Netherlands Food and Consumer
Product Safety Authority
*Ministry of Economic affairs*

# Pest Risk Analysis for *Opogona sacchari*

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Netherlands Food and Consumer Product Safety Authority

Utrecht, the Netherlands

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## Summary

### Biology

The moth *Opogona sacchari* has a wide host range and is mainly known as a pest of tropical and subtropical plants like banana, pine apple and various ornamentals from (sub)tropical origin. Females lay eggs in crevices in plant tissue, in groups of about five eggs. A female lays 50-200 eggs in total. After hatching the larva enters the plant and tunnels in woody or fleshy stems. In woody plants such as *Dracaena* and *Yucca* the larvae live on dead and living portions of the cortex and pith, and infested tissues may feel soft. In some plant species (e.g. *Chamaedorea* palms), the larvae typically feed at the base of the plant where the aerial roots enter the soil. Larval development requires several weeks depending on temperature. The pupae work themselves partially out of the tissue to allow emergence of the adult. See EPPO (1997) for a full datasheet.

### Reason for performing the PRA

At present, EU council directive 2000/29/EC lists *Opogona sacchari* as an Annex IAII organism which means that it is regulated for all plants and products and known to occur in the EU. The pest is regularly found in plants for planting imported from third countries and moving in trade within the EU despite its regulatory status. Infestations are difficult to detect during import inspections, larvae are present inside the host tissue, and many infested consignments likely enter without being detected. As a result *O. sacchari* is present in greenhouses growing ornamentals in several EU countries. Except from Madeira and Azores, only a few findings of the pest have been reported outside greenhouses thus far. Because of the many findings of the pest in the EU, the present PRA evaluates the risk of *O. sacchari*, the current legislation and options to reduce the risk of entry into and spread within the EU.

### PRA area

The risk assessment area is the 27 Member States of the EU including Madeira and Azores but excluding the Spanish Canary Islands and the French Overseas Departments.

### Distribution of *Opogona sacchari*

*O. sacchari* was originally reported from the Mascarene Islands (Africa) and was later also reported from continental Africa and other African islands. The pest has been introduced in many other parts of the world. It is present on Madeira, Azores and Canary Islands. On continental Europe, it is present in greenhouses growing ornamental host plants. It has only incidentally/locally been reported from outdoor locations.

Known worldwide distribution of *Opogona sacchari*:

| Continent | Country |
|---|---|
| **Africa** | Madagascar, Mauritius, Morocco, Nigeria, Réunion, Rodrigues Island, Saint Helena, Seychelles, South Africa |
| **Asia** | China, Japan |
| **Europe** | France, Germany, Italy, the Netherlands, Poland, Portugal (Madeira and Azores), Spain (Canary Islands), Switzerland |
| **America** | Barbados, Bermuda, Costa Rica, Guadeloupe, Honduras, Peru, USA (Florida and Hawaii), Venezuela |

### Area of potential establishment

*O. sacchari* can establish in greenhouses where host plants are grown. It has been reported in greenhouses in Europe since at least 1970s. The pest is present on Madeira and Azores and can probably establish outdoors in (parts of) the Mediterranean area and southern Portugal. There are a few reports of outdoor findings, in southern Italy and southern France. However, in Italy, it is no longer reported from outdoors, and the pest is currently only known to be present in greenhouses. In France, *O.sacchari* is locally still

present in the open in the French Riviera (Var and Alpes-Maritimes departments) where it can probably maintain persistent populations. It is assessed that *O. sacchari* can establish outdoors in parts of southern EU-countries but there is uncertainty about the limits of the area of potential establishment.

**Probability of introduction (entry and establishment)**
*O. sacchari* is already present in parts of the EU. Therefore, *O. sacchari* may enter non-infested areas in the EU either through imports from third countries where the pest is present or through spread from areas already infested in the EU (mainly greenhouses in several EU-countries). Therefore, both the probability of entry from third countries as well as the probability of spread through trade of plants within the EU is discussed in the entry part. The probability of entry is assessed without (the current) phytosanitary measures in place against the pest.

Two pathways have been identified by which *O. sacchari* may enter new areas:
1. import and trade of plants for planting of host plants;
2. import and trade of plant parts of host plants intended for consumption.

Natural spread only occurs over short distances and is discussed below.

<u>Probability of entry from third countries</u>:
Pathway 1: very high (low uncertainty) The many introductions/findings in the past and recent years on plants for planting indicates a very high probability of entry (1 or more "entries" per year).

Pathway 2: low (medium uncertainty). Low because of the presumed low probability of association (less than 1 "entry" in 10 years). No interceptions known in the EU.

<u>Probability of spread within the EU by trade</u>
Pathway 1: very high (low uncertainty) The many introductions/findings in the past and recent years on plants for planting indicates a very high probability of spread. Pathway 1 is considered by far the most important pathway both for entry from third countries as for spread within the EU. Pathway 2 is not relevant for trade within the EU because there are no reports of infestations of fruits within the EU.

<u>Probability of introduction</u>
The probability of introduction into greenhouses in the EU has been rated as very high (low uncertainty). Greenhouses with ornamental host plants have shown to be suitable for establishment. Thus entry of the pest with movement of infested plants into a greenhouse will likely lead to establishment of the pest as long as host plants are present. The outdoor environment seems less suitable for establishment at least in a large part of the PRA area. The pest has been present in greenhouses in the EU since at least the 1970s but has thus far been reported from a few outdoor locations only. Therefore, the probability of introduction outdoors has been assessed as medium (medium uncertainty).

**Natural spread**
Data on dispersal distances are scarce, but moths likely do not fly far from the plant they emerge from. Dispersal distances will likely within a range of 1 km and probably much less.

**Potential consequences**

<u>Endangered area</u>:
- Greenhouses growing ornamental host plants of *O. sacchari*.
- Ornamental host plants grown as amenity trees along roads, in gardens, parcs etc in southern EU.

- Banana and pine apple crops are within the endangered area but are grown on a very limited scale in the PRA area with the exception of Madeira and Azores where the pest is already present.

Economic impact:
*Greenhouses with ornamental host plants*: generally medium, incidentally major (medium uncertainty). *O. sacchari* has potentially a major impact because it can kill its host plant and can destroy or make whole plant lots unmarketable. The pest has been present in greenhouses in the EU probably since the 1970s or even earlier and under practical conditions, the impact is reduced by cultural measures and the use of crop protection agents specifically targeted against *O. sacchari* and/or other pests. The assessment is based on the current impact *O. sacchari* has in greenhouses in the EU. The uncertainty is medium because of lack of quantitative data on plant losses in greenhouses. Note that control of the moths may depend on a limited number of insecticides (e.g. pyretroids only) and in case of withdrawal of these insecticides, the impact of the pest may increase.

*Ornamental host plants outdoors in southern EU*: medium (medium uncertainty: it is uncertain to which extent plants in gardens, parcs, along roads etc are endangered). Limited information suggest that locally or incidentally damage may occur in southern Europe. Damaged and dying plants infested with *O. sacchari* have been observed at some locations.

Export markets: minimal or minor impact (low uncertainty). Plants or plant parts (e.g. fruits) that can become infested are mainly imported into the EU and not exported.

Environmental impact: minor (medium uncertainty). Locally or incidentally plants may be damaged but no large scale outbreaks are expected in healthy natural vegetations.

Social impact: minor (low uncertainty). Direct impact of the pest will be mainly limited to greenhouses growing host plants. The pest has already been present in greenhouses in some EU-countries for many years. *O. sacchari* is probably present in the PRA area since 1970s or earlier and is not expected to become a major pest in the PRA area. Hence social impact is assessed to be minor.

**Risk reduction options**

Current official measures
*O. sacchari* is a quarantine pest in the EU but official measures to prevent entry or stop spread have not been very effective mainly because of the cryptic and polyphagous nature of the pest. The pest has been present in the EU for several decades but there are no plant passport requirements for many of its host plants to control internal movement.

Options to reduce the probability of introduction and spread
Four options have been identified which will largely reduce the risk of introduction and spread of *O. sacchari* by import and trade of plants for planting:

I Host plants should originate from a pest free area,
II Host plants should originate from a pest free place or site of production. In areas where the pest is present outdoors, complete physical protection will be needed to ensure pest freedom.
III Pre- or post-entry quarantine.

Each of these three options will largely interfere with trade. A fourth option identified will have a much lower protection level but interfere much less with trade:
IV Regulating of plants moving in trade.

This option does not require specific growing conditions or treatments. This option is not expected to change the risk of *O. sacchari* significantly as compared to the current situation in the PRA area.

<u>Eradication</u>
After introduction of the pest in a greenhouse, eradication is possible. Eradication of outdoor populations which may occur in southern Europe may be difficult and may only be feasible at early detection.

**Uncertainties**
The main uncertainties in the present PRA are:

- The current distribution of *O. sacchari* in Europe and other continents.
- The suitability of the climate in southern EU for establishment of *O. sacchari* and the potential impact of the pest in the open.
- Natural spread distances

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## Methodology

The set-up of the present PRA follows partly the PRA-scheme of the European and Mediterranean Plant Protection Organisation (EPPO, http://www.eppo.org/). The present PRA scheme asks for:

- the host plants and pest distribution;
- the probability of entry (including transfer to a suitable place or habitat where the pest can establish) according to a 4-point qualitative scale (low, medium, high, very high; see explanation below);
- the area of potential establishment (description, no rating);
- the rate of spread once the pest has established (description, preferably with estimated distances, no rating);
- the probability of introduction (the probability that the pest enters and establishes according to a 4-point qualitative scale (the same scale as for the probability of entry).
- the economic, environmental and social impact according to a 5-point qualitative scale (minimal, minor, moderate, major, massive);
- the endangered area (description, no rating);
- the identification and evaluation of risk reduction options;
- the main uncertainties.

