in some countries:<br>The import of following host plants for planting is prohibited to EU countries from South American countries where the pest occurs: *Citrus*, *Pyrus*, *Vitis*, *Fragaria*, *Solanum lycopersicum*<br><br>For other plant genera there is no prohibition but the following EU-legislation makes association less likely if properly implemented:<br>Deciduous trees and shrubs, intended for planting, other than seeds and in tissue culture originating in third countries other than European and Mediterranean countries should be dormant and free from leaves (article 40 Annex IVAI), as adults are less likely to remain in the trees if there are no leaves, and import is likely to happen in winter time for South America.<br>Soil and growing media, attached to or associated with plants should be free from insects (article 34 Annex IVAI) |
| **Pathway subject to a plant health inspection at import?** | Yes, partly, in some EPPO countries,<br>All plants for planting are subject to inspection at import in the EU. . |
| **Pest already intercepted?** | No. There is no evidence that *N. xanthographus* has been intercepted on plants for planting from countries where the pest is known to occur. However, it has been suggested that the species may have been introduced into Chile (including Easter Island and Juan Fernandez Island) on plants for planting (pers comm, Ripa, 2019). |
| **Plants concerned** | **Hosts of *N. xanthographus* on which larval development has been recorded (Table A).** |

| Pathway | Host plants for planting (except seeds, tissue culture, pollen) with or without growing media |
|---|---|
| | *Actinidia deliciosa* (kiwifruit), *Annona cherimola* (chirimoya), *Citrus sinensis* (orange), *Citrus limon* (lemon), *Diospyros kaki* (persimmon), *Eriobotrya japonica* (loquat), *Juglans regia* (walnut), *Malus domestica* (apple), *Persea americana* (avocado), *Prunus cerasus* (sour cherry), *Prunus domestica* (plum), *Prunus persica* (peach), *Pyrus communis* (pear), *Vaccinium* sect. *cyanococcus* (blueberry), *Vitis vinifera* (grape).<br><br>Note that the following species are also included in table A as there is a strong consensus that larvae develop on the species but it has not been recorded in the literature: *Erythrina crista-galli* (cockspur coral tree), *Prunus armeniaca* (apricot), *Prunus avium* (sweet cherry), *Prunus persica* var. *nucipersica* (nectarine), *Prunus dulcis* (almond).<br><br>**Other species reported as hosts but where there is no evidence for larval development (Table B).**<br>*Fragaria* (strawberry), *Helianthus annuus* (sunflower), *Ilex paraguariensis*, *Ligustrum* spp., *Solanum lycopersicum* (tomato), *Mespilus germanica* (common medlar), *Olea europaea* (olive), *Phaseolus vulgaris* (green bean), *Populus nigra* (black poplar), *Prunus salicina* (Japanese plum), *Raphanus sativus*, *Robinia pseudoacacia*, *Rubus idaeus* (raspberry), *Salix viminalis*, *Salix babylonica*, *Acacia*, *Cichorium intybus* ('achicoria') |
| **Most likely stages that may be associated** | **Aboveground parts of host plants:**<br>Eggs: Eggs may potentially be associated with host plants as eggs are often laid in the crevices of bark, and incidentally in dried rolled leaves (very rare event).<br>Adults: It is unlikely that adults will be associated with host plants if imported without leaves and/or as dormant. If host plants have foliage, it is unlikely that adults will remain on the plants due to the disturbance of packing. Adults let go of the vegetation and drop to the ground when disturbed.<br><br>**Belowground parts of the plant and within growing media:**<br>Larvae: Newly hatched larvae feed on rootlets. Older larvae feed in groves at the surface of the roots. Larvae are very likely to be eliminated if the growing medium is washed off and larvae are thus very unlikely to be associated with bare rooted plants.<br>Pupae: Pupae may be associated with the growing media (very unlikely to be associated with bare rooted plants)<br>Adults: Newly emerged adults from pupal cases may be present in the soil for at least 30 days.<br><br>**For unrooted cuttings**, it is not clear from the information available whether eggs could be associated with such material. However, cuttings would be produced from young shoots where the bark would not be suitable for egg-laying. Although adults may be associated with shoots, they are likely to become dislodged or fall off during the preparation of the commodity, and they may also be more easily detected on this material. |
| **Important factors for association with the pathway** | Adults, pupae and larvae may be associated with (dormant) plants if traded with soil or other growing medium attached. The probability of association of larvae is higher if weeds are present (neonate larvae may especially feed on roots of weeds).<br><br>Eggs may be present on above ground plant parts. Eggs are small (1 mm) but are laid in clusters of 25-40. Still, egg clusters are not so easy to see during an inspection.<br>There may be requirements in place in importing countries for growing media accompanying plants that would mitigate the risk. For example in the EU (a) growing medium at planting: free from soil and organic matter, or found free from insects and harmful nematodes and inspected, or treated, and (b) since planting: measures to maintain the growing medium free from harmful organisms, |

| Pathway | Host plants for planting (except seeds, tissue culture, pollen) with or without growing media |
|---|---|
| | or plants shaken free from the media and, if replanted, using growing media meeting above requirements. This would eliminate some life stages that are free in the soil.<br>Host plants in Table A can carry all life stages while table B hosts are only known to be associated with adults while there is uncertainty about whether they are also associated with other life stages. For table B plants, adults will fall from the plant when moved making the association with the host B during movement less likely.<br>Association of life stages with artificially dwarfed plants, although they have suitable bark and growing media, is considered less likely as the plants would be subject to controls over a longer period which could allow to detect the pest.<br>The pest may be present in nurseries if those are located in infested areas. |
| **Survival during transport and storage** | Eggs are very sensitive to desiccation, and it is not known how humidity and cool conditions would affect their survival and viability. Larvae could survive transport and storage. However, as plants are most likely to be transported in cool conditions to keep them dormant, adults are not likely not emerge during transport. If adults emerge from the soil during transport, they would need to feed, and therefore have a very low probability to survive on dormant plants. However, Adults are reported to be able to survive without feeding for at least 1 week in humid conditions (pers com, Ripa, 2019).<br><br>The pest is not likely to multiply in transport and storage as this will be short in comparison with its life cycle. Transport is also likely to occur under cool conditions, which would favour survival but probably not continued development. |
| **Trade** | No detailed data are available for import of host plants from South America into the EPPO region. In the EU some genera are prohibited from countries where the pest is present (see above).<br>For the period 2000-2011, ISEFOR data (regarding imports from non-EU countries into the EU – Eschen *et al.*, 2017) indicate the following imports. However, these data are incomplete and there is a high uncertainty concerning the import volumes of plants for planting of host plants of *N. xanthographus* into the EPPO region. |

| Commodity | Number pieces (year country) (CL=Chile; AR=Argentina; BR=Brazil) |
|---|---|
| *Acacia* | 5 (2008 CL) |
| *Actinidia* | 50 (2009 CL), 100 (2010 CL), 1150 (AR 2010) |
| *Citrus* (flower plants) | 19 (2000 BR), 1 (2001 BR) |
| *Fragaria* (cuttings/budstick) | 2400 (2009 BR) |
| *Helianthus annuus* (unrooted plants) | Unclear quantity (indicated as 3,75) (2009 AR) |
| *Helianthus* | 50 (2010 BR) |
| *Ligustrum* (bonsai) | 3000 (2009 BR) |
| *Malus* (budstick) | 20 (2010 BR) |
| *Phaseolus* | 37 (2003 CL) |
| *Prunus* | 14 (2001 CL) |
| *Pyrus communis* | 23139 (2011 CL) |
| *Rubus* | 1600 (2010 CL), 2010 (2009 CL) |
| *Vaccinium* | 1 (2002 AR), 10 (2001 CL) |
| *Vitis* (unrooted plants) | 1 (2002 AR), 176 ( 2006 AR), 22 (2010, AR) |

| Pathway | Host plants for planting (except seeds, tissue culture, pollen) with or without growing media |
|---|---|
| **Transfer to a host** | As the commodity is intended for planting there is a high potential of pest transfer to other hosts. Plants for planting will generally be planted in favourable conditions for their development and these may also be favourable for pest development. Transfer to another host plant will depend on where the plants will be used.<br>Transfer would be less likely for plants that are used indoors (e.g. bonsais). |
| **Likelihood of entry and uncertainty** | The ratings below apply to species that are known to carry eggs and larvae (table A). The risk is lower for plant species that may carry only adults (or information is lacking about specific life stages associated with these species in the literature) (table B). The highest risk of entry is considered to be plants for planting with growing medium.<br><br>**Unrooted cutting**: very low with low uncertainty (unlikely that eggs are present and no root material for larvae to feed on).<br><br>**Rooted cuttings in small plugs**: very low with moderate uncertainty (it is unlikely that adults will have laid eggs on cuttings in small plugs and larvae will enter the small plugs. Uncertainty relates to adults laying eggs on this material, survival/viability of eggs).<br><br>**Bare rooted plants**: moderate with high uncertainty (eggs may be present on the material and the presence of root material can provide food material for larvae. Uncertainty is related to the survival/viability of eggs in transport)<br><br>**Plants with growing media**: high with moderate uncertainty (larvae and pupae can be present in the growing medium and the presence of root material can allow for feeding. Uncertainty relates to the quantity of soil, growing conditions and practices carried out before export act to restrict the movement. |

### 8.1.3 *Other pathways considered*

- **Travellers carrying fruit or plants for planting of main hosts from where the pest occurs.** Travellers may carry fruit or plants for planting of hosts in their luggage. No regular inspections of travellers or their luggage is carried out in the EPPO region. Travel to and from countries where the pest occurs has increased in recent years. Due to the many uncertainties, it did not prove possible to assess this pathway in detail. However, the EWG made general recommendations in section 16.

- **Soil and other growing media (on its own or associated with plants for planting of non-hosts).** The pest may be associated with soil or other growing medium as such, or with growing medium of non-host plants if those have been grown close to host plants. Larvae, pupae or adults newly emerged from pupal cases may be present in soil because host species may have been grown in that soil. Eggs are very unlikely to be present on non-host in that growing medium. Note that *N. xanthographus* is very polyphagous and its host range is probably wider than known (see section 7). Due to the many uncertainties, it did not prove possible to assess these pathways in detail. However, the EWG made general recommendations in section 16.

- **Contaminant of soil attached to used vehicles, machinery and equipment.** Larvae, pupae and teneral adults may become contaminants of soil and other growing medium attached to used machinery and equipment. However, these larvae and pupae are at a certain depth in the soil, and it would also require the presence of substantial amounts of soil. This is also mentioned for the related species *N. leucoloma*. However, there is probably very little movement of used machinery from the countries where the pest occurs into the EPPO region and if there is, it is probable that such equipment would undergo phytosanitary procedures such as decontamination. In addition, this pathway is now covered by an International Standard for Phytosanitary Measures (ISPM 41) (FAO, 2017). Data is lacking to fully assess and rate this pathway.