Rating guidance is provided in Annex I. For entry, a 4-point scale was used and not a 5-point scale as in the EPPO-scheme. In the present PRA-scheme, the rating levels corresponds with a quantitative interval while the EPPO-scheme has no rating guidance for "entry". It was considered that a 5-point scale would suggest a too high level of accuracy for the "entry-assessment". The information available to assess the probability of entry in PRAs is often very limited. The lowest rating level in the present PRA-scheme ("low") corresponds to an average of less than one entry in 10 years. In many cases, it is not considered possible to assess lower probabilities in a more accurate way (e.g. to make a difference between for example one entry in 10 – 25 years and one entry in less than 25 years). Also, the use of more narrow intervals for the three highest rating levels and to split them in four rating levels was not considered appropriate (see Annex I for the full rating guidance).

Similar to the EPPO-scheme, the level of uncertainty is rated according to a 3-point qualitative scale (low, medium and high). Adapted from IPPC definitions, low, medium and high uncertainty are defined as expressing 90, 50 and 35% confidence, respectively, that the score selected is the correct one (Mumford *et al*., 2010).

*Opogona sacchari* is already present in the PRA area (EU) at many locations and the pest can enter areas or sites in the PRA-area that are not yet infested by import or by trade from areas or places where the pest is present. Therefore, the spread of the pest by trade of plants within the EU is discussed in the entry section as well as the probability of new introductions from outside the EU.

# 1. Pest Risk Initiation

**1.1 What is the reason for performing the PRA?**

At present, EU council directive 2000/29/EC lists *Opogona sacchari* as an Annex IAII organism which means that it is regulated for all plants and products and is known to occur in the EU. The pest is regularly found in plants for planting imported from third countries and moving in trade within the EU despite its quarantine status. Infestations are difficult to detect during import inspections, larvae are present inside the host tissue, and many infested consignments likely enter without being detected. As a result *O. sacchari* is present in greenhouses growing ornamentals in several EU countries. Except from Madeira and Azores, only a few findings of the pest have been reported outside greenhouses thus far. Because of the many findings of the pest in the EU, the present PRA evaluates the risk of *O. sacchari*, the current legislation and options to reduce the risk of entry into and spread within the EU.

**1.2 Scientific name, taxonomy and type of pest**

From the EPPO-datasheet (EPPO, 1997) with a few additions:

Name: *Opogona sacchari* (Bojer)

Synonyms: *Alucita sacchari* Bojer
*Tinea subcervinella* Walker
*Opogona subcervinella* (Walker)
*Hieroxestis subcervinella* Walker

Taxonomic position: Insecta: Lepidoptera: Tineidae, Hieroxestinae

Common names: Banana moth (English)
Teigne du bananier (French)
Traça da banana (Portuguese)
Bananenboorder (Dutch)
Bananentriebbohrer (German)

Bayer computer code: OPOGSC

EPPO A2 list: No. 154

EU Annex designation: I/AII

**1.3 PRA area**

The risk assessment area is the 27 Member States of the EU including Madeira and Azores but excluding the Spanish Canary Islands and the French Overseas Departments.

**1.4 Does a relevant earlier PRA exist?**

A PRA has been published for China in Chinese (Ju et al., 2004) but has not been translated in English. A PRA for the EU has not been found.

# 2. Pest Risk Assessment

## 2.1 Host plants and pest distribution

### 2.1.1 Specify all the host plant species (for pests directly affecting plants). Indicate the ones which are present in the PRA area.

*O. sacchari* has a wide host range with species in many different plant families (Table 2.1). Table 2.1 contains plants species and genera from mainly 3 databases/reviews (Davis & Peña, 1990; EPPO, 2011b; NHM, 2012) and also includes species/genera on which *O. sacchari* has been officially notified in the EU. It does likely not provide a full list of host plants. A Chinese review reports for example 87 species of 28 families (Shang, 2003). On the other hand, plant species or genera might have been listed in databases or reviews even when larvae of the pest have only been found on dead or decaying planting material, on stored bulbs or tubers, incidentally on one or a few plants or only in laboratory tests. *Capsicum* spp. (pepper) and *Solanum melongena* (egg plant) have not been included in Table 2.1 although listed by EPPO (2011b) and Davis & Peña, because we have only found literature sources describing infestation of *Capsicum* and *Solanum melongena* fruits in laboratory experiments. Süss (1974) has described infestation after placing neonate larvae directly on the fruits; it was not tested if females would oviposit on the plant or fruit. Billen (1987) has reported good rearing results of *O.sacchari* on *Capsicum* spp. and *S. melongena* in laboratory conditions, but no details were provided the way the experiment was done. In both cases, infestation under natural conditions was not investigated. No other original sources have been found reporting *Capsicum annuum* and/or *Solanum melongena* as host plants for *Opogona sacchari*. Therefore, we do not consider these species as host plants.

Plant species need to have plant parts big enough for the larvae to tunnel in but the minimal diameter needed is not known. In Europe, infestations have been reported from *Musa*, *Ananas* and many ornamental species (see 2.6 Potential consequences for details and references). Many of the host plants (especially ornamental species) are present in the PRA area, either in the natural environment or growing in open or protected cultivation.

Table 2.1. Plant species or genera mentioned as host plants of *Opogona sacchari* in literature and/or databases[1]

| Plant species, scientific name | Common name (if different) | Reference |
|---|---|---|
| *Albizia julibrissin* | | NHM, 2012 |
| *Alium* (bulbs used as bait) | Onion bulbs | B. Kummer, pers. comm. April, 2013 |
| *Alocasia* | | Notified (Table 2.4) |
| *Ananas comosus* | Pine apple | EPPO, 2011b |
| Arecaceae (e.g. *Chameadorea, Chrysalidocarpus* (Areca), *Howea* (Kentia)*, Phoenix, Ravenae, Washingtonia*) | Palms | EPPO, 2011b, several notifications (Table 2.4) |
| *Bactris gasipaes* | | NHM, 2012 |
| *Bambusa* | Bamboo | Oldham, 1928[2] |
| *Beaucarnea* | | Notified (Table 2.4) |
| *Begonia* | | EPPO, 2011b |
| *Bougainvillea spectabilis* | Bougainvilla | EPPO, 2011b |
| Bromeliaceae | | EPPO, 2011b |
| Cactaceae | | EPPO, 2011b (notification on *Mammillaria* sp. Table 2.4) |
| *Caesalpinia echinata* | | Wei, 2011 |
| *Carica papaya* | Papaya | Peña, 1990a |
| *Clerodendrum* | | Davis & Peña, 1990 |

| Plant species, scientific name | Common name (if different) | Reference |
|---|---|---|
| *Coffea* | | Notified (Table 2.4) |
| *Colocasia esculenta* | Taro | Peña, 1990a |
| *Cordyline terminalis* | | Heppner, 1975 |
| *Crassula* | | Notified (Table 2.4) |
| *Crinum* | | Notified (Table 2.4) |
| *Cycas* | | Notified (Table 2.4) |
| *Cyperus* | | Notified (Table 2.4) |
| *Dahlia* | | Davis & Peña, 1990 |
| *Dieffenbachia maculata* | | EPPO, 2011b |
| *Dioscorea* | Yam | Davis & Peña, 1990 |
| *Dracaena* | | EPPO, 2011b |
| *Enterolobium* | | NHM, 2012 |
| *Erythrina variegata* | | NHM, 2012 |
| *Euphorbia pulcherrima* | Poinsettia | EPPO, 2011b |
| *Ficus* | | EPPO, 2011b |
| *Gladiolus* | | Davis & Peña, 1990 |
| *Heliconia psittacorum* | | EPPO, 2011b |
| *Hibiscus* | | NHM, 2012 |
| *Hippeastrum* | | EPPO, 2011b |
| *Ipomoea batatas* | Sweet potato | Hansen 1997 |
| *Maranta* | | EPPO, 2011b |
| *Musa* | Banana | Oldham, 1928 |
| *Orchidaceae* | Orchids | NHM, 2012 |
| *Pachira* | | Notified (Table 2.4) |
| *Pandanus* | | Notified (Table 2.4) |
| *Philodendron* | | EPPO, 2011b |
| *Polyscias* | | NHM, 2012 |
| *Russelia* | | Notified (Table 2.4) |
| *Saccharum officinarum* | Sugarcane | Oldham, 1928 |
| *Saintpaulia ionantha* | African violet | EPPO, 2011b |
| *Salix*[4] | Willow | Shen et al., 2006 |
| *Sansevieria trifasciata* | Snake plant | EPPO, 2011b |
| *Schlumbergera* | | Notified (Table 2.4) |
| *Sinningia* | Gloxinia | EPPO, 2011b |
| *Solanum tuberosum* (stored tubers) | Potato | Oldham, 1928[3] |
| *Sophora japonica* | Pagoda tree | Shen et al., 2006 |
| *Strelitzia reginae* | | EPPO, 2011b |
| *Syagrus* | | NHM, 2012 |
| *Tulipa* (bulbs used as bait) | Tulip bulbs | B. Kummer, pers. comm. April, 2013 |
| *Wisteria sinensis*[4] | Chinese wisteria | Shen et al., 2006 |
| *Yucca* | | EPPO, 2011b |
| *Zea mays* | Maize | Oldham, 1928 |
| *Zingiber officinale* | Ginger | NHM, 2012 |

[1] Note that plant species or genera might have been listed even if the pest has been found on dead or decaying planting material, on stored bulbs or tubers and/or incidentally on one or a few plants only.

[2] In the case of *Bambusa*, Oldham (1928) reports on observations by growers; he did not observe the species on *Bambusa* himself.

[3] *Solanum tuberosum* has been referred to as a host plant in several articles, e.g. Davis & Peña, 1990, and Oldham, 1928 (refering to Walsingham (1907) and Durrant (1928)). Potato tubers are also used as diet for the larvae in several laboratory studies (e.g. Wei, 2011; Cheng, 1999; Peña, 1990a). Detailed records all refer to feeding on the stored tubers (e.g. Davis & Peña, 1990 and Oldham, 1928)); we did not find records

indicating feeding on potato in the field. Therefore we assume that reports of potato as a host plant all refer to feeding on the stored tubers only.

[4] In China, the species has amongst others been collected from *Salix babylonica* (weeping willow), *Wisteria sinensis* and *Sophora japonica var. pendula* (Japanese pagoda tree) (Shen et al., 2006). In the Netherlands a fully grown larva was found in a *Salix* tree growing next to a greenhouse infested with *O. sacchari* in the autumn of 2008. The *Salix* tree had been simultaneously infested by larvae of *Cossus cossus* which might have given an entrance for the larva of *Opogona sacchari.*

### 2.1.2 Specify the pest distribution

*O. sacchari* was originally reported from the Mascarene Islands (Africa) and was later also reported from continental Africa and other African islands (Davis & Peña, 1990). According to EPPO (1997), the origin of *O. sacchari* are the humid tropical and subtropical regions of Africa (EPPO, 1997) from where it has been introduced in many other parts of the world. It has been introduced into many countries and is nowadays present in many areas of the world (CABI, 2011; EPPO, 2011; Annex II). *O. sacchari* is present outdoors on Madeira, Azores. On continental Europe, the pest has been present in greenhouses growing ornamental host plants since at least 1970s (EPPO, 2011b). Jannone (1966 in Porcelli & Parenzan, 1993) has stated that the pest was introduced in the 1950s in Italy. There are a few reports on outdoor findings, in southern Italy and France (Porcelli & Parenzan, 1993; Annex II). However, in Italy, it is no longer reported from outdoors, and the pest is currently only known to be present in greenhouses. *O. sacchari* is locally still present in the open in southern France where it can probably maintain persistent populations (pers. comm. J.M. Ramel, January 2013). It is, however, still uncertain in which parts of continental Europe, *O. sacchari* could maintain persistent populations in the open. Details and references on the distribution of the pest are presented in Annex II.

## <u>2.2 Probability of entry</u>

*O. sacchari* is already present in parts of the EU. Therefore, *O. sacchari* may enter non-infested areas in the EU either through imports from third countries where the pest is present or through spread from areas already infested in the EU (mainly greenhouses in several EU-countries). Therefore, both the probability of entry from third countries as well as the probability of spread by trade within the EU is discussed in the entry part. The probability of entry and spread (by trade) is assessed without (the current) phytosanitary measures in place and the likelihood of detection at import (likelihood to survive current phytosanitary procedures) is, therefore, not assessed in this part of the PRA but in chapter 3 (Identification and evaluation of risk reduction options).

### 2.2.1 Identification of pathways

<u>Plants for planting of host plants other than seeds with or without soil/potting medium attached</u>

Larvae feed inside the host plant tissue and are difficult or even impossible to detect by visual inspections especially when only the early immature stages are present. The same goes for the eggs, which are being deposited (in cracks) in the plant tissue. Many interceptions have shown the relevance of this pathway. This pathway is discussed in detail below.

<u>Plant parts intended for consumption like fruits and tubers</u>

*O. sacchari* can infest fruits (e.g. Pigatti et al., 1982). Indeed, banana, rambutan, mango fruits, sweet potatoes and pine apple fruit have been found infested in Hawaii (Armstrong, 2001; Vorsino et al., 2005; Follett P, private communication, 2009 in Jang et al., 2010). Oldham (1928) observed larvae which ate the fruit pulp of banana, although nowadays damage of fruit is not being observed on the Canary Islands (pers. comm. A.D. González Hernández, RPPO of the Canary Islands, August 2012). This pathway is analysed in more detail below for entry from third countries.

Soil as such

Larvae can be present in the potting medium or soil in which host plants are grown (Heppner et al., 1987 cited in EPPO, 1997; Hollingsworth & Follett, 2007). Soil/potting medium attached to host plants is, therefore, a pathway. This pathway is, however, included in the pathway "plants for planting of host pants other than seeds" (see above). Soil as such is not considered a pathway. Theoretically, soil could be infested if host plants have been grown on it. However, it is unlikely that soil/potting medium that has been used to grow host plants of *O. sacchari* is traded/imported. Soil as such is, therefore, not discussed further as a pathway in the present PRA. Also note that import of "soil as such" is forbidden from most non-EU countries (Directive 2000/29/EC).

Natural spread

*O. sacchari* is currently present in greenhouses in many EU-countries. *O. sacchari* naturally moves over short distances only (see below: 2.2.5). Therefore, natural spread will not contribute much to the invasion of new areas within the EU. Natural spread will be discussed in more detail in 2.2.5 (Natural spread).

### 2.2.2 Probability of entry from third countries

Pathway 1: Plants for planting of host plants other than seeds with or without soil/potting medium attached

*Probability of association*

*O. sacchari* is present in many countries from which host plants are imported into the EU (Annex I, Table 2.2). *O. sacchari* has been intercepted many times on plants for planting in the EU (Table 2.4). Because of its cryptic nature, many infested consignments may have entered undetected. In the Netherlands, *O. sacchari* was intercepted for the first time in 1971 and because of its detection problems post-entry inspections have been recommended (Veenenbos, 1981). For example, between 2004 and 2009 over 95% of the infestations/infested plant lots found in the Netherlands (approximately 90) were detected at post-entry inspections, and less than 5% during import inspections (source: database of the NPPO of the Netherlands).

In most cases of interceptions notified in Europhyt, the plants had been exported from an EU-country (Table 2.4). For most of these interceptions, Europhyt also indicates that the plants originated within the EU (40 out of the 67 cases; 7 cases not indicated). However, these 40 cases may include re-export from plants imported from third countries on which the pest had not been detected during import inspection (Veenenbos, 1981; EPPO, 1997). Therefore, the number of plants/consignments which were infested outside the EU and entered the EU remains uncertain. Since 1994, there are at least 20 of such cases but the actual number is likely much higher as also suggested by the number of findings in the Netherlands during post-entry inspections indicated above (see also Annex II for details on the situation in the EU).

There are no sufficient figures to assess the probability of association in a quantitative way (i.e. % of infested consignments or lots). The overall percentage of infested consignments is probably low (i.e. less than 1%) considering the large import volume (Table 2.2) but may vary considerably between plant species and/or origins. The probability of association with import of *Yucca* plants from Central America was much higher in the past, e.g. 15-20 years ago when planting material was obtained from the wild in Central America and not from commercial plantations like today (see also Table 2.5).

Note that because of the lack of quantitative data only a final rating for the probability of entry is given mainly based on the number of introductions and findings/interceptions (see below).

*Import volume*
*O. sacchari* can infest a large number of plant species (see Q 2.1.1) and the number of sub-pathways by plant species x country of origin is very large. Table 2.2 shows Dutch import volumes of some host plant genera from countries where *O. sacchari* is known to be present and on which the pest has been found in the EU (Annex I; Table 2.4)

Table 2.2. Import of plants for planting of a selected number of host plants of *Opogona sacchari* from countries where *O. sacchari* is known to be present into the Netherlands during 2005-2011 (source: import database of the NPPO of the Netherlands)

| Plant genus | Year | Number of plants | Number of consignments |
|---|---|---:|---:|
| *Areca* | 2005 | 770,092 | 277 |
| | 2006 | 562,737 | 210 |
| | 2007 | 119,218 | 28 |
| | 2008 | 75,817 | 19 |
| | 2009 | 458,259 | 244 |
| | 2010 | 627,498 | 249 |
| | 2011 | 41,727 | 55 |
| *Bougainvillea* | 2005 | 48,962 | 15 |
| | 2006 | 46,272 | 12 |
| | 2007 | 1,100 | 3 |
| | 2008 | 51 | 2 |
| | 2009 | 4,094 | 19 |
| | 2010 | 1,529 | 11 |
| | 2011 | 2,861 | 9 |
| *Cycas* | 2005 | 461,220 | 183 |
| | 2006 | 766,115 | 95 |
| | 2007 | 813,798 | 209 |
| | 2008 | 641,938 | 221 |
| | 2009 | 808,655 | 219 |
| | 2010 | 744,201 | 295 |
| | 2011 | 705,338 | 287 |
| *Dracaena* | 2005 | 84,127,961 | 3,849 |
| | 2006 | 82,530,122 | 3,673 |
| | 2007 | 73,147,321 | 3,704 |
| | 2008 | 65,974,323 | 3,718 |
| | 2009 | 60,573,382 | 2,918 |
| | 2010 | 55,002,068 | 2,847 |
| | 2011 | 56,785,685 | 2,648 |
| *Pachira* | 2005 | 1,504,663 | 160 |
| | 2006 | 766,115 | 95 |
| | 2007 | 1,072,643 | 109 |
| | 2008 | 1,615,671 | 85 |
| | 2009 | 1,659,756 | 69 |
| | 2010 | 2,268,150 | 70 |
| | 2011 | 1,467,934 | 55 |
| *Phoenix* | 2005 | $1.1 \times 10^6$ | $3 \times 10^2$ |
| | 2006 | $0.5 \times 10^6$ | $3 \times 10^2$ |
| | 2007 | $0.9 \times 10^6$ | $3 \times 10^2$ |
| | 2008 | $0.9 \times 10^6$ | $3 \times 10^2$ |