- **Contaminant of containers used to transport hosts.** The pest could be contaminating containers used to transport hosts. Packing material of hosts is considered in the host fruit pathway (Table 4). However, data are lacking to fully assess and rate this pathway.

### 8.2 Pathways with a very low likelihood of entry

- **Tubers or root commodities with growing media attached**
  There may be casual association possible if potatoes or other root crops are planted in soil infested with larvae. However, the larvae do not enter the tubers and are likely to be removed during harvest and cleaning practices.
  (uncertainty: low)

- **Leafy vegetables**
  Historically, adult feeding has been reported on *Brassica campestris* (Caballero (1972). However, it is unlikely that adults will remain on the material through harvesting, packing and transport. Any damaged material will be discarded at harvest and packaging.
  (uncertainty: low)

- **Wood and bark of hosts**
  No life stages would be present on wood without bark (very low likelihood of entry with low uncertainty).
  For wood with bark (incl. round wood, wood chips etc.) or bark, eggs may be present in bark crevices. Adults are unlikely to remain associated to the commodity. It is not known if the pest is present in managed forest areas, and whether the wood of fruit trees would be traded internationally. The genus *Naupactus* is originally known from native habitats including forests. In Argentina, *N. xanthographus* is present in gallery forests (subtropical forests extending along the rivers), including on *E. crista-galli*, which is not a timber species. In Chile, where *N. xanthographu*s was introduced, it is not known from forests. Wood is likely to have undergone some level of drying, which will lower the survival of the eggs (which are sensitive to desiccation and fungal growth in case of excessive humidity). No data is available on whether the hosts are traded as wood or bark from countries where the pest occurs. If the wood is laid on soil, neonatal larvae may enter the soil and would need to find roots of a suitable

host. Transfer from wood chips would only occur if they are used for mulch.
(uncertainty: moderate - uncertainty if wood is used from old orchards, presence in forest or plantations, survival).

- **Tissue culture of hosts.**
  Many host species (e.g. *Vitis*) may be exchanged as tissue culture for the purpose of breeding. However, no life stage of *N. xanthographus* could be associated with tissue cultures of its hosts.
  (uncertainty: low)

- **Cut flowers (sunflower) and cut branches of hosts**.
  Adults may be associated, but they are unlikely to remain on the material through harvesting, packing and transport. Larvae hatching from any eggs present on cut branches are very unlikely to find a suitable place for development.
  (uncertainty: moderate - survival of adults, packaging conditions)

- **Processed commodities made from fruit of the hosts (e.g. dried fruit, pulp, canned preparations etc.).** Such commodities would be processed to a degree that would not allow survival of adult *N. xanthographus*.
  (uncertainty: low)

- **Sun dried/dehydrated bales of alfalfa.**
  Adults and eggs probably cannot survive the sun-dry process and will not survive industrial dehydration.
  (uncertainty: low)

- **Seeds of host plants, grain (*Glycine max*).**
  Life stages of *N. xanthographus* are not associated with seeds or grain.
  (uncertainty: low)

- **Weed hosts.**
  *Naupactus xanthographus* has a number of weed hosts (see section 7). These are more likely to be moved as seeds (in consignments of, for example, plant products or soil), and the pest is not associated with seeds. Weed hosts may be present in plants for planting (e.g. in pots), this is covered under 8.1.
  (uncertainty: moderate - life stage of weed moved, survival of adults)

- **Other hitch-hiking (contaminant).**
  Hitch-hiking of eggs, larvae, pupae is considered in the "host fruit" pathway. Hitch-hiking with airplanes has not been recorded. *N. xanthographus* is not a major pasture/grassland pest, and is unlikely to be present in airfields, and as it cannot fly, it is unlikely to reach airplanes. Adults of the related species *N. leucoloma* were recorded as a possible hitch-hiker associated with hay and other crops. There is no data on this for *N. xanthographus*, which has also been found only on fruit in trade. Hitch-hiking on other commodities is not considered likely.
  (uncertainty: low)

- **Natural spread**.
  *N. xanthographus* is present only in South America and cannot spread naturally to the EPPO region. In addition, the pest cannot fly.
  (uncertainty: low)

- **Intentional human assisted movement of individuals**, e.g. trade by collectors.
  *N. xanthographus* may circulate between hobbyist entomologists, but it is likely that specimens would be traded once dead. Live insects for study may be circulated but is likely to be for use only in laboratories.
  (uncertainty: low)

**8.3 Overall rating of the likelihood of entry:**

| Overall rating of the likelihood of entry | Very low ☐ | Low ☐ | Moderate ☐ | High ☒ | Very high ☐ |
|---|---|---|---|---|---|
| Rating of uncertainty | | | Low ☐ | Moderate ☒ | High ☐ |

## 9. Likelihood of establishment outdoors in the PRA area

### 9.1 Host plants in the EPPO region

Host plants of *N. xanthographus* occur throughout the EPPO region which is favourable to its establishment.

Many of the identified host plants are grown for commercial purposes in the EPPO region. Most of the species detailed in the following paragraphs are grown both outdoors and under protected conditions (see also section 10). In some areas of the EPPO region, annual crops (e.g. tomatoes) can be grown outdoors all year round.

**Species recorded as hosts of *N. xanthographus* through field observations (where varying stages of development have been recorded) (see section 7A)**

*Actinidia deliciosa*: Kiwifruit acreage and production in the EPPO region has increased consistently during the last 10 years. Some of the leading producers are Italy, France, Greece, Portugal and Spain. *Actinidia deliciosa* forms approximately 90% of the French *Actinidia* spp. production. Italy produces more kiwifruit than any other country in the world apart possibly from China (Testolin & Ferguson, 2009). In Italy kiwifruit account for c. 3.5% of the total area for fruit production (Testolin & Ferguson, 2009). Kiwifruit was first introduced to Turkey in 1988 (Yalcin & Samanci, 1997). Several areas are favorable for kiwi fruit production: Black Sea, Marmara, Aegean and Mediterranean Region (Yildirim *et al.* 2011). The cultivation of kiwifruit in Greece started in 1972, in the region of Pieria in Central Macedonia. Since then, the cultivation have spread in other regions of Greece, like Kavala, Imathia, Arta, Lamia etc. Kiwifruit has been grown in France since about thirty years and France is among the main producers in Europe after Italy. *Actinidia* is produced in over half of French territory (in the west and the south) but the main producing areas are in the south-west (Aquitaine, Charente, Midi-Pyrénées) and the Mediterranean basin (Languedoc-Roussillon, Rhône valley, Corsica). In Spain, the northern regions of the peninsula concentrate the largest part of the kiwifruit cultivated area.

*Annona cherimola* is grown for its fruit within the EPPO region. Spain is considered the most important producer worldwide with approximately 3102 ha producing 44305 t in 2016 (MAPA 2018) in the Almuñécar and Motril valleys (in Granada province (MAPA 2018).

*Citrus sinensis* and *Citrus limon* are grown throughout the warmer regions of the EPPO region. The Euro-Mediterranean citrus industry includes approximately 12 % of the world's citrus growing area and produces approximately 20 % of the world's citrus fruit (Siverio *et al.*, 2017; FAOSTAT). Around 70 % of the Euro-Mediterranean citrus fruit production is concentrated in four countries: Spain (27 %), Italy (16%), Egypt (15%) and Turkey (10%) (Siverio *et al.*, 2017). Citrus is also produced in the following EPPO countries (listed in descending order of Citrus production): Morocco, Algeria, Greece, Israel, Tunisia, Portugal, Cyprus, Jordan, Georgia, Croatia, Albania, France, Azerbaijan, Bosnia and Herzegovina and Portugal (FAO, 2017).

*Diospyros kaki* is cultivated in a few countries of the PRA area: Azerbaijan, Israel, Italy, Slovenia (small area) Spain and Uzbekistan, as well as some crops registered in Portugal, Greece, Cyprus, Morocco. In Spain there are 17 833 ha under cultivation (2016 data (MAPA, 2018)). In Turkey, Aksoy (1995) reports 370.000 trees for a production of 10.000 tonnes. Italy is one of the main producers in Europe (Yonemori *et al.*, 2008). The situation may be similar in other Mediterranean and Caucasus countries (i.e. small areas in commercial cultivation, but large numbers of trees outside commercial production) (EPPO PRA on *Oemona hirta* with added data for Spain).

*Eriobotrya japonica* (loquat) has been introduced into the EPPO region firstly as an ornamental species and then later for its fruits (Caballero & Fernandez, 2003). In Spain, in 2016, there were 2 461 ha (27 272 t) in regular production (MAPA, 2018). Caballero and Fernandez (2003) also details production in Turkey (1 470 ha), Italy (663 ha), Morocco (385 ha) and Greece (300 ha). It is also recorded as cultivated commercially in Cyprus, Tunisia (EPPO PRA on *Apriona*, citing others with added data for Spain).

*Erythrina crista-galli* is grown throughout the EPPO region as a garden ornamental. EPPO (2019) highlights that the species is widely planted as a garden or street tree. The species has a long history of being grown in the EPPO region, for example the species was first introduced into Italy in 1771 (pers. comm. G. Brundu, University of Sassari, Italy, 2019). The species is present on a number of nursery websites including sites in the United Kingdom, Spain, France etc.5ºC10ºC. It is also expected that the species is present in botanical gardens throughout the EPPO region due to its showy bright flowers. GBIF (2019) have a limited number of georeferenced points for the species in the EPPO region (ten points on the map and 17 when the region is explored in more detail (in the case of the latter this includes a combination of preserved specimen from herbariums and human observations).

*Glycine max* (soybean) is grown within the EPPO region. The largest soybean producers are Italy, Romania, France and Hungary accounting for more than 80% of EU cultivation area. In Italy, soybeans are produced in the northern regions of the country, with the province of Veneto accounting for 50% of the nation's total soybean production.

*Juglans regia* (walnut) is widespread and native within the EPPO region. The species is economically important and grown worldwide for its timber and edible nuts (Pollegioni *et al.*, 2017). Kyrgyzstan hosts unique pure walnut forests (EPPO thousand cankers PRA).

*Persea americana*: within Europe, Spain has a commercial production and is the largest producer of avocados (92 936 tonnes 2017; 11 455 ha (2016 data (MAPA, 2018)) mainly along the coast of Malaga and Granada. In addition, avocado production for 2017 (in tonnes) was as follows countries: Bosnia and Herzegovina (1 053), Cyprus (885), Greece (1 515), Israel (110 000), Tunisia (328), Turkey (2 765) (FAO, 2018).

*Prunus armeniaca* and *P. persica* are grown commercially mostly in the southern part of the region but are also present further North in small holdings and gardens (as well as *P. persica* var. *nucipersica*). In 2013, according to FAOSTAT, apricot and peach were cultivated commercially in 36 EPPO countries on over 370.000 ha. In terms of area, the top 5 EPPO countries were Spain, Italy, Greece, Turkey and Algeria (with ca. 84.000, 76.000, 43.000, 29.000 and 19.000 ha. respectively). Italy and Spain were the 2nd and 3rd producers worldwide (1.402.000 t and 1.330.000 t) and Greece, Turkey, France, Algeria, Tunisia and Uzbekistan were amongst the 20 largest producers worldwide (from the EPPO PRA on *Candidatus* 'Phytoplasma phoenicium').

*Prunus dulcis* production is more concentrated in warmer parts of the EPPO region. In 2013, in the EPPO region according to FAOSTAT, almonds were cultivated in 24 EPPO countries on over 1.058.000 ha, including the Mediterranean Basin, Turkey and Uzbekistan. Spain was the 3rd producer worldwide (149.000 t), and Morocco, Turkey, Italy, Tunisia, Algeria, Greece, Uzbekistan and Israel were amongst the 20 largest producers worldwide (from EPPO PRA on *Candidatus* 'Phytoplasma phoenicium').

*Prunus avium* and *P. domestica* are also widely grown, as well as *Malus domestica* and *Pyrus communis* (no detailed data were sought).

*Vitis vinifera* is widely grown in the EPPO region. In 2015, it was cultivated on 4.530.132 ha in total. The largest areas were in Spain, France, Italy and Turkey (67% of the total), with substantial areas also in Portugal, Romania, Moldova, Uzbekistan (13% of the total). In recent years, the northern limit of grapevine growing has moved further north with increasing production in countries including UK and Belgium (EPPO PRA on *Oemona hirta*, 2015).

Many of the weeds recorded as hosts in Chile are native to the EPPO region where they are also weeds.

**Other species reported as hosts or damaged by *N. xanthographus* but for which evidence is lacking that they are true hosts (see section 7B)**

Species listed in Table 3B have been reported as hosts or damaged by *N. xanthographus*, but there is no information that these plants can support complete development of the pest. These plants are grown throughout the EPPO region in varying abundance. No quantitative data was sought. Some species are more abundant in the warmer Mediterranean part of the region and Central Asia, like *Olea europaea* and others are grown in more continental regions such as *Beta vulgaris*. Species such as *Fragaria*, *Solanum lycopersicum*, *Rubus idaeus* and *Phaseolus vulgaris* are grown widely in the EPPO region, commercially in the field or under protected conditions (glasshouse, tunnels, plastic) and in gardens. *Helianthus annuus* is grown throughout the EPPO region both as a field crop and also as an ornamental species.

In summary, host plants are numerous within the EPPO region and include economically important crop species, ornamental species within the horticulture trade and native plant species found throughout the EPPO region. Many of the economically important plant species are grown within the warmer areas of the EPPO region (for example *Citrus* and *Prunus* species). In addition, *N. xanthographus* has passed onto new hosts in its native range, and this may also happen if it is introduced in the EPPO region.

**9.2 Climatic suitability**

In the native range, *N. xanthographus* is present in the Köppen-Geiger (Annex 4) climatic zone Cfa and Cfb (i.e. Argentina, Brazil and Paraguay). The species is also present in zones Cwa, Cwb, Bsh, Bsk and Bwh though it is probable that, in some of these, it is due to artificial irrigation being used in agricultural systems. In Chile, where the species is non-native, *N. xanthographus* is present in the Köppen-Geiger zone Csb and Bwk. Within the EPPO region, all these climate categories occur with Cfb covering the biggest area.

With regard to plant hardiness zones (Annex 5), within the current area of distribution (Table 2), *N. xanthographus* appears to occur mostly in the plant hardiness zones 7 to 10 Zones 7, 8 and 9 are present within the EPPO region. Plant hardiness zone 9 is most aligned to the natural area of distribution in the native range and occurs within the EPPO region in Albania, France, Ireland, Italy, Spain, and the United Kingdom. The EWG considered that summer temperatures seem to be a more important factor for establishment in the EPPO region than winter temperature, because the overwinter larvae are deep in the soil, hence buffered from low temperatures.

Guzmán *et al.* (2012) showed, through ecological niche modelling using MAXENT, that the climate was favourable for the establishment of *N. xanthographus* in France, Portugal, Ireland and the United Kingdom. There is also some indication that parts of Morocco and Italy (North Italy and Sardinia) and the southern area of Spain are suitable for the establishment of *N. xanthographus*. Other areas of the EPPO region were not suitable. The three variables which provided the most useful information for the model were annual mean temperature, isothermality and temperature annual range. Guzmán *et al.* (2012) highlight that the ecological niche of *N. xanthographus* appears to be defined by mean annual temperature values of 15 – 18 ºC, isothermality values of ≤ 40 and an annual temperature range of 26-28ºC. However, the EWG considered that this modelling underestimates the potential area of distribution, as *N. xanthographus* occurs in multiple Köppen-Geiger climatic zones and these encompass a far wider range of temperatures. In addition, it does not take account of areas where irrigation is used and where temperatures are suitable for *N. xanthographus*.

Sub-optimal climate conditions within areas of the EPPO region may significantly influence the area where the species may occur and its life cycle. Temperatures at 20 cm depth in the soil have to reach 13.5 ºC for the emergence of adults from the soil. It could be that a major factor in limiting the potential distribution within the EPPO region is the soil temperature, and how early in the year the 13.5 °C threshold is reached. Although soil temperatures are difficult to find across the EPPO region, information from areas where they are available indicate that 13.5 °C can be achieved from May through to October (data from the south east of the United Kingdom (UK Met Office data), and this is likely to be extended in the southern regions of EPPO. In these areas there should be enough thermal energy for adults to lay eggs and the larvae to develop to sufficient maturity to overwinter. Within its current area of distribution, *N. xanthographus* shows a moderate level of variation in phenology for all stages of its life cycle. The completion of the life cycle has been shown to range from 12 to 16 months depending on the climatic conditions (Lanteri & del Río, 2017; Luppichini *et al.*, 2013; Ripa, 1992; pers. comm. A Lanteri, 2019). Thus, the species shows plasticity to environmental conditions which can benefit its establishment into new areas. The period for egg development has been shown to range from 10 to 30 days (during March to April) and from 42 to 98 days during May to July depending on the ambient temperatures (Loiácono & Díaz, 1992). Within the EPPO region, sub-optimal climate conditions may act to extend the period of development in the below-ground stage (larvae, pupae) and reducing the time period when adults emerge from the soil. In Chile, three peaks of emergence can occur where the first is in late spring, the second in early summer and a third can occur in late summer (mid-February to March in Chile) (Ripa, 1986): this may be reduced to a single emergence period within some areas of the EPPO region.

In addition to temperature, precipitation and humidity have been highlighted as important abiotic factors in the establishment of *N. xanthographus.* In dry areas and during very dry summers, the larval development is prolonged and can extend to the next year (pers. comm. A Lanteri, 2019). Artificial irrigation is essential for the survival of *N. xanthographus* in dry areas of Argentina and Chile. This may also facilitate its establishment in the EPPO region, as in dry areas within the EPPO region, host crops have irrigation and plots are not usually dry.

Soil humidity, which is important for the survival of the larvae and essential for the emergence of adults (they usually emerge after rain), may act to limit the potential area of establishment. *N. xanthographus* naturally occurs in areas with 1000-2000 mm maximum annual precipitation. Minimum annual precipitation may be important, but this may not be limiting in areas where irrigation is applied.

The EWG found it very difficult to predict the potential area of distribution in the EPPO region. The climatic conditions in the Mediterranean area are considered suitable for establishment where irrigation is used. The EWG found it very difficult to indicate the northern and eastern limit of its potential distribution due to the lack of information on thresholds (in terms of temperature, rainfall, etc.) for survival and thermal energy for completion of the life cycle.

**9.3 Biological considerations**

If the pest enters as adults, for the establishment of a population, there should be simultaneous entry of at least a male and a female, or a gravid female. If a female arrives, there is a high likelihood that it is gravid. Adults can live for 4 months. However, individuals should be fit enough for reproduction, which may be affected by transport conditions. The female needs to find a suitable place for oviposition and females need foliage to feed before laying eggs, therefore finding host plants or being imported on host plants that are moved to suitable conditions is essential to establishment.

Countries where the pest occur have exported grapes for decades to many other countries. It is known that adults have reached other countries with fruit (based on known interceptions e.g. in the USA and the EPPO region). The pest has been intercepted in the USA many times, which suggests that the pest has arrived many times with fruit without being detected as only a sample of a consignment is usually inspected at import (it is not feasible to inspected every bunch of grapes that arrives). However, establishment has not happened. This may be due to the lack of fitness of the weevils at arrival, or because the pest needs to go through many steps (arrival, finding a host ect.) before it is established or other factors may prevent establishment (e.g. arrival in winter where the climatic conditions are not suitable). The phytosanitary requirements that were applied at the time of the interceptions are also not known.

If a gravid female is able to transfer, depending on the age of the female, oviposition may occur from shortly to few weeks after arrival. Females can lay up to 850 eggs and may retain viable sperm for 3.5 months. The neonatal larvae need to find a host to feed on rootlets, and development needs to be completed through the larval and pupal stages to adults.

A viable egg cluster present on a traded plant would present a higher chance of establishment. There are up to 20-25 eggs in a cluster. Eggs are relatively tolerant to low temperatures and when the temperature increases, eggs can continue their development. If a viable egg cluster is present on a plant, which is planted in the field, it is likely to lead to neonatal larvae. These would need to find rootlets to feed on, and development should be completed through the larval and pupal stages to lead to adults.

If larvae are present in the traded growing medium, they would only establish if a host with roots of a suitable size is planted in the medium. It is possible that neonatal larvae have a more restricted host range. Larvae could be associated with plants for planting with growing medium, in which case a host is already present.
If pupae or teneral adults are present in growing medium, they would need suitable conditions to emerge from the soil (13.5 ºC soil temperature). They may be associated to plants for planting with growing medium. However, pupae and teneral adults are very sensitive to disturbance, temperature, dry conditions, pathogens, etc.

The fact that *N. xanthographus* is flightless may act to promote locally high populations which increases the chance for females and male to find each other and mate provided that sufficient host plants are present at the site where the pest entered initially.

The related species *Naupactus cervinus* and *N. leucoloma* have moved internationally and have established in the EPPO region (EPPO, 1999; Germann, 2016). One major difference with *N. xanthographus* is their parthenogenetic reproduction, which is considered as favouring establishment (Guzman et al., 2012).

*N. xanthographus* has one generation per year in its current area of distribution, with a life cycle of 12-16 months. In the EPPO region, it is not known if the life cycle could be longer outdoors in suboptimal areas.