| Plant genus | Year | Number of plants | Number of consignments |
|---|---|---|---|
| | 2009 | $1.0 \times 10^6$ | $3 \times 10^2$ |
| | 2010 | $0.5 \times 10^6$ | $4 \times 10^2$ |
| | 2011 | $0.5 \times 10^6$ | $4 \times 10^2$ |
| *Yucca* | 2005 | 2,485,398 | 211 |
| | 2006 | 2,174,928 | 199 |
| | 2007 | 2,191,075 | 155 |
| | 2008 | 2,406,876 | 132 |
| | 2009 | 1,573,920 | 118 |
| | 2010 | 1,349,542 | 156 |
| | 2011 | 1,118,927 | 141 |

*Probability to survive transport*
Transport conditions which allow (sub)tropical plants to survive, will likely also allow *O. sacchari* to survive. According to a Dutch importer, temperature during transport is about 15°C and transportation time is about 3 weeks from Central America. These conditions will allow for survival of *O. sacchari*. A temperature of 15°C even allows for the development of the larvae (Billen 1987). The many interceptions on plants for planting (see above) also show that *O. sacchari* can survive transport.

*Probability of transfer*
The probability of transfer to a suitable place or habitat where the pest can establish will largely depend on the destination of the commodity. Commercial greenhouses where host plants are present throughout the year are likely suitable for establishment but consumer households not (see Q 2.1.2). Imported plants are usually placed in commercial greenhouses where they stay for several weeks or months before being sold to consumers. In that way, transfer can easily occur to other host plants present in the greenhouse. The probability of transfer (after arrival in the PRA area) is more difficult to assess when plants are placed in the open because there is uncertainty where the pest can establish in the open in the PRA area (see Q 2.2.4).

Pathway 2: Plant parts intended for consumption like fruits and tubers

*Probability of association*
In the EU, there are no notifications of interceptions on fruits (Europhyt, accessed 11-05-2012) despite the high import volumes of for example bananas from countries where *O. sacchari* is present (Table 2.3). However, many types of fruits or tubers which may be infested, like bananas, mangoes and sweet potatoes may generally not be inspected at import because they do not need to be according to the current EU-legislation (2000/29/EC). Armstrong (2001) reared *O. sacchari* from culled bananas in Hawaii and considered discarding of culled bananas adequate to maintain banana fruit lots free of *O. sacchari*. Thus, during packing/selection of fruits most infested fruits/tubers are possibly rejected because they are aberrant or damaged. On the Canary Islands, infestation of fruits (papaya, bananas, pineapple) is currently not known to occur; larvae are found in the stems and debris of the plants but are not reported from the fruits (pers. comm. A. D. González Hernández, RPPO Canary Islands, August 2012).

*Import volume*
Bananas and other tropical fruits, which may be infested, are imported in large volumes: nearly one million tonnes of bananas are imported from South and Central American countries where *Opogona sacchari* is known to be present (Table 2.3).

Table 2.3. Import of bananas (quantity in 100 kg) from Barbados, Brazil, Costa Rica, Honduras en Peru into the EU during 2009-2011 (source: Eurostat).

| Country | 2009 | 2010 | 2011 |
|---|---|---|---|
| Barbados | - | $6.3 \times 10^2$ | $8.2 \times 10^2$ |
| Brazil | $5.6 \times 10^5$ | $6.4 \times 10^5$ | $5.2 \times 10^5$ |
| Costa Rica | $7.6 \times 10^6$ | $7.8 \times 10^6$ | $8.5 \times 10^6$ |
| Honduras | $8.5 \times 10^4$ | $1.5 \times 10^5$ | $1.7 \times 10^5$ |
| Peru | $4.4 \times 10^5$ | $5.2 \times 10^5$ | $6.6 \times 10^5$ |

*Probability to survive transport*
(Sub)tropical fruits are transported at temperatures above 0°C which will allow for survival of *O. sacchari* (Ju et al., 2003). .

*Probability of transfer*
The probability of transfer in areas where *O. sacchari* cannot establish outdoors (largest part of the PRA area) is assessed to be low (see also EPPO, 1997). Adults that emerge from the fruit will have to find a greenhouse with a host plant to initiate a population. The probability of such an event is low, since the adults are weak flyers. The probability of transfer in parts of southern Europe where *O. sacchari* could establish outdoors is assessed to be medium.

**Probability of entry from third countries**:
Very high for import of plants for planting of host plants. The uncertainty is low. The many introductions/findings in the past and recent years (despite the current quarantine status) indicate a very high probability of entry.

Low for imports of plant parts of host plants intended for consumption because of the low probability of association. Medium uncertainty. No interceptions known in the EU.

### 2.2.3 Probability of spread within the EU by trade of plants for planting

*O. sacchari* has been intercepted and found many times on plants in the EU (Tables 2.4, 2.5). The pest has been reported from greenhouses in many EU-countries (Annex II). The interceptions notified in Europhyt likely underestimate the number of infested plants/consignments moving in trade. For example, Labanowski (1999) reported the presence of *O. sacchari* on *Yucca elephantis* imported from the Netherlands in 1991 and on *Dracaena* and *Yucca* spp. in Poland in 1992. The NPPO of Poland reported in 2006 the finding of *O. sacchari* in plants of Dracaena at a production site. The infested plants had been imported from the Netherlands (EPPO, 2006). Tusnadi et al., (1997) reported the presence of the pest in two plants of *Dracaena fragrans* at a florist in Budapest. The NPPO of Czech Republic observed the pest in public and private areas in *Yucca* plants and in the accompanying growing medium in 2000, in *Beaucarnea* in 2005 and on banana fruits in 2006. In all cases the pest was associated with imported plants (EPPO, 2011a). See also Annex II.

(Sub)tropical plants are often imported from third countries and subsequently traded within the EU. Trade volume, probability of survival and transfer will be similar (of the same order) to that of import of these plants (see above: Q 2.2.2).

**Probability of spread by EU-internal trade of plants for planting**: very high, low uncertainty. The many interceptions despite the current quarantine status indicates the very high probability of spread.

Table 2.4. Number of EU-notifications of *Opogona sacchari* on plants for planting imported from non-EU member states (Europhyt, accessed 11th May 2012)

| Year | Number | Plant genus/family |
|---|---|---|
| 1994 | 1 | *Ficus* |
| 1996 | 4 | *Areca* |
| 2001 | 2 | *Pachira, Strelitzia* |
| 2002 | 2 | *Dracaena, Cactaceae* |
| 2005 | 1 | *Albizia, Bougainvillea, Washingtonia, Phoenix, Dracaena, Jasminum, Ficus, Hibiscus, Plantago*[1] |
| 2006 | 1 | *Dracaena* |
| 2007 | 1 | *Bougainvillea* |
| 2010 | 5 | *Crassula, Cyperus, Hibiscus, Palmaceae* |
| 2011 | 3 | *Dracaena, Pachira, Schlumbergera,* |
| **Total** | 20 | |

[1] Uncertain which plant genera were infested because all 9 genera were included in one notification.

Table 2.5. Number of EU-notifications of *Opogona sacchari* on plants for planting traded within the EU; note that many of these plants may have been traded within the EU shortly after importation from non-EU member states (Europhyt, accessed 11th May 2012)

| Year | Number | Plant genus/family |
|---|---|---|
| 2000 | 2 | *Yucca* |
| 2002 | 2 | *Cycas, Ravenea* |
| 2005 | 18 | *Areca, Beaucarnea, Crinum, Dracaena, Kentia, Pachira, Pandanus, Russelia*[2], *Yucca,* |
| 2006 | 11 | *Alocasia, Coffea, Pachira, Ravenea, Russelia* |
| 2007 | 3 | *Dracaena, Pachira, Philodendron* |
| 2009 | 2 | *Cycas, Washingtonia* |
| 2011 | 7 | *Areca, Beaucarnea, Chrysalidocarpus*[1], *Ficus, Sansevieria* |
| 2012 | 2 | *Dracaena, Mammillaria* |
| **Total** | 47 | |

[1] Included in a notification with another plant genus/other genera

## 2.3 Area of potential establishment

### 2.3.1. Factors affecting the limits and suitability of the area of potential establishment

How widespread are host plants or suitable habitats in the PRA area?

In the northern half of Europe, host plants are mainly present indoors. Thus host plants are present in:

- Commercial greenhouses:
- Tropical glasshouses, tropical swimming pools, offices etc. Tropical glasshouses and swimming pools with host plants are likely suitable habitats; they are present over the whole PRA area but at low density.
- Private houses: some host plant species (e.g. Dracaena, Sanseviera) are quite common pot plants. Private houses are, however, not suitable places to maintain populations (see below).
- During summers, incidentally and temporarily outdoors.