### 9.4 Conclusion on the likelihood of establishment outdoors

The EWG assessed that the climatic conditions are appropriate in part of the EPPO region, at least in the Mediterranean area, and the host plants would not be a limiting factor. All the hosts detailed in this PRA are present in the part of the EPPO region which has a climate suitable for *N. xanthographus* (taking into account irrigation in drier areas). However, the EWG noted that the probability of establishment after entry is different for different pathways because they carry different life stages and possibly different numbers of individuals. Plants for planting are considered to be the pathway that lead to establishment in Chile as well as Juan Fernandez and Easter Islands.

Considering the biological factors above, the EWG considered that the probability of establishment would depend on the life stages that could be associated with the different pathways, and establishment was thus rated separately following entry on fruits (adults), bare rooted plants (eggs) and plants for planting with growing media (eggs, larvae, pupae, teneral adults).

**Rating of the likelihood of establishment outdoors**

**For plants for planting with growing medium**

| | | | | | |
|---|---|---|---|---|---|
| *Rating of the likelihood of establishment outdoors* | *Very low* ☐ | *Low* ☐ | *Moderate* ☐ | *High* ☒ | *Very high* ☐ |
| *Rating of uncertainty* | | | *Low* ☒ | *Moderate* ☐ | *High* ☐ |

Note that on **bare rooted plants**, the rating of the likelihood of establishment outdoors is **moderate with a moderate uncertainty** (fitness of the eggs, lack of evidence), and if entry on **fruit**, it is **low with a low uncertainty (**based on circumstantial evidence: many interceptions but no known establishment)

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

In Chile, *N. xanthographus* is occasionally present in protected conditions/nurseries on *Citrus* or ornamental plants; however, this is rare due to the level of pest control in the nurseries. It can be maintained for experimental purposes in potted plants under protected conditions (pers. comm. R. Ripa, 2019). In all cases, production under protected conditions is likely to be subject to some controls that may help early detection. The pest control methods applied in protected conditions may have a medium impact on establishment of the pest, e.g. adults if insecticide sprays are applied.

Areas where hosts are grown under protected cultivation in the EPPO area are likely to be at risk. This relates especially to woody hosts cultivated in protected conditions, such as in nurseries, tropical greenhouses e.g. in botanical gardens. Host trees, including fruit trees are generally not grown in protected conditions, but there are some specialized productions. For example, for early fruit production, peach trees are grown commercially in tunnels in Jordan, apricot trees in Turkey (EPPO, 2017), and high economic value cherry trees in Spain (pers. comm. N. Avendano, Tecnologias y Servicios Agrarios, Spain, 2019). In the UK, there is a small amount of fruit e.g. *Prunus avium* grown in “semi protected cultivation” – essentially polytunnels with roof and reduced sides, and special dwarf tree cultivars.  It was not investigated further whether other host fruit trees are grown commercially under protected conditions in the EPPO region.

Host trees may also be temporarily grown under protected conditions in nurseries. If plants are brought into glasshouses, their presence in glasshouses would probably be temporary, but the pest may find other hosts.

In protected conditions, the life cycle may be shorter.

Some plants whose host status is not clear (see table B) are also grown under protected conditions, such as *Fragaria* and *Solanum lycopersicum.*

The management of temperatures under protection (e.g. polytunnels, glasshouses) maintains average temperatures between 20 and 35°C, which are suitable for the pest. There is an uncertainty on whether the pest would survive during periods when no suitable crop is grown in protected conditions, especially as the species is flightless and movement to other hosts may be restricted. However, female may still lay eggs and there may still be root biomass belowground to support initial development of the larvae. In areas where the pest can survive outdoors, the presence of wild hosts may facilitate reintroductions into glasshouses.

**Conclusion on the likelihood of establishment in protected conditions**

The EWG consider that conditions in protected cultivation are suitable for establishment (especially where host plants are continuously grown over multiple seasons). However, individual transient outbreaks may eventually be eradicated if the pest has not established outdoors (see section 16.1). However, it is recognized that the area concerned by such establishment is marginal compared to outdoor areas. The same biological considerations apply as for establishment outdoors.

The potential for establishment would depend on the commodity which the pest has arrived on. The likelihood of establishment would increase if the commodity is placed in or very close to hosts grown in protected conditions. Imported fruit may be repacked in or close to areas where crops are produced in protected conditions. However, the frequency by which this will happen is considered to be very low. In protected conditions, adults would find suitable conditions at a time when the climatic conditions outdoors are not favourable. Male and female adults are more likely to find each other and mate. Plants for planting may be brought directly to protected conditions (e.g. nurseries). Conditions are more constant than outdoors, and there would be better chances for a population to develop, although the pest may be detected and managed.

**For plants for planting**

| | | | | | |
|---|---|---|---|---|---|
| *Rating of the likelihood of establishment in protected conditions* | *Very low* ☐ | *Low* ☐ | *Moderate* ☐ | *High* ☒ | *Very high* ☐ |
| *Rating of uncertainty* | | | *Low* ☐ | *Moderate* ☒ | *High* ☐ |

Note that on **bare rooted plants**, the rating of the likelihood of establishment outdoors is **moderate with a moderate uncertainty**, and if entry on **fruit**, it is **low with a moderate uncertainty**

## 11. Spread in the PRA area

### 11.1 Natural spread

*Naupactus xanthographus* may spread naturally but since the species is flightless, natural spread is expected to be slow. However, females of the closely related species, *Naupactus leucoloma*, which is also flightless and smaller than *N. xanthographus* (8-12 mm instead of 12-16 mm – EPPO, 1999 and this PRA), have been reported as crawling between 0.4 and 1.2 km during their 2-5-month adult life span (Metcalf & Metcalf, 1993) and adults of *N. xanthographus* can live for up to four months or maybe even longer (see 2.2. Life cycle). However, there are differences in the patterns of movement: *N. xanthographus* normally climbs on a plant and moves within this plant, while *N. leucoloma* has been recorded to walking long distances on the ground(Metcalf & Metcalf, 1993). *N. xanthographus* may move between plants with branch contact or structures connecting plants. *N. xanthographus* may move to close by hosts or neighbouring plots/orchards. For these reasons, the natural spread of *N. xanthographus* is expected to be slower than for *N. leucoloma*.

*Naupactus* adults have been observed to float on plant parts along rivers. The same may happen with eggs attached to plant material. Neonatal larvae of *N. xanthographus* may fall into water and be carried through irrigation systems (R. Ripa, pers. comm. 2019).

### 11.2 Human-assisted spread

There is the potential for longer distance dispersal in commodities transported internationally (for example fruits and plants for planting). Hitchhiking may also play a role locally. Trade of fruits has been shown to transport the pest. Within the EPPO region, the pest could move with fruits and conveyances (especially crates which have carried infested commodities), and with plants for planting. Adults may adhere to clothes, and this may contribute to local spread. Moreover, the pest can be carried by travellers such as with fruits (e.g. grapes) and plants for planting.

There is a massive movement of fruits and plants for planting of host plants between countries of the EPPO region, including of large plants that may be associated with large quantities of growing medium. also (Table 4).

### 11.3 Conclusion on spread

Long-distance spread will only be by human-assisted spread, and natural spread will only be local and slow. Human-assisted spread will also facilitate local spread. The pest can spread with plants for planting, fruits, boxes used for harvesting and by adhering to clothing. The magnitude of spread will very much depend on the practices (movement of equipment etc) within the fields/orchards, and practices applied to the various commodities, both in the country of origin and destination within the EPPO region. In many countries such practices may be enough to restrict a high rate of spread.

| | | | | | |
|---|---|---|---|---|---|
| *Rating of the magnitude of spread* | *Very low* ☐ | *Low* ☐ | *Moderate* ☐ ☒ | *High* ☐ | *Very high* ☐ |
| *Rating of uncertainty* | | | *Low* ☐ | *Moderate* ☒ | *High* ☐ |

## 12. Impact in the current area of distribution

### 12.1 Nature of the damage

In Chile, the impact is high on grapes, peaches and nectarines. Impact is worse when weeds are present. On other fruit hosts, it is present but impact is generally low (R. Ripa, pers. comm. 2019).

In South America, one of the most severely affected host plants is grapevine (*Vitis vinifera*) due to the damage *N. xanthographus* inflicts on the species in Chile, Argentina (Mendoza) and Brazil (Rio Grande do Sul) (Caballero 1972; Ripa 1986a; Koch & Waterhouse, 2000; Lanteri *et al.* 2002; Ripa and Larral 2008). Especially in Chile, where *N. xanthographus* is an introduced species, it is regarded as one of the most important pests of grapevine due to its direct feeding of larvae on the roots of host plants and superficial damage by adults on leaves and fruits (González 1989; Ripa, 1992). The most obvious damage (impact) is caused by adults, which feed on grapevine shoots and leaves, being particularly injurious to young plants. This feeding behaviour produces a characteristic “notching” on the leaf margins. Most severe damage is due to larvae. Mortality of plants has been observed only on some species such as peach and nectarine (R. Ripa, pers. comm. 2019). Plants look weak with chlorosis because of the reduced water and nutrient uptake and potassium deficiency.

In Chile, peach and nectarine is also attacked. For example Caballero (1972) noted that mature peach trees attacked by an average of 100 larvae decline in their production or die after 4 to 5 years of attack. In Chile, there is no economic damage on *Citrus*, but it supports the pest and has been a means of movement of the pest. INIA (2008) mention that the most severe attacks on *Citrus* and avocado are observed in areas where there had previously been grapevine, peach, alfalfa, etc. and where the larvae still remain viable in the soil.

In recent publications, mentions of impact relate mostly to grapevine and alfalfa. *N. xanthographus* seems to otherwise be part of the pest complex of many fruit crops. Damage to field crops other than alfalfa (e.g. potato) is not detailed in recent publications.

In Argentina and Uruguay (where it is native), *N. xanthographus* is usually not very damaging. Some damage has been recorded on alfalfa (*Medicago sativa*) and garden plants in Argentina, but to a lesser extent than in Chile (Lanteri *et al.*, 2002). In Argentina, it causes damage in combination with other weevil species (Lanteri, pers. comm.).

In addition to grapevine, in Chile and Argentina, *N. xanthographus* is mentioned in the management recommendations or pest inventories of other fruit crops, such as red fruit (del Río *et al.*, 2010), strawberry (listed with other weevils; Cisternas, 2013a), raspberry (Cisternasb, 2013b ) olive (Quiroz & Larrain, 2003 cherry (Lorenzatti, 2007 and 2008 cited in Sinavimo 2019), pome fruit (Cichon *et al*, 1996, Cucchi *et al.*, 2007, cited in Sinavimo 2019), soya (Lorenzatti de Diez *et al.*, 1997, Saini, 2001 cited in Sinavimo, 2019), as well as sunflower (Saini 2004 cited in Sinavimo, 2019).

No detailed information was found on impact in southern Brazil, Paraguay or Uruguay.