In southern EU host plants are also present outdoors throughout the year. For examples (partly taken from EPPO, 2009)

- Ornamental palm trees are widespread in the Mediterranean countries and Portugal.
- Palms are found in the wild in the Mediterranean Basin and Portugal. Endemic species exist: *Phoenix theophrasti* in Greece and Turkey, and *Chamaerops humilis* in Spain, Italy, France, Morocco (*C. humilis* subsp. *cerasifera*).
- Sugar cane (Saccharum officinarum): minor crop in the EU (60 and 1000 ha in Portugal and Spain (continental), respectively, in 2007).
- Banana (*Musa* spp.): minor crop with 8, 260 and 1,206 ha in Italy, Cyprus and Portugal (Madeira and Azores), respectively in 2006. The 10,000 ha of banana crop indicated for Spain are located on the Canary Islands (pers. comm. Antonia González RPPO Canary Islands, 20th June 2012) which are outside the PRA-area.

Suitability of climate in the PRA area

*O. sacchari* is present outdoors on the Canary islands, Madeira and the Azores. The Canary islands have mainly a warm and dry climate comparable to that of the Mediterranean Basin (Annex III; Climate category 'Csa', warm temperature, dry and hot summer according to Köppen-Geiger). Therefore, it is assessed that the climate in (parts of) the Mediterranean Basin and the mainland of southern Portugal is suitable for establishment. However, the outdoor climate in the larger part of the PRA area seems not suitable for establishment. Although O*. sacchari* was already introduced into greenhouses in the EU in 1970s (EPPO, 2011b) and possibly earlier (Jannone (1966) in Porcelli & Parenzan, 1993)), it has since then been reported from a few outdoor locations only (locally in southern Italy and France, see also Annex II). In Italy, the pest is currently only known to be present in greenhouses (Annex II).

In Japan, the first detection of *O. sacchari* was in 1986 and its presence appears to be in the warm regions of Honshu, Shikoku, Kyushu, and the Ryukyu Islands (Yoshimatsu et al., 2004) which also have high amounts of precipitation (e.g. http://en.allmetsat.com/climate/).

Summers in the Mediterranean area are dry; more humid conditions may be more suitable for establishment. *O. sacchari* seems for example a major pest on Hawaii which has a more humid and also warmer climate than southern Europe (Annex III; see also the impact section). Du et al. (2006) found a relative humidity of 45% and 90% to be the minimum and. optimum level, respectively, for hatching of the eggs.

Low winter temperatures may be a more limiting factor for establishment of *O. sacchari* than relative humidity during summer. Ju et al. (2003) found that the majority of larvae died after 72 h at -2°C, and all of the larvae died after 48 h at -5°C under experimental conditions. Temperatures inside plants and in soil will, however, be higher than ambient temperatures and larvae of *O. sacchari* may survive short periods of ambient temperatures below 0°C under natural conditions. *O. sacchari* larvae did not survive in soil Jining City (China) during winter (Anonymous, 2010) where minimum temperatures are far below 0°C.

<u>How suitable are protected conditions for establishment?</u>
The presence of *O.sacchari* in greenhouses in several EU-countries shows that protected conditions are suitable for establishment (Annex I).

<u>Effect of soil properties</u>
Larvae can be present in soil near roots of host plants. According to R.G. Hollingsworth (unpublished data referred to in Hollingsworth & Follett, 2007), larvae can feed on the planting medium itself if it is high in organic matter. Thus, growing media rich in organic matter may favour establishment. Low soil humidity may limit the development of larvae present in soil (Suss, 1975). However, the pest attacks the above ground parts of the majority of the host plants or can do so if soil conditions are unfavourable. No part of the developmental cycle is passed obligatorily in the soil. Therefore, soil properties will generally not affect the establishment potential of this pest.

<u>Effect of management practices</u>
Host plants that are present outdoors in the PRA area are mostly grown for ornamental purposes and are present in private gardens, public areas etc with minimal management against pests and diseases (i.e. no or only incidental application of insecticides).

Ornamental host plants present in commercial greenhouses (protected conditions) have often been imported from third countries and are usually sold after a short growing period (e.g. 2-6 months). The short growing period may hamper establishment, but research shows that development of a new generation can take place within three months (see table 3.1). In many greenhouses, host plants are present throughout the year which will favour establishment.

<u>Effect of existing crop protection measures</u>
Insecticides are generally used in the cultivation of ornamentals although the frequency may vary greatly among plant species, between growers and possibly also between countries. Insecticide treatments will generally affect establishment to limited extent because the larvae are protected within the host plant tissue. However, small initial populations may be more vulnerable to insecticide applications (Allee effects) and in incidental cases it may prevent establishment.

### 2.3.2. Reproductive strategy and transient populations

<u>How likely can the pest establish starting from a low initial inoculum level/a few individuals? (take into account the reproductive strategy of the pest)</u>
It is likely that *Opogona sacchari* can initiate a population starting from a few individuals emerging from an infested plant or lot based on its biology. Females produce a pheromone which attracts males and male moths do likely not disperse far from the plant they emerged from (Jang et al., 2010; see also 2.4.1 Natural spread). This increases the chance that even with only a few specimens present males and females will find each other and mate. Female moths can lay 50 – 200 eggs (EPPO, 1997). Du (2006) found even an average of 290 eggs per female under optimal laboratory conditions. The eggs are deposited in small groups of about 5 eggs (EPPO, 1997; Oldham, 1928) decreasing the chance that all eggs may be predated or parasitized. The risk of predation and parasitism is also decreased by the fact that the eggs are deposited in the plant tissue with the aid of a short ovipositor and the fact that the larvae are internal feeders. The

survival rate of eggs and larvae may therefore be high. *Opogona sacchari* can have up to 8 generations per year under favourable conditions, resulting in a rapid population build-up.

How likely will transient populations occur?
*O. sacchari* is unlikely to establish outdoors in a large part of the PRA area (northern, western and central Europe). However, transient populations may occur outdoors during summer months.

### 2.3.3 Description of the area of potential establishment and endangered area

Protected cultivation
Greenhouses where host plants are grown are suitable for establishment as indicated by the presence of the pest in greenhouses in countries in various parts of the PRA area (e.g. Netherlands, France and Italy).

Outdoors
Despite the fact that *O. sacchari* has been present in greenhouses in southern Europe since at least the 1970s, the pest has only been reported from a few locations in the open and it is still uncertain if it has really established outdoors (except from Madeira and Azores). It is assessed that *O. sacchari* can probably establish in southern Europe but that the climatic conditions are not highly favourable for population development. Its potential area of distribution may be limited to the southern parts of Portugal, Spain, France, Italy and Greece and to Cyprus and Malta.

### 2.3.4 How often has the pest been introduced into new areas outside its original area of distribution? (specify the instances, if possible)

The origin of *O. sacchari* are the humid tropical and subtropical regions of Africa (EPPO, 1997). It has been introduced into many countries and is nowadays present on all continents except Oceania and Antarctica (CABI, 2011; EPPO, 2011). On continental Europe, *O. sacchari* has mainly been reported from greenhouses. It is present outdoors on Madeira, Azores and Canary Islands (CABI, 2011; EPPO, 2011)

## 2.4 Spread

### 2.4.1 Natural spread

*(indicate the rate of natural spread)*
Moths are active during nightfall and the dark (Billen, 1987). Data on dispersal distance are very limited, but moths likely do not fly far from the plant they emerge from. Dispersal distances will likely be within a range of 1 km and probably much less, like most other Tineids (Robinson & Nielsen, 1993). Oldham (1928) observed "activity during the night with flight from spot to spot". EPPO (1997): "*O. sacchari* can disperse itself by flight within glasshouses or over short distances in the field." Results of field experiments with sex pheromone traps suggest that males have a low dispersal rate (Jang et al., 2010): "the same traps caught relatively large numbers of adults for some weeks while adjacent traps less than 7 m away caught 5-10 fold less adults" and "larval counts were higher adjacent to traps that regularly caught greater numbers of moths". The observed patterns could, however, also be explained by an efficient catch of males soon after emergence or by relatively low sensitivity and short active response to the lure (Jang et al., 2010)

There is no documentation that spread occurs between greenhouses in areas where the pest cannot establish outdoors.

### 2.4.2 Spread by human assistance

*(indicate the distances and frequency by which the pest may be spread with human assistance)*

Trade of infested planting material is the main pathway for long-distance spread and has already been discussed in the entry section (Q 2.2.4).

## 2.5 Probability of introduction

*(assess the probability of introduction based on the probability of entry, the environmental suitability and the reproductive strategy of the pest).*

Greenhouses

The probability of introduction into greenhouses with import and trade of ornamental host plants has been assessed very high (low uncertainty). The probability of entry is very high through import or trade of infested planting material; the climatic conditions in greenhouses are suitable for establishment. Male and female moths are needed for establishment but the reproductive strategy has not been limiting for establishment in greenhouses in the past.