### 12.2 Direct and indirect impact on fruit and other host production

Ripa (1992) report that in some regions, *N. xanthographus* can reduce grape production by up to 30 % and this is mainly due to the larva feeding on the root system. Howerver, when talking to farmers in the region V of Chile, Ripa (1992) estimated that the damage due to infestation of *N. xanthographus* can reach up to 60 %.

### 12.3 Impact on export markets

*Naupactus xanthographus* has caused export problems in countries where it occurs because of quarantine requirements of importing countries. The detection of the pest in consignments can lead to their rejection. This can be of high economic loss considering that Chile exports a high percentage of its fruit grown in-country. For example, it is estimated that in 2013 and 2014 Chile exported 95 % and 94 % of its grape production, respectively (FAO, 2016). Ripa (1992) show that the presence of adult *N. xanthographus* on table grapes for export has resulted in the rejection of the commodity. Between 1981/82 and 1982/1983, 43.6 and 38.6 % of checked lots were rejected for export, respectively (Ripa, 1992).

### 12.4 Environmental impact

There are few data available on the environmental impact of the pest. There are no known studies that have assessed the ecological impact of the pest on native biodiversity where the species is known to be problematic (i.e. Chile). However, control methods involve chemical control of the pest and as such chemical applications may have detrimental impacts on the environment.

### 12.5 Existing control measures

***Physical barriers on host plants***

The control of *N. xanthographus* in Chile has focused on the control of the adults through two main methods. Firstly, the establishment of a toxic barrier (local restricted chemical control) on the trunk of individual host species. As the species is flightless, this can be an effective method of preventing adults reaching the foliage of the host plant. Ripa (1992) detail that this method involves the placement of a plastic film (material) smeared with an insecticide paste (INIA Pasta 82.4: contains 4 % concentrations of azinphos-methyl) [‘insecticide bands’ below] that causes insect mortality when it walks on it. A strip of polyethylene, 15 to 20 cm wide, is rolled around each trunk and attached at a height of 1 m at 1.2 m above ground level. If stakes are used to support the host plants, these must also be treated using the same method. The insecticide bands must be installed before the emergence of the adults from the soil. The bands that are currently available lose effectiveness after 180days (pers comm. R Ripa, 2019).

In organic production areas, the use of synthetic insecticides is not accepted. Therefore, Pinto & Zaviezo (2003) studied the use of organic substitutes (mineral oil, azadirachtin and polybutene) under laboratory and greenhouse conditions, in comparison with the traditional options (azinphos-methyl and INIA mix). Azinphos-methyl and INIA mix show a high mortality (Pinto and Zaviezo, 2003). Mineral oil, azadirachtin and polybutene can show an initial higher mortality than the control, with azadirachtin being as effective as the traditional chemical treatments.

***Chemical control***
Chemical application of the foliage has been applied in Chile against adults (for example Indoxacarb). Luppichini *et al.* (2013) highlight that the effectiveness of pesticides is short-term. Effectiveness can be achieved up to reach 30 days or more (R. Ripa, pers. comm. 2019).

The commercial product INIA Pasta 82.4 with 4% concentrations of azinphos-methyl showed 100 % control of adults (Ripa, 1987).

***Cultural control***
Polyethylene sheets can be placed under the host plants and the trunks can be tapped (with a rubber mallet) so that adults may fall from the infested plants and be collected in the polyethylene sheets (Ripa, 1992). However, this is mostly used as a monitoring method. Weed control is used to lower infestations by removing food sources for the larvae. New crops should not be established in contaminated fields until the pest has been eradicated.

Ploughing to a sufficient depth would damage and disturb life stages in the soil (R. Ripa, pers. comm. 2019).

***Biological control***
*N. xanthographus* larvae have been shown to be susceptible to the fungus *Metarhizium anisopliae*. Ripa and Rodríguez (1989) tested 8 isolates of the fungus against larvae and showed it had high virulence when used in spore suspensions of $10^6$ and $10^7$ conidia/spores per ml. The strains IP1 and CM-14 caused the highest mortality. Additionally, Ripa (1992) showed that *M. anisopliae* var. *major*, *M. anisopliae* var. *anisopliae*, and *Beauveria bassiana* can cause mortality of the larvae. Other organisms such as nematodes (e.g. *Steinernema feltiae)* and parasitic wasps (e.g. *Platistaslus asinus*) have been evaluated as potential biological control agents but there is no data on the effectiveness of these biocontrol agents at the present time (R. Ripa, pers. comm. 2019).

The EWG only rated the impact in Chile where the pest has been introduced. Uncertainty is due to the limited amount of quantitative data. The impact in other countries was not rated because of the lack of information.

| *Rating of the magnitude of impact in Chile* | | *Very low* ☐ | *Low* ☐ | *Moderate* ☐ | *High* ☒ | *Very high* ☐ |
|---|---|---|---|---|---|---|
| *Rating of uncertainty* | | | | *Low* ☐ | *Moderate* ☒ | *High* ☐ |

**13. Potential impact in the PRA area**
Will impacts be largely the same as in Chile? **Yes** especially in the Mediterranean region

*N. xanthographus* may cause damage to a large number of host plants, in particular fruit trees. Yield losses are expected in especially grapevine which is a high value crop in the Mediterranean region. . If. This includes both plants in production and young plants (which may be damaged or killed – see section 7). All fruit trees are perennial plants and the establishment of *N. xanthographus* would have long term consequences.

Specific control measures may have to be implemented against *N. xanthographus*, especially in fruit trees, which will increase production costs. Insecticides that have been used in Chile are not available in Europe (e.g. azinphos-methyl) and other phytosanitary treatments may not be available. Insecticide bands around trees are used in some circumstances against *Cydia pomonella* for apple in the UK. However, this would require that insecticides are authorised for this purpose. In addition, grapevine has a high density of plants and the method will thereby have a high cost.

Cropping in the EPPO region often relies on Integrated Pest Management (IPM) strategies targeting specific pests, and it will take several years before control may be included in IPM programmes in the PRA area, and impact may be high in the meantime. Adding new specific treatments against *N. xanthographus* may have an effect on the IPM techniques (e.g. effects on natural enemies). Biological control would have to be investigated. In addition, due to the need for more applications of insecticides, in addition to those already applied against other pests, the MRL (maximum residue limits) may be exceeded.

It is not known if potential effective natural enemies to control *N. xanthographus* are present in the EPPO region. However, the natural enemies reported in Chile do occur: *Beauveria bassiana* and *Metarhizium anisopliae* and are used in crop production, *Steinernema feltiae*, *Heterorhabditis* and other entomopathogenic nematodes are also present.

Loss of fruit harvest or young plants will depend on the type of crop, as well as on the pests already present and how they are managed. It is not known whether the timing of applications against other pests would be suitable for, hence effective against, *N. xanthographus*. The impact may be major in the first years after the pest has built up damaging populations, before new control techniques are developed. The time taken to register necessary plant protection products could contribute to limitations on control options.

*Impact on export: Naupactus xanthographus* will have an impact on exports. It is a quarantine pest for many countries in the Americas and Asia. There is a large trade of the main fruit commodities within the EPPO region (see fruit pathway under section 8), and the major exporters probably export also to countries outside the EPPO region. There is a zero tolerance for the presence of adults, pest body parts in fresh or canned fruit within the EU and for export to some other countries (e.g. Japan). The presence of the pest may have a high impact on some major exporters, but the effect is rated as moderate for the entire region.

It is not known if *N. xanthographus* would have an impact on species other than fruit trees or on plants in the wild (for example *Juglans regia*). Such effects are apparently not observed in South America. It may have impact in gardens or on *Medicago sativa*, as reported from Argentina.

As potential impacts in the PRA area are considered by the EWG to be the same as those for the current area the ratings are high with a moderate uncertainty.

| | | | | | |
|---|---|---|---|---|---|
| *Rating of the magnitude of impact in the PRA area* | *Very low* ☐ | *Low* ☐ | *Moderate* ☐ | *High* ☒ | *Very high* ☐ |
| *Rating of uncertainty* | | | *Low* ☐ | *Moderate* ☒ | *High* ☐ |

**14. Identification of the endangered area**

There is a not enough information available to determine the northernmost limit of potential establishment but for the purposes of this PRA the EWG considered *N. xanthographus* has the potential to establish in the warmer areas of the EPPO region, in particular the Mediterranean region. This mainly concerns host plants grown on a commercial basis in particular *grapevine*, peach and nectarine, and for other host plants there would be impact on export such as for citrus, kiwi, apple, pear, blueberry and avocado.

There is an uncertainty on potential impact on hosts in other parts of the EPPO region, but even in the case of transient populations, there may be impact on exports.

**15. Overall assessment of risk**

Summary of ratings:

| | **Likelihood** | **Uncertainty** |
|---|---|---|
| **Likelihood of Entry (overall)** | **High** | **Moderate** |
| Grapes and packaging of grapes | Moderate | High |
| Other fruits and their packaging | Moderate to low | High |
| Unrooted cutting | Very low | Low |
| Rooted cuttings in small plugs | Very low | Moderate |
| Bare rooted plants | Moderate | High |
| Plants with growing medium | High | Moderate |
| **Likelihood of establishment outdoors**<br>**If entered with**<br>- plants for planting with growing medium<br>- bare rooted plants | <br><br>High<br>Moderate | <br><br>Low<br>Moderate |

| | | |
|---|---|---|
| - fruits | Low | Moderate |
| **Likelihood of establishment in protected conditions**<br>**If entered with**<br>- plants for planting with growing medium<br>- bare rooted plants<br>- fruits | <br><br>High<br>Moderate<br>Low | <br><br>Moderate<br>Moderate<br>Moderate |
| **Rate of spread** | Moderate | Moderate |
| **Magnitude of impact in Chile** | High | Moderate |
| **Magnitude of potential impact in the EPPO region, especially the Mediterranean region.** | High | Moderate |

*N. xanthographus* is a flightless weevil native to the pampean biogeographical provinces of South America (in Paraguay, Uruguay, Brazil, and Central northeastern Argentina). It is very polyphagous, with a number of fruit woody hosts (including berries), and herbaceous hosts such as alfalfa. It is of minor importance in Argentina, but after introduction into Chile it has become a major pest, especially on grapevine, peach and nectarine. It has quarantine status in a number of countries, including the USA, and the pest has had major impact on fruit trade. It has a 12-16 months life cycle. Eggs are laid in bark crevices, larvae, pupae and teneral adults are in the soil, and adults live on the aboveground foliage. Larvae are usually in the soil below 20 cm, although this does not apply to pots. Neonatal larvae feed on rootlets and it is thought that the presence of weeds is important in the life cycle. The damage is mostly due to all larval stages feeding on root systems, and adults feed on foliage. Unlike some other *Naupactus* spp., it is not parthenogenic. Many host plants are present in the EPPO region including several weed hosts.