Outdoors

The probability of introduction outdoors (except from Madeira and Azores where the pest is already present) has been assessed medium (medium uncertainty). The probability of entry is probably very high: plant species which have been found infested in greenhouses are also planted outdoors (e.g. palm trees) and the pest may also enter the outdoor environment from infested greenhouses. A larva of *O. sacchari* has for example been found in a willow tree nearby a glasshouse in the Netherlands. *O. sacchari* was known from that glasshouse at least in the past. Apparently, moths escaped from the glasshouses and laid egg(s) in the willow tree. The outdoor climatic conditions in the Netherlands, however, are unlikely to be suitable for establishment. Outdoor conditions in (parts of) southern Europe are probably suitable for establishment but do not seem to be highly favourable (see above). *O. sacchari* has been present in greenhouses in southern Italy since at least the 1970s and outdoor locations in southern Europe have been exposed to the pest for several decades. There is an Italian article from 1973 about the finding of the pest outdoors but the pest does not seem to have established outside greenhouses in Italy (Annex II). There are, however, indications that the pest is present outdoors in southern France (Annex II).

**Conclusions on the area of potential establishment, probability of introduction (entry + establishment) and the rate of natural spread**

Area of potential establishment
*O. sacchari* can establish in greenhouses where host plants are grown. The pest can probably establish outdoors in (parts of) the Mediterranean area and southern Portugal.

Probability of introduction (entry + establishment) with import and trade of host plants
The probability of introduction in greenhouses in the EU has been rated as very high (low uncertainty). Greenhouses with ornamental host plants have shown to be suitable for establishment both in northern and in southern EU-countries. Thus entry of the pest with movement of infested plants into a greenhouse will likely lead to establishment of the pest as long as host plants are present.

The probability of introduction outdoors has been assessed as medium (medium uncertainty). The outdoor environment seems less suitable for establishment than greenhouses. The pest has been present in greenhouses in the EU since at least 1970s but has thus far been reported from a few outdoor locations only.

Rate of natural spread after introduction
Natural spread of *O. sacchari* will be slow. Moths probably stay within a range of 100 m and possibly a much shorter range from the plants they emerged. Natural spread between greenhouses in areas where the pest cannot establish outdoors has not been documented.

## 2.6 Potential consequences

### Economic impact

**2.6.1 What is the economic impact of the pest in its current area of distribution?**
*O. sacchari* has been introduced into many countries and is nowadays present in many regions in the World (Annex II). On continental Europe, *O. sacchari* has mainly been reported from greenhouses (Annex II). Outdoors it is present on Madeira, Azores and Canary Islands (CABI, 2011; EPPO, 2011). The pest can weaken and even kill its host plant. Damaged plants, plants that are dying or already dead or plants with pruning wounds seem especially vulnerable for attack by *O. sacchari.* Jang et al. (2010) for example reported that *O. sacchari* was reproducing on dead and dying papaya trunks in an abandoned papaya field. See also below the discussion on attack of banana and pine apple plants on the Canary islands and sugar cane for other examples.

Generally, little information has been published on the economic impact of *O. sacchari*. Its impact has mainly been described in general (qualitative) terms:

- *Hawaii*. In Hawaii, *O. saccharii* has been reported as a significant pest of ornamentals, banana and pine apple plantations (Vorsino et al., 2005): "On pineapple plantations, the levels of *O. sacchari* infestation vary with location, with the age of the plant, and with propagation material (A. Vorsino, unpublished data). The vegetative propagation material observed were those mainly used in Hawaii's pineapple industry, these include slips, suckers and crowns. Infestation levels on pineapple crowns range from 10–60%." The larvae eventually kill the planting material. Major infestations occur under optimal conditions.
- *Florida*. In Florida, *O. sacchari* is considered a serious pest of many ornamental plant species and particularly *Dracaena fragrans*, *Chamaedora* sp., *Cordyline terminalis* and *Polyscias* sp. are attacked (Davis & Pena, 1990; Pena et al., 1990a).
- *China*. In China, *O. sacchari* may have been introduced with import of the non-endemic *Dracaena fragrans* and in the 1990s many *Dracaena fragrans* plants were killed by the pest (Yan et al., 2001). Yan et al (2001) also indicated that *O. sacchari* is regarded as a particularly serious threat in the southern provinces of Guangzhou, Fujian and Hainan. *O. sacchari* has been reported as a serious pest "causing destructive damage to some ornamental plants" by Tian et al. (2000) and "an important pest of many ornamentals and crops in China" by Ju et al., (2003). Anonymous (2010) has stated: "By now, there are 37 species of Opogona sacchari host plants in 12 families found in Shandong Province. Among them, 11 species belong to Palmaceae family, 8 to Agavaceae family and 6 to Araceae family. *Dracaena fragrans* belonging to the Agavaceae family and *Dieffenbochia daguensis* belonging to the Bombacaceae family are the two most severely and broadly damaged ones. *Cordyline fruticosa*, *Yucca elephantipes*, *Nolina recurvata*, *Euphorbia pulcherrima*, *Pelargonium hortonum*, *Cayloto ochlandra* Hance, *Chrysalidocarpus lutescens* and other plants are also harmed in some degree. There is no harm found among field crops."
- *Canary islands*. On the Canary islands (information from A. D. González Hernández, RPPO Canary Islands, August 2012), *O. sacchari* affects several crops and plant species: banana trees, papaya, Strelitzia (as cut flower), pineapple, some palm trees (*Phoenix canariensis*, *Howea forsteriana*) and some ornamental plants (*Dracaena*, Araceae, etc.). The control of this pest is carried out with insecticide treatments, generally with organophosphates and, in case of banana trees, particularly with chlorpyrifos. The use of pheromones is not (yet) widespread. In the case of banana plants, this pest is found in the stumps that remain after the harvest of bunches and it produces a faster rot of the plant. In the past, damage on banana plants occurred when the pest got inside the banana rachis through the bellota (inflorescence) terminal raceme, which produced the early ripening of the bananas located in the terminal end, but never inside the

banana fruits. The strategy followed now is to eliminate the bellota, leaving longer the terminal end of the bunch rachis which prevents damage to the fruits. In the case of papaya plants, it is exclusively found in the plant stems, and particularly in older plants, with presents previous damages in stems which the larvae use to penetrate. In pineapple, it is found in stumps of harvested plants and in older plantations. In the case of Strelitzia, it may be found in the stems of the floral sticks, but due to the market requirements, any damage produced in the flower (on one hand, the flower will not open and, on the other hand, the presence of a hole in the stem) will result in the rejection by the buyer. The impact of *O. sacchari* on the Canary Islands is rated by A.D. González Hernández as (according to rating guidance provided):

  - o for banana and papaya production: minor (common treatments in these crops targeted against other pests are sufficient to control *O. sacchari*; only in exceptional cases specific treatments are applied; fruit is not damaged).
  - o for production of ornamentals including palms: medium.
  - o for public areas (parcs): medium (almost exclusively found in palm trees).

- *Madeira*. The following information was kindly gathered and provided by M. Khadem Centre of life sciences, University of Madeira, Portugal, pers. comm. 21st December 2012): *O. sacchari* is present outdoors on Madeira Island. It affects banana cultivation but data are lacking on the damage caused. Apparently, the pest is not a problem when the cultivation is properly cared for. After cutting, the old banana trunks should be cleared from the area without allowing their decomposition in the vicinity of new plants. No specific measures are taken against this pest. *Opogona sacchari* also affects some ornamental species such as estrelicia (*Strelitzia reginae*) and orchids in greenhouses but no assessments are available on the damage it causes. There are no data available on the impact of this pest in gardens or natural vegetation.
- *Banana.* EPPO (1997) has stated the following "*O. sacchari* is a serious pest of bananas in the Canary Islands and Brazil (Sampaio et al., 1983). Though widespread, in Africa the impact is relatively minor, since bananas are not a major export crop." Sampaio et al. (1983) reported that *O. sacchari* was widely present in banana plantations in Sao Paulo and also that the abundance of the pest varied with the amount of rainfall. However, no quantitative data on the impact of the pest were provided in the abstract of the paper (full paper in Portuguese).
- *Sugar cane*. The impact of *O. sacchari* on sugar cane has been discussed by Davis & Pena (1990). Alam (1980, cited in Davis & Pena, 1990) reported extensive damage on live sugar cane on Barbados while J.E. Jones observed mainly infestation of dead stalks which corresponded largely with the observations of Bojer (1986, cited in Davis & Pena, 1990). In Florida, infestation of sugar cane has not been reported.
- *Greenhouses in the PRA area. O. sacchari* is present in part of the PRA area, mainly in glasshouses (Q 2.1.2). No quantitative information has been found about its current impact in the PRA area. In the Netherlands companies that import host plants from countries where *O. sacchari* is present, experience incidentally or more regularly outbreaks of *O. sacchari* (information obtained from Dutch companies). Generally, *O. sacchari* is considered not a major problem by the companies (In 2012, four companies were visited and asked about pest incidence and control measures); it is mainly controlled by scouting and subsequently removal of inferior looking plants, and application of pyrethroids against the moths. Entomopathogenic nematodes are also applied when sufficiently effective (larvae present in the pots). On some crops, control of *O. sacchari* can be difficult and costly also due to repeated introductions (e.g. one company reported that *O. sacchari* is regularly imported with *Ficus* plants with a thick stem base and originating in China). In Italy, growers do generally not apply specific treatments against *O. sacchari*; a few specific treatments are applied against the pest in greenhouses in the province of Catania, Sicily (pers. comm. G.