The EWG noted that certain pathways are closed in many EPPO countries due to prohibitions and regulations currently in place. In addition, no complete data on trade were available for the whole EPPO region, and the pathways were assessed assuming that there is import. Plants for planting with growing medium may carry all life stages, and the likelihood of entry was rated as high with a moderate uncertainty. Bare rooted plants may carry eggs, and the likelihood of entry was rated as moderate to high with high uncertainty. Fruit carry only adults. Given the many interceptions on fruit, it is not clear why the pest has not already established in other areas. The likelihood of entry on fruit was rated as moderate with a high uncertainty for grapes and low with a moderate uncertainty for other fruits. Entry on rooted cuttings in small plugs was rated as low with a low uncertainty. A number of pathways identified, although not considered unlikely, could not be studied in detail. These include travellers transporting fruits and plants, growing medium on its own or associated with non-host plants, contaminant of containers or with soil attached to used vehicles, machinery and equipment used machinery. A large number of other pathways were considered but rated as very unlikely (section 8.2).

The EWG considered that the distribution of hosts plants would not be limiting for establishment in the EPPO region, and that climatic conditions would be suitable at least in the Mediterranean region (due to lack of information, the EWG was not in a position to determine the northernmost limit of potential establishment). The EWG considered that the likelihood of establishment would depend on which commodity the pest entered because the different pathways may carry different life stages in different numbers. Establishment outdoors if entered on plants for planting with growing medium had a high likelihood with low uncertainty, on bare rooted plants a moderate likelihood with moderate uncertainty and on fruit a low likelihood with moderate uncertainty. The assessment for establishment in protected conditions was similar.

Natural spread would only be local. The pest would spread longer distances through human-assisted pathways, such as the trade of plants for planting and fruits. Spread within a production area with human assistance could be high (e.g. harvesting boxes and bins, clothes, irrigation etc.). The magnitude of spread was assessed to be moderate with a moderate uncertainty.

Potential impact in crop production in the most suitable parts of the EPPO region (e.g. the Mediterranean area) was rated similar to impact in Chile, with a high magnitude and moderate uncertainty. The presence of the pest is also expected to affect exports from the EPPO region. The EWG acknowledged that many of the measures used in Chile are either not available in the EPPO region (e.g. some insecticides) or would need to be adapted to e.g. IPM-procedures used in the EPPO region. Eradication may be feasible in some cases but it would require capacities for detection and identification as well as an early detection. Larvae are present several decimetres below soil level which makes eradication difficult already at the field level.

Because of the severe outbreaks in Chile, especially on grapevine, peach and nectarine, and the potential impact on these important host plants in the EPPO region, the EWG considered that phytosanitary measures should be recommended to prevent the introduction of the pest into the EPPO region.

Overall the EWG considered the phytosanitary risk to the endangered area to be moderate with a moderate uncertainty, based on the discussion detailed above. However, there was a minority opinion within the EWG that the phytosanitary risk to the endangered area is high with a moderate uncertainty. The minority opinion considered the high rating was justified based on the score for plants for planting with growing media attached (the likelihood of introduction was rated 'high') coupled with a high rating for impacts.

## Stage 3. Pest risk management

### 16. Phytosanitary measures

### 16.1 Phytosanitary measures to prevent entry

The entry section (section 8) identifies plants for planting and fruits from where the pest occurs as major pathways. Measures were considered for these pathways. For plants for plantings, measures were not considered necessary for unrooted cuttings. Measures are not evaluated in detail for rooted cuttings in small plugs but the EWG suggested a measure. Measures for packaging were added to the fruit and the plants for planting pathways.

The EWG suggested that measures for fruit should be applied for hosts in Table A and Table B (as adults may be associated to all those species). The Working Party on Phytosanitary Regulations (June 2020) recommended that measures were only needed for fruits of hosts in Table A. Regarding plants for planting, measures should apply to species in Table A (known to carry eggs and larvae), however there is an uncertainty on whether other plants can carry these stages. Annex 1 summarizes the consideration of measures.

The EWG considered imports of plants for planting (other than seeds, *in vitro* plants, unrooted cuttings and rooted cuttings in small plugs) from infested area as a high risk and would generally not advise to allow import of such plants. However, the risk could be reduced under conditions specified below.

It is noted that border inspections should be part of verification of compliance.

| Possible pathways (in order of importance) | Measures identified (see Annex 1 for detail) |
|---|---|
| **Host plants for planting (other than seeds, in vitro plants, unrooted cuttings, and rooted cuttings in small plugs) (see Table 3A Hosts of *N. xanthographus*)** | Pest free area (PFA)<br>Or<br>Plants should be produced in a pest-free production site for *Naupactus xanthographus* established according to EPPO Standard PM 5/8 *Guidelines on the phytosanitary measure 'Plants grown under complete physical isolation'*<br>Or<br>Pest free production site / Pest free place of production (Official inspections + Monitoring and Control methods against adults + measures in the buffer zone) (may only be feasible in areas of low pest density<br>Or<br>Post entry quarantine in the framework of bilateral agreements for small scale imports. Root washing (if soil or growing medium is attached) + visual inspection + Post-entry quarantine (3 months) (followed by root washing)<br><br>Handling and packaging methods to prevent the contamination by adults during storage and transport should be applied in addition to all above options. |
| Rooted cuttings in small plugs only | Use clean growing medium + visual inspection for larvae in production + treatment of the plants against adults |

| | |
|---|---|
| **Host fruits (see Table 3A Hosts of *N. xanthographus*)** | Pest free area (PFA)<br>Or<br>Produced in a pest-free production site for *Naupactus xanthographus* established according to EPPO Standard PM 5/8 *Guidelines on the phytosanitary measure 'Plants grown under complete physical isolation'*<br>Or<br>Harvested in South American winter (based on bilateral agreement – information on absence of adults)<br>Or<br>Pest-free production site/Pest free place of production (Official inspections + Monitoring and Control methods against adults + measures in the buffer zone)<br>Or<br>Washing (may be feasible for some fruit e.g. *Annona cherimola, Citrus limon, Citrus sinensis, Malus domestica, Persea americana, Prunus domestica, Prunus persica, Pyrus communis*))<br>Or<br>Treatment of crop + Visual inspection in the crop + Visual inspection of consignment [combination]<br><br>Handling and packaging methods to prevent the contamination of fruit consignments should be applied in addition to all above options. |

### 16.2 Eradication and containment in the EPPO region

*N. xanthographus* is flightless, has a long-life cycle (one generation per year),), but has two or three peaks of oviposition and times of adults emergence. Eradication may be feasible, but early detection is essential as the reproduction capacity is high and the pest can easily be spread by human assistance and established populations may be difficult to eradicate, especially life stages in the soil (larvae are present quite deep in the soil). The host range is also very broad. If eggs or larvae are detected in the field where *N. cervinus* occurs, identification of the species may be complicated. It may be difficult to detect the pest before it has spread to other places in the EPPO region through human-assisted pathways.

Eradication would be easier if the plants are grown in pots where the pest cannot reach the soil, than when plants are planted directly in the soil.

Eradication would be more feasible indoors because the growing medium could be eliminated or treated, removing larvae and pupae. Appropriate measures should be applied to ensure that adults are eliminated.

It would be useful to develop contingency plans in advance of the introduction of the pest.

Eradication measures that can be applied: intensive monitoring to determine pest distribution and densities (including using beating of trees, sleeves on the trees (to catch adults), soil sampling to find larvae), on hosts and on weeds,

- demarcation of infested zones and buffer zones,
- activities to reduce populations using insecticides (e.g. indoxacarb). However, larvae are deep in the soil,
- removal and destruction of vegetation, e.g. application of herbicides, ploughing,
- monitoring including identification for life stages in the soil (note: morphological identification is only appropriate for adult identification. Immature stages either need to be reared to adult or molecular methods need to be used),
- sleeves on trees to catch adults or poles, which simulates trees (with shade) with sleeve for the same purpose,
- barrier around the infested area to prevent exit of the pest from the area may be feasible on a very small scale,
- regulatory measures to prevent spread of the pest by human assistance (e.g. prohibition of the movement of host plant material from the demarcated area, cleaning/steam treatment of harvesting boxes),
- measures for cleaning of machinery,
- public information and outreach campaigns (support of residents and land owners).

The EWG discussed the size of the delimited area where eradication measures should be applied. It considered that the delimited area should be at least 100 m around a detection, but surveys should be done in a much larger area (e.g. 1 km radius), and trace-back and trace-forward studies should be carried out to identify possible areas infested by the pest.

**17. Uncertainty**

Main sources of uncertainty within the risk assessment are:

- What has prevented the establishment of the pest outside South America despite a high number of interceptions of adults in fruit consignments, and what the reason is for the lack of recent interceptions.
- Hosts: Association with the different hosts mentioned in the literature; full host range; host preferences,
- Climatic conditions limiting its establishment (incl. in South America), as well as area of the EPPO region suitable for establishment and endangered,
- Fitness of life stages after transport, especially adults and eggs,
- Role of weeds for larvae development,
- Potential number of generations per year and peaks of emergence in the EPPO region,
- Situation of the status of the species in Uruguay, Paraguay and Brazil (including associations with host plants and pest status).

**18. Remarks**

- Investigate control methods that could be applied if the pest was introduced (incl. development of insecticide bands),
- Study existing natural enemies in the EPPO region, using *N. cervinus* (as a key reference species), where it is present in the EPPO region.  In South America *N. cervinus* and *N. xanthographus* share parasitoids,
- Investigation to assess the viability/fertility of all life stages after transport on the different commodities, should be investigated,
- Early detection and contingency planning could be developed as this would be essential to allow for eradication,
- Development of awareness raising material (ect. posters, brochures).