Rotundo, University of Molise, Italy, 7th January 2013). In France, the type of damage encountered is: decline and plant death and unmarketable plants. Plants damaged or infested with *O. sacchari* are (generally) destroyed but no quantitative data on yield losses (i.e. % plant loss) are available (see Annex II for details on the situation in France).

- *Amenity trees, ornamentals in gardens en parcs*. Information from France: dead or dying palm trees infested with *O. sacchari* have been observed in Provence Côte d'Azur (southern France) (Annex II). No quantitative data are available and it is unknown if healthy plants have been attacked or that plants that were already stressed and weakened for other reasons have been attacked. Porcelli & Parenzan (1993) have reported damage on *Strelitzia reginae* in Puglia (southern Italy) both in the open as in greenhouses.

<u>Conclusions on the impact in the current area of distribution:</u>
Generally, the impact seems to vary between areas. Quantitative data are lacking and, therefore, the uncertainty of the assessment is medium or even high (for sugar cane). Impact per crop or plant category:

- Sugar cane: the current impact is highly uncertain, damage has been reported on live crops by one author while others reported that *O. sacchari* mainly infested dead cane tissue.
- Banana, pine apple, papaya: minor impact on the Canary Islands because it is controlled by insecticide sprays targeted against other pests and no cultural measures are taken primarily directed against *O. sacchari*. Impact also seems minor on Madeira (medium uncertainty). The impact is probably major on Hawaii (medium uncertainty). From other areas in the world, information on the impact under commercial conditions is very limited.
- Commercially produced ornamentals in greenhouses: *O. sacchari* can infest a wide range of ornamental plant species; in general, the impact is medium although incidentally or in certain situations (heavily infested consignment) the impact can be major.
- Ornamentals, palm trees outdoors: medium impact on the Canary islands (medium uncertainty). In southern China, *O. sacchari* seems to have a major impact on some ornamentals (medium uncertainty).
- The impact seems higher in areas with a more tropical climate (warm and humid) like Hawaii and southern China.

### 2.6.2 What is the potential direct economic impact in the PRA area? *(without any control measures)*

<u>Crop plants</u>
*O. sacchari* is potentially a major pest of bananas and pine apple. In the PRA area, banana plantations (for the production of fruit) are present on Madeira and Azores (Portugal) where *O. sacchari* is already present. Some bananas are produced in Italy and Cyprus according to statistics available (Q2.3.1). Banana plantations are (as far as known) not present on mainland Spain and Portugal. Also sugar cane and pine apple are minor crops (or not present at all) on mainland Europe (Q 2.3.1).

<u>Ornamentals</u>
In general, ornamental plants will become unmarketable once damaged by *O. sacchari*. However, the damage is not only cosmetic; affected plants can eventually die. Thus, without any control measures and under suitable climatic conditions (like in commercial greenhouses or tropical glasshouses (e.g. in botanical gardens, zoos or tropical holiday worlds like the "Tropical Islands"), the economic impact is expected to be major for various ornamental plant species (major impact). Targeted measures (e.g. intensive monitoring, removal of infested and damaged plants and/or application of insecticides if possible) will be needed to reduce the impact.

Conclusion
Major impact (considerable losses in absence of control measures) with a medium uncertainty (no quantitative data available and there is uncertainty about the suitability of the outdoor climate for population development on continental Europe).

### 2.6.3 Which control measures are available in the PRA area?

Monitoring methods
In protected cultivation most growers use black light traps for monitoring (and trapping), which do attract the moths sufficiently. The position of the light traps is important for the trapping success and they have to be placed directly above the plants. However, light traps are not specific and attract also other moth species and other insects. Pheromone lures for *Opogona sacchari*, which have the benefit of specifically trapping the species, have recently become available (Sidders et al., 2009). Tulip bulbs can be used as baits for egg laying of *O. sacchari* but this method has to further verified (http://www.stadtentwicklung.berlin.de/pflanzenschutz/pflanzenschutztagung/download/Aspekte_zum_Pflanzenschutz.pdf; pers. comm. B. Kummer, April 2013).

Insecticides
Peña et al. (1990a) tested the efficacy of different insecticides (spray application) against larvae of *O. sacchari* in *Dracaena* and *Chamaedorea* sp. In *Dracaena* sp., good results were obtained with methomyl, chlorpyriphos, carbaryl and dimethoate. and in *Chamaedorea* sp. with carbaryl, methomyl, chlorpyriphos and oxamyl. These insecticides and/or application methods (spray application) are not registered anymore in the Netherlands. Carbaryl has not been registered in the EU (EU pesticide database on http://ec.europa.eu/food/plant/protection/evaluation/database_act_subs_en.htm, last access 14th August 2012). The insecticides mentioned above have a systemic mode of action. Insecticides that are currently available in the Netherlands against larvae of Lepidoptera have only a contact and/or stomach action (e.g. indoxacarb, spinosad and methoxyfenozide). Because larvae of *O. sacchari* are usually present inside plant tissue these insecticides may not be very effective against the larvae. The adults (moths) can be controlled by repeated application of pyrethroids

Biological control agents
Application of entomopathogenic nematodes (*Steinernema feltiae, S. carpocapsae* and/or *Heterorhabditis bacteriophora*) to soil if larvae are present (Peña *et al.*, 1990b; Bloemhard & Van Slooten, 2004). For example, larvae are often present in the rhizosphere of infested *Chamaedorea* sp. and Bromeliaceae. Peña *et al.* (1990b) found 100% mortality of larvae 4 days after application of 500 ml with $1x10^5$ nematodes/ml per 3,8-L pot in *Chamaedorea elegans*.

Bloemhard & Van Slooten (2004): 50-100% mortality after application of $5x10^5$ nematodes per m2 to potting soil infested with larvae of *O. sacchari*.

Cultivation methods
Removal of damaged or inferior plants because these plants may be infested and otherwise such plants are more vulnerable for attack by *O. sacchari*.

**2.6.4 What is the expected direct economic impact when the pest would become introduced?** *(with the use of control measures)*

Outdoors:
Thus far, the distribution of *O. sacchari* on continental Europe seems to be mainly limited to greenhouses, despite the fact that the pest is already present in greenhouses in southern Europe for several decades (see 2.3 Area of potential establishment). It is a pest of banana which is grown at a very limited scale in the PRA-area except on Madeira, where the pest is present outdoors. The expected additional impact will, therefore, mainly concern damage to palm trees and other ornamental host pants of the pest. The pest may cause death or decay of individual plants, but overall damage is expected to be limited. This assumption is based on the fact, that the pest is already present in Europe for several decades and many infested plants have likely been planted outdoors since; still there are no reports of large scale outbreaks of the pest (see also Annex II). The expected direct impact is, therefore, assessed as medium: yield and/or quality losses are limited (medium uncertainty).

Greenhouses:
Generally, a medium impact (medium uncertainty). This assessment is mainly based on information obtained from greenhouse companies in the EU where *O. sacchari* is present or where the pest is regularly introduced with import/trade of plants (Q2.6.1). The uncertainty is medium because no quantitative data are available on the impact of O. *sacchari*. Note that control of the moths may depend on a limited number of insecticides (e.g. pyrethroids only) and in case of withdrawal of these insecticides, the impact of the pest may increase.

**Export markets**

**2.6.5 What is the expected impact on export markets for the PRA area?**
Establishment of *O. sacchari* could affect the export of plants for planting to countries where the pest is regulated (e.g. USA). However, plants for planting of host plants of *O. sacchari* (tropical and subtropical plants) are mainly imported into the EU and not exported. *O. sacchari* is already present in many greenhouses in EU-member states and does not seem to affect export markets. Export volume of tropical fruits which may become infested with the pest is very limited. In conclusion, a minimal or minor impact is expected on export markets of the EU (low uncertainty).

**Environmental impact**

**2.6.6 What is the expected environmental impact in the PRA area?**
*O. sacchari* has been introduced in many areas outside the area of origin (probably the (sub)tropical regions in Africa). In some areas, e.g. the Canary islands the pest has already been present at least since the 1920s (EPPO, 1997). In Hawaii, where it was found in 1990 for the first time and probably introduced in the 1980s it is considered a pest of various crop plants (bananas, pine apple) and ornamental plants (Hollingsworth & Follett, 2007). Xie et al. (2001) have stated the following about the impact of the pest in China "Banana moth now occurs in many areas where fragrant dracaena is planted, and is regarded as a particularly serious threat in the southern provinces of Guangzhou, Fujian and Hainan. Until 1997, reports of this pest have been confined to ornamental plantings and nurseries. However, it is believed to pose a potential threat to natural ecosystems….".

*O. sacchari* may attack palms (and other host plants) that are present as amenity trees in the whole Mediterranean area and also threaten palm forests (e.g. the Elche palm forest in Spain which is a UNESCO site) and palms in historical parks and collections. *O. sacchari* may be damage the endemic *Phoenix theophrasti* in Greece (registered on the

IUCN red list), *Chamaerops humilis* in Spain, Italy, France, Morocco (*C. humilis subsp. cerasifera*) etc. In natural forests, no treatments are implemented to control the pest. Plants of natural forests are likely to be more resistant to *O. sacchari* than plants in nurseries since they are not pruned which can create invasion ports for the pest (see also the EPPO PRA on *Metamasium hemipterus*). The climate in the PRA area (except on Madeira and Azores) does not seem highly favourable for outdoor establishment of the pest (see Q 2.2.4).

In conclusion, the environmental impact is assessed minor with a medium uncertainty. Locally or incidentally plants may be damaged and killed but no large scale outbreaks are expected in healthy natural vegetations.