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## ANNEX 1. *Consideration of pest risk management options*

The table below summarizes the consideration of possible measures for the pathways fruit, plants for planting and tubers and roots (based on EPPO Standard PM 5/3). When a measure is considered appropriate, it is noted "yes", or "yes, in combination" if it should be combined with other measures in a systems approach[5]. "No" indicates that a measure is not considered appropriate. A short justification is included. Elements that are common to both pathways are in bold.

| **Option** | **Host fruits** | **Host plants for planting other than seeds, in vitro plants and unrooted cuttings and rooted cuttings in small plugs** |
|---|---|---|
| Existing measures in EPPO countries | Partly, see section 8. **But not sufficient to prevent entry of the pest** | Partly, see section 8 |
| **Options at the place of production** | | |
| Visual inspection | Yes, in combination * (for measures marked with *, see after the table)<br>Part of infested fruits may be sorted at harvest if staff are trained adequately or by cleaning procedures. However, not every single individual, may be detected. US and EU interceptions on fruit indicate that not every adult is removed by current sorting and packing procedures.<br>Detection is very difficult in bunches of grapes where the insect can easily hide. | Yes, in combination*<br>**Rooted plants with soil or growing medium attached.** Adults, larvae and eggs may be associated. Visual inspection may detect adults (as for fruit) but eggs are small and may not be detected. Visual inspection for larvae in the soil or roots would not be reliable.<br><br>Yes, in combination*<br>**Bare rooted plants**. Only eggs are likely to be associated. Some egg masses may be detected, although eggs are small and may not be detected. |
| Testing | Not relevant. | Not relevant. |
| Treatment of crop | Yes, in combination*.<br>**Not reliable to guarantee pest freedom. New adults may emerge from soil. In addition, it is possible that adults can contaminate the fruits at harvest.**<br>However, insecticide bands can be placed around the trunk of each tree/shrub which is (nearly) 100% effective to prevent adults that emerge from the soil reaching the fruit. In addition, control methods can be applied at the border of a site to prevent the entry of adults from the surroundings. These measures are very effective in controlling adults and can lead to a site which is free from the pest most of the time. Only incidentally may adults enter the site. Combined with regular official inspection, this could provide a sufficient level of protection. | Yes, in combination*<br><br>*Plants in pots.* Soil treatments (e.g. insecticides, heat treatment) may eliminate most larvae and teneral adults, but probably not pupae. Aboveground sprays may eliminate most adults. The effect on eggs is not known. |
| Resistant cultivars | No. **No resistant cultivars are available.** | No |
| Growing the crop in glasshouses/screenhouses | Yes. This would require complete physical isolation (following EPPO Standard PM 5/8 *Guidelines on the phytosanitary measure 'Plants grown under complete physical isolation*'; i.e. including additional measures to guarantee pest freedom). Possible for some hosts, but difficult to implement | Yes, for bonsais.<br>Yes (theoretically) for others.<br>This would require complete physical isolation (following EPPO Standard PM5/8 *Guidelines on the phytosanitary measure 'Plants grown under* |

[5] 'The integration of different risk management measures, at least two of which act independently, and which cumulatively achieve the appropriate level of protection against regulated pests' (ISPM 5).

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| | in commercial production. It would require to prevent the entry of adults aboveground and of larvae below ground. Plants should be isolated from the ground (e.g. on tables) to avoid infestation by larvae (e.g. *Fragaria*, *Vaccinium*) or plants may be grown without growing medium.<br>**Complete physical protection against *N. xanthographus* may be difficult to implement in commercial production.**<br>Handling and packing should be done within the facility or assuring prevention from getting infested during transport/packing. Only new (or cleaned/disinfected) packaging should be used. | *complete physical isolation*' - EPPO, 2016, i.e. including additional measures to guarantee pest freedom). The growing medium used should be free from the pest. However, this is not common practice for nurseries, especially for trees, and would be realistic only for small scale production of high value material. This may be used already for mother plants of fruit crops with regards to other pests. Handling and packing should be done within the facility |
| Specified age of plant, growth stage or time of year of harvest | Yes for *Citrus*. *N. xanthographus* adults would not be associated with *Citrus* harvested in winter (see section 8.1). This would require a bilateral agreement, and the exporting country providing information about the presence of adults in winter. The EWG noted that this would depend on the area of origin (e.g. possibly not from areas with warm winters).<br><br>No for other fruits. Adults may be present at the time of fruit harvest. | Yes in combination* for *rooted plants*. The probability of association is reduced if plants are dormant (free of leaves and fruit) and free from soil (bare rooted). It cannot fully guarantee absence of the pest because eggs may be present on the trunk<br>The pest may be associated with the plants throughout the year. |
| Produced in a certification scheme | No<br>**Not relevant for an insect.** | No |
| Possibility for pest-free production site, place of production, area? | Yes (see detailed consideration for Pest-free site and Pest-free area below). | Yes (see detailed consideration for Pest-free site and Pest-free area below). |
| Pest-free production site | Yes, under complete physical isolation, following EPPO Standard PM 5/8 *Guidelines on the phytosanitary measure 'Plants grown under complete physical isolation*' (see above).<br><br>Handling and packing should be done within the pest-free production site Only new or clean/disinfected packaging should be used.<br><br>**The EWG considered that a pest-free production site without complete physical isolation is unlikely to be feasible, and would only be applicable in areas of low pest prevalence. However, it may be theoretically possible to establish a pest-free production site according to ISPM 10. Requirements should apply, such as:**<br>• **Official inspections**<br>• **Monitoring for adults**<br>• **Surroundings (buffer zone) free from hosts and weeds, no irrigation in the buffer zone, areas of production with naturally low rainfall and spraying with insecticides** | Yes, under complete physical isolation, following EPPO Standard PM 5/8 *Guidelines on the phytosanitary measure 'Plants grown under complete physical isolation*' (see above).<br><br>Handling and packing should be done within the pest-free production site<br><br>The EWG considered that a pest-free production site without complete physical isolation is unlikely to be feasible, and would only be applicable in areas of low pest density. However, it may be theoretically possible to establish a pest-free production site according to ISPM 10. Requirements should apply, such as:<br>• Official inspections<br>• Monitoring and control methods against adults<br>• Surroundings (buffer zone) free from hosts and weeds, no irrigation in the buffer zone, areas of production with naturally low rainfall, and spraying with insecticides |
| Pest-free place of production | Yes | Yes, as for fruit |

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| | **Requirements for pest-free production site should apply for all sites in the place of production where hosts are grown.** | |
| Pest free area | Yes<br>**PFA is a possible measure as described in ISPM 4.**<br>There are areas free from the pest in at least Argentina, Brazil **and** Chile. This is not known for Uruguay and Paraguay.<br>In order to declare a PFA, the exporting country should provide surveillance data to demonstrate that the pest is absent from all or part of its territory and information on how pest freedom is maintained.<br>If the pest is present in part of the country, specific surveys should be conducted to delimitate and to maintain the PFA. Measures should be in place to prevent that infested plants or fruit, or growing medium or packaging, are moved to the PFA. This may be difficult to implement due to the large number of host plants. To provide a buffer against the introduction of *N. xanthographus*, the PFA should be distant from any infestation (**t**he EWG did not recommend a distance appropriate for a PFA situation). There should be official inspections for the presence of *N. xanthographus* (during a sufficient period). No signs of the pest should have been found at least in the past 2 years, depending on the intensity of surveys. Immediately prior to export, consignments should be subjected to an official meticulous inspection. Material from a PFA should not be mixed in a consignment with material from areas that may be infested**.** | Yes, as for fruit |
| **Options after harvest, at pre-clearance or during transport** | | |
| Visual inspection | Yes in combination*<br>Interceptions of infested fruits at import inspection indicate that there is a risk of not detecting low infestation levels or early infestation prior to dispatch. Detection is much more difficult in bunches of grapes where the adults can easily hide. | Yes in combination*<br>*For bare rooted plants*. Plants should be inspected to verify the absence of eggs.<br><br>*For plants with growing medium*. Adults can be detected by visual inspection but they can remain undetected because only part of the consignment is usually inspected. Detection of all larvae (in the soil) and pupae is difficult. |
| Testing | No. **Not relevant.** | No |
| Treatment of the consignment | Yes (+ handling/packing preventing infestation)<br>- Thorough washing of the fruits would eliminate adults. Washing may be feasible for some fruits (e.g. *Annona cherimola, Citrus limon, Citrus sinensis, Malus domestica, Persea americana, Prunus domestica, Prunus persica, Pyrus* communis) but may not be feasible for all fruit (e.g. *Vaccinium*, table grapes). Other treatments may be possible but no information was found on effective quarantine treatments against *N. xanthographus*. Hot water or cold water immersions may be an option (though not suitable for table grapes and other soft fruits), as well as | Yes in combination*. Treatment would not guarantee the absence of the pest.<br><br>Treatment of plants in pots. Soil treatments (e.g. insecticides, heat treatment) may eliminate most larvae and teneral adults, but probably not pupae. Aboveground sprays may eliminate most adults. The effect on eggs is not known.<br><br>For bare rooted plants, the EWG did not know if hot water treatment or |

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| | irradiation, vapour heat treatment, insecticide sprays (from USDA treatment manual, 2019). Fumigation with methyl bromide is not recommended (phased out in 2015). Phosphine fumigation is applied in Chile to consignments of some fruits and is effective against *N. xanthographus xanthographus* (pers com, Ripa, 2019), but the EWG did not know if it was an acceptable option in the EPPO region. | insecticide dipping would be effective against the eggs.<br><br>Removal or replacement of growing media would reduce the larval association.<br><br>Root washing would eliminate larvae, pupae or teneral adults. |
| Pest only on certain parts of plants/plant product, which can be removed. | No. The presence or absence of green parts with the fruit does not significantly affect the likelihood of association of the pest with the fruit. | Not possible for plants for planting. |
| Prevention of infestation by packing/handling method | Yes, in combination* (additional to relevant measures)<br>Handling and packaging methods should avoid the contamination of fruit consignments.<br>Only new or disinfected/cleaned packaging should be used. After import, packaging should be destroyed or safely disposed of. | Yes, in combination*<br>Plants should be kept in conditions where they cannot be contaminated by adults. |
| Limited distribution in time and/or space or limited use | No because the application of this measure is difficult to control. For fruits, consignments may be imported during winter time in the EPPO region for immediate processing or direct consumption where *N. xanthographus* cannot survive outdoors. In any case, no handling or packing should be done in or in close proximity of a place producing host plants (separation of trade and production flows). However, it is difficult to guarantee that the consignment is used in a place which is separated from production, at least within the EU.<br>Immediate processing of the fruits and destruction of the waste (e.g. burning, deep burial) is possible, but it is not practical and difficult to control in practice. | No.<br>Not applicable for plants as the intended use is for planting. If adults emerged, they may find hosts in the vicinity.<br>Limiting the distribution of plants to areas where the pest is not likely to establish is not feasible at least in the EU (and this area cannot be precisely defined). |
| Pre-entry quarantine | Not suitable for fruits as they are perishable and imported in large volume. | Not suitable for plants for planting alone. |
| **Options that can be implemented after entry of consignments** | | |
| Post-entry quarantine | No.<br>Not suitable for fruits as they are perishable and imported in large volume. | Yes in combination with root washing. Plants may be kept in post-entry quarantine in the framework of bilateral agreements for 3 months to detect the pest (in conditions suitable for the fast development of the pest). Roots should be washed to remove larvae (if soil and growing medium is attached). Inspection should be conducted to check that the soil has been properly removed and checked for adults, and roots checked for larvae. A 3-month period with visual inspections (allowing eggs to develop into larvae) followed by root washing to remove all larvae which have hatched during the post-entry quarantine period. Plants with larvae hatched should not be released.<br><br>It is likely to be applicable only for small scale imports. It may pose practical difficulties for trees. |

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| Only surveillance and eradication in the importing country | No because the application of this option is difficult to control.<br>Measures could be put in place, but the pest may be detected after it has already established and spread to other locations.<br>In the part of the EPPO region where the pest cannot establish outdoors, infested consignments could in theory be imported. This would require the separation of trade and production flows (separate facilities for imported consignments and for growing hosts indoors) and a good surveillance system. Eradication is considered possible at a local scale (see section 16.1). This would be possible only as long as the trade volumes are very low. This may be possible in individual EPPO countries in the northern part of the region, but may not be feasible overall. | No. as for fruits |

*The EWG considered whether the measures identified above as ‘Yes in combination’ (all such measures are listed below for information) could be combined, and concluded that combination of the following measures strongly reduced the probability of entry with the pathway:

- **host fruit: -** visual inspection at the place of production + treatment of the crop + visual inspection after harvest, at pre-clearance or during transport.
- **host plants for planting other than seeds, in vitro plants, unrooted cutting and rooted cuttings in small plugs -** the only effective combination is post entry - quarantine with root washing. No other combination of measures was considered sufficiently effective

| ‘Yes in combination’ measures | Host fruit | Host plants for planting |
|---|---|---|
| Visual inspection at the place of production | X | X |
| Treatment of the crop | X | X |
| Specified age of plant, growth stage or time of year of harvest | | X (for rooted plants) |
| Visual inspection after harvest, at pre-clearance or during transport | X | X |
| Treatment of the consignment | | X (soil treatment of potted plants and aboveground sprays)<br><br>Removal or replacement of growing media<br>Root washing |
| Post-entry quarantine | | X (with root washing) |
| | | |

**ANNEX 2.** ***Annex 2. Different life stages of N. xanthographus***

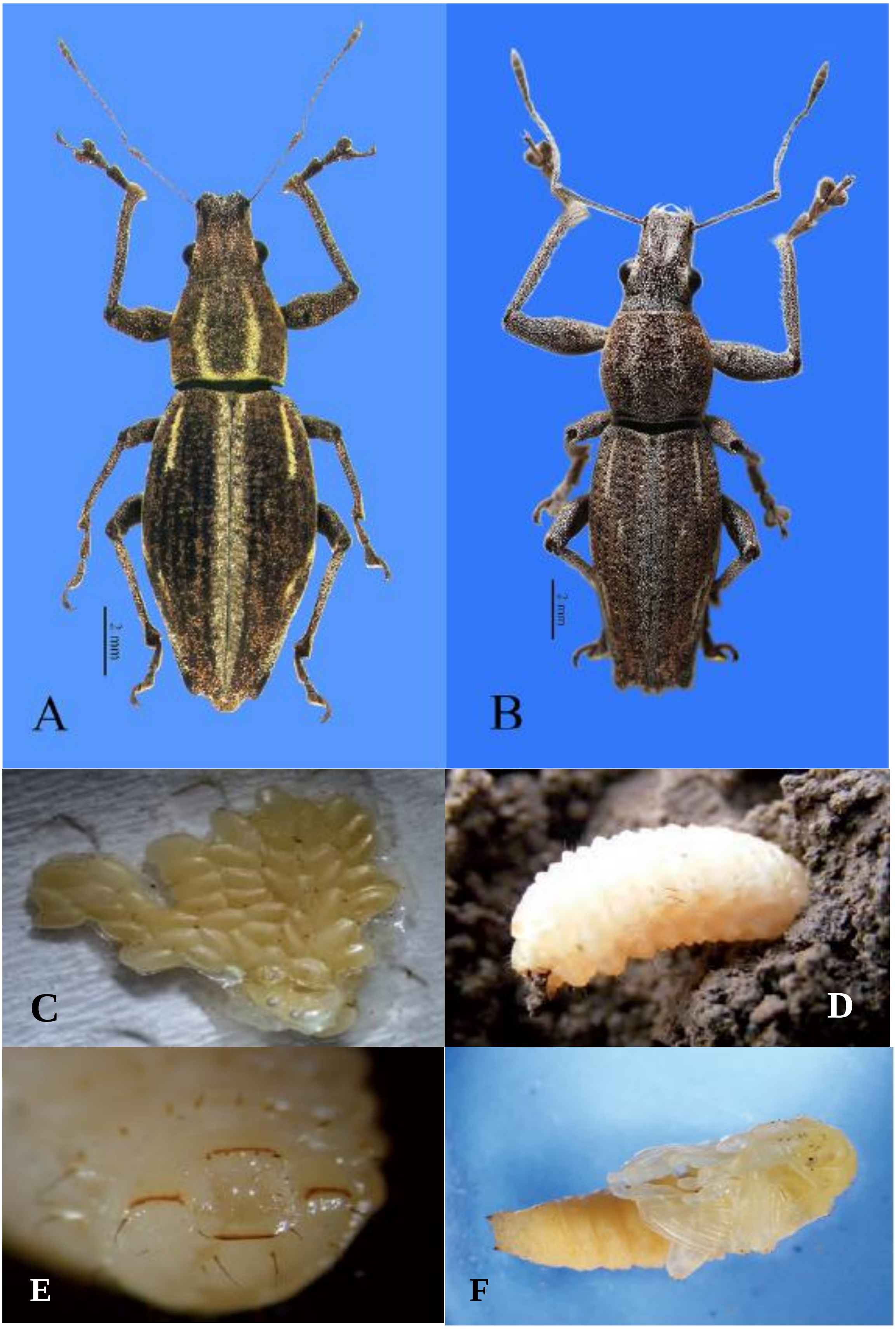



Figure 1: (A) *Naupactus xanthographus* female and (B) *Naupactus xanthographus* male (del Río & Lanteri, 2019), (C) egg mass, (D) larvae, (E) last abdominal segment of larvae, and (F) pupa of *Naupactus xanthographus* (Figures C -F from Luppichini et al., 2013).

## ANNEX 3. *Annex 3. Trade of fruit from South American countries where the pest occurs into the EPPO region*

Section A.

Table 1. Export of grapes from countries where the pest occurs into the EPPO region. From FAOStat
Table 2. Export of pears from countries where the pest occurs into the EPPO region. From FAOStat
Table 3. Export of oranges from countries where the pest occurs into the EPPO region. From FAOStat
Table 4. Export of lemons and limes from countries where the pest occurs into the EPPO region. From FAOStat
Table 5. Export of kiwi from countries where the pest occurs into the EPPO region. From FAOStat
Table 6. Export of apples from countries where the pest occurs into the EPPO region. From FAOStat
Table 7. Export of avocados from countries where the pest occurs into the EPPO region. From FAOStat

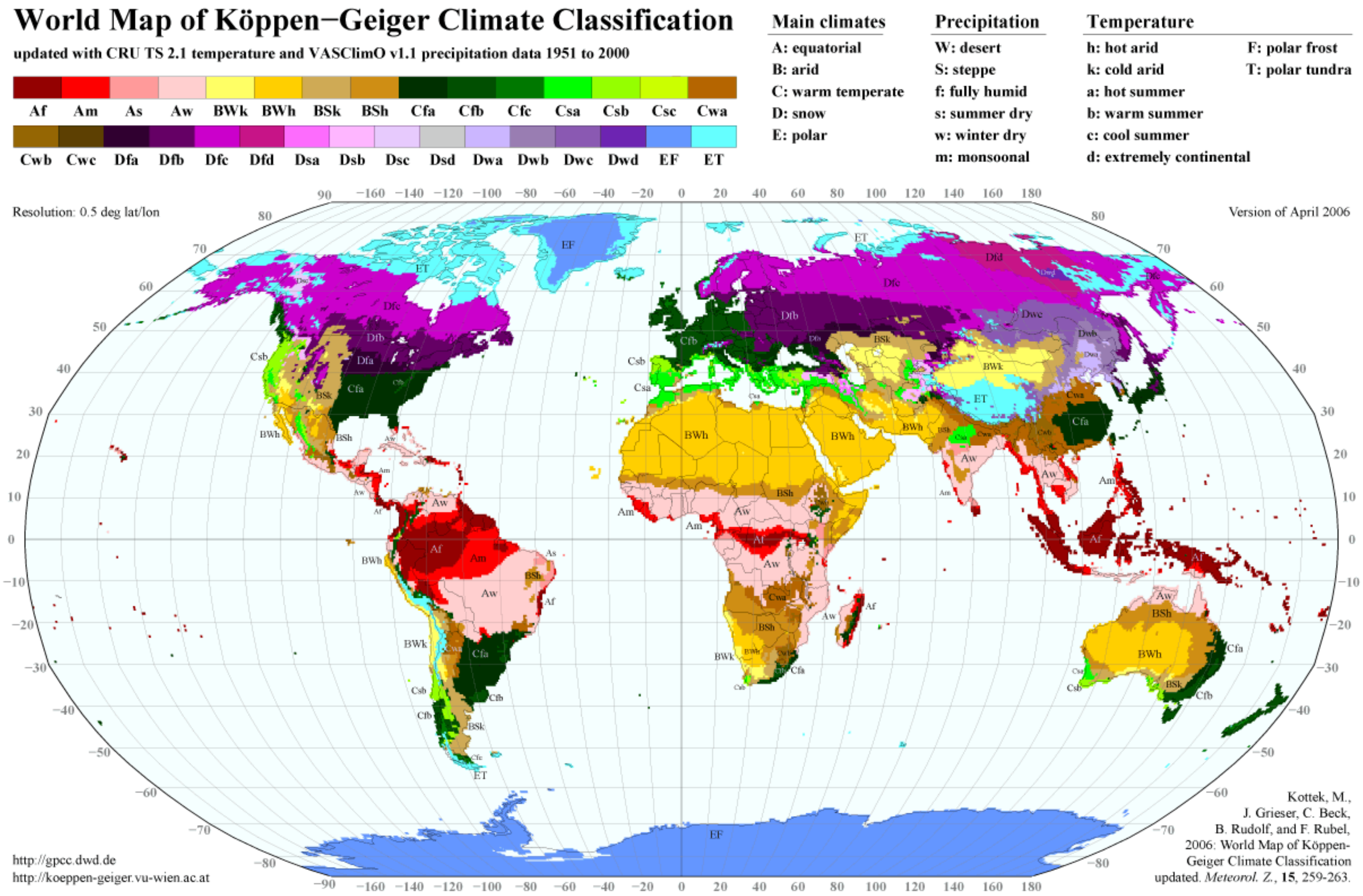
The tables are available via the link here

Section B.

Table 1. Areas of avocado cultivated with apples (in ha) in EPPO countries (2017)
Table 2. Areas of apples cultivated with avocado (in ha) in EPPO countries (2017)
Table 3. Areas of cultivated with lemon and limes (in ha) in EPPO countries (2017)
Table 4. Areas of oranges cultivated with grapes (in ha) in EPPO countries (2017)
Table 5. Areas of grape cultivated with oranges (in ha) in EPPO countries (2017)

The tables are available via the link here

## ANNEX 4. Köppen-Geiger Climate classification maps



**ANNEX 5. Plant hardiness zone map**