**Social impact**

**2.6.7 What is the expected social impact in the PRA area?**
Minor (low uncertainty). Impact will be mainly limited to greenhouses growing host plants. The pest has already been present in greenhouses in some EU-countries. *O. sacchari* is not expected to become a major pest in the PRA area. Hence social impact is assessed to be minor.

**Endangered area**

**2.6.8 What is the endangered area?**
Greenhouses growing host plants of *O. sacchari*. Low uncertainty
Outdoors (excluding Madeira and Azores because the pest is already present on those islands): the pest can likely establish in the Mediterranean area but conditions do not seem highly favourable for population development. Despite the fact that *O. sacchari* has been present in greenhouses in southern Europe since the 1970s, the pest has only been reported from a few outdoor locations. Thus, it is uncertain if outdoor crops and natural vegetation in southern Europe is endangered. Locally palm trees and ornamentals may be damaged.

**Conclusions on impact**

**Endangered area:** greenhouses growing host plants of *O. sacchari*. The pest is already present in greenhouses causing damage to ornamentals. Outdoors (limited parts of southern Europe): ornamental host plants including palm trees along roads, in gardens, parcs etc. Banana crop is within the endangered area but is grown on a very limited scale in the in the PRA area with the exception of Madeira and Azores where the pest is already present.

**Economic impact:**
Greenhouses with ornamental host plants: generally medium, incidentally major (low uncertainty). The pest has been present in greenhouses in the EU probably since 1970s and the assessment is based on the current impact *O. sacchari* has in greenhouses in the EU. The uncertainty is medium because of lack of quantitative data on plant/quality losses.

Ornamental host plants outdoors in southern EU: medium. The uncertainty is medium: it is uncertain to which extent plants along roads in gardens and parcs are endangered). Limited information suggest that locally or incidentally damage may occur in southern Europe. Damaged and dying plants infested with *O. sacchari* have been observed at some locations.

**Export markets:** minimal or minor impact (low uncertainty). Plants or plant parts (e.g. fruits) that can become infested are mainly imported into the EU and not exported.

**Environmental impact:** minor (medium uncertainty). Locally or incidentally plants may be damaged and killed but no large scale outbreaks are expected in healthy natural vegetations of endemic plants.

**Social impact:** minor (low uncertainty). Direct impact of the pest will be mainly limited to greenhouses growing host plants. The pest has already been present in greenhouses in some EU-countries for many years. *O. sacchari* is not expected to become a major pest in the PRA area. Hence social impact is assessed to be minor.

# 3. Identification and evaluation of risk reduction options

### 3.1 Indicate the pathway.

The pathway is "import and trade of plants for planting of host plants other than seeds"

### 3.2 Identification of management options

Table 3.1: overview of possible risk reduction options for the pathway "import and trade of plants for planting of host plants other than seeds"

| Risk reduction option | Reduction of risk | Justification[1] |
|---|---|---|
| **I. options at the place of production** | | |
| a. Detection of the pest at the place of production by inspection or testing | To limited extent | Visual inspection not sufficient because eggs and/or larvae can be present without any (clear) external symptoms |
| b. Prevention of infestation of the commodity at the place of production:<br>• use of resistant cultivars,<br>• growing the crop in specified conditions (e.g. physical protection),<br>• crop treatments, and/or<br>• harvest at certain times of the year or growth stages | Yes: physical protection | Resistant cultivars not available.<br>Moths can be kept out of the production place using insect screening. Light- and pheromone-traps are effective for monitoring and trapping. Crop treatment is not sufficient because eggs and larvae inside the plant tissue are not affected. Limiting harvest at certain times or growth stages is no option because the whole plant or plant parts than can become infested are traded. |
| c. Establishment and maintenance of a pest-free production site, pest free production place or pest free production area | Yes by physical protection | Physical protection: see above. Although *O. sacchari is* not known to disperse over long distances, it has a very wide host range and can also reproduce on dead or decaying plant material. Maintenance of a host plant free buffer zone around a production place is, therefore, not a feasible option. |
| **II. options after harvest, at pre-clearance or during transport** | | |
| a. Detection of the pest in consignments by inspection or testing | To limited extent | Visual inspection not sufficient because eggs and/or larvae can be present without any (clear) external symptoms |
| b. Removal of the pest from the consignment by treatment or other phytosanitary procedures (remove certain parts of the plant or plant product, handling and packing methods) | Yes, but only applicable for certain host plants and plant material | Heat treatments of stems of *Dracaena* and *Yucca* spp. or treatment with entomopathogenic nematodes. Methylbromide is also an option for certain commodities but methylbromide will be phased out in the near future. |
| **III. options that can be implemented after entry of consignments** | | |
| a. Detection during post-entry quarantine | Yes | Post-entry quarantine for several months at 20°C or higher temperatures. Light traps and pheromone traps are available for monitoring; preferably pheromone traps because of their specificity.. |
| b. Consider whether consignments that may be infested be accepted without risk for certain end uses, limited distribution in the PRA area, or | No | Pathway is plants for planting |

| Risk reduction option | Reduction of risk | Justification[1] |
| --- | --- | --- |
| limited periods of entry, and can such limitations be applied in practice | | |
| c. Effective measures that could be taken in the importing country (surveillance, eradication, containment) to prevent establishment and/or economic or other impacts | Yes | Eradication from greenhouses is possible, but has been shown to be difficult due to repeated introductions. |

[1] a more detailed justification is given below.

**I. options at the place of production**

a. Inspection or testing

Visual inspection is not very effective as already stated above because the eggs, larvae and often also the pupae are present inside host plant tissue. This is probably the main reason that *O. sacchari* has been introduced into so many countries (see Q. 2.2.8). Testing is not applicable for insects. Light- and pheromone traps are available for monitoring of adults (Sidders et al., 2009) but cannot be used to detect plants infested with eggs, larvae and/or pupae.

b. Prevention of infestation of the commodity at the place of production

Resistant cultivars are not available.

Crop treatments can reduce infestation, e.g. by intensive spray programs against moths. However, crop treatments cannot guarantee pest freedom because of the larvae and pupae which are hidden in the plant tissue and/or soil especially not when plants are grown outdoors and the pest can enter from the environment. In greenhouses, two to three applications per week against the adults (e.g. pyrethroids) will be needed to prevent adults from laying eggs (EPPO, 1997; Table 3.1). Pheromone traps are available which may allow for other control methods, e.g. mass trapping or mating disruption. These techniques could be rather successful but need further investigation (e.g. Jang et al., 2010).

Physical protection can guarantee pest freedom of the crop. It may be difficult to keep the production site fully free of the pest especially in areas with a high pest prevalence because the pest may enter through cracks in screens. Monitoring will be needed by visual inspections and the use of pheromone traps to detect any entry of the pest.

c. Pest free production area, place or site

Maintenance of a pest free production place or site in an area where the pest is present can be obtained by physical protection in combination with monitoring (see above).

**II. options after harvest, at pre-clearance or during transport**

a. Detection of the pest in consignments by inspection or testing

Visual inspection is not very effective because of the cryptic nature of the larvae (see above).

b. Removal of the pest from the consignment by treatment or other phytosanitary procedures

*Fumigation*

EPPO (PM 3/14(2)) has developed a protocol to eliminate *O. sacchari* from *Dracaena* and *Yucca* cuttings using methyl bromide. However, not such protocols are available for other plants for planting. Many of these plants are imported with foliage and fumigation is expected to phytotoxic. Moreover, methyl bromide has adverse effects on the ozone layer and will be phased out in the future.

*Irradiation*

The international standard ISPM 18 (FAO, 2006) provides technical guidance for the application of ionizing radiation (irradiation) as a phytosanitary treatment. Pests can be killed by irradiation but dosages needed to kill pests will be detrimental to (most) plant species/type of planting material (Hansen & Hara, 1994; Potenza et al., 2000). However, dosages needed to render the pest sterile are much lower. Hollingsworth & Follett (2007) studied the effect of irradiation on *O. sacchari* in laboratory experiments. Radiation (150

Gy) of eggs, 0-2 days old larvae, 1-, 2- and 3-weeks old larvae, young and old pupae resulted in a 96, 96, 95, 73, 61, 8 and 9% decrease in the development of adults. However, eggs laid by adults emerged from treated pupae did not hatch and it was concluded that radiation with 150 Gy should be sufficient for sterilization of immature stages of *O. sacchari* in commodities. It will be difficult, however, to verify that the plants have been irradiated, because the treatment does not kill the pest but only sterilize it (Hansen & Hara, 1994). Such treatments will therefore require good audit and certification systems to assure that the proper treatment has been conducted (see also ISPM18).

In the USA, irradiation has been approved as a phytosanitary treatment for fresh fruit and vegetables (Follett, 2009) but as far as we know there is no or little experience with irradiation of plants for planting. Wit & Van den Vrie (1985) already observed damage on several cut flower species at dosages of 50 or 100 Gy and research will be needed to test to which extent dosages of 150 Gy will affect the quality of plants for planting. Therefore, irradiation of plants for planting it still considered an experimental or hypothetical method which needs validation.

*Heat treatment*
A hot water bath (60 min 47°C, followed by 10 min 20°C) is an EPPO approved method for treatment of *Dracaena* and *Yucca* cuttings (EPPO PM 10/2 (1)). However, for plants with foliage of which many are imported hot water treatment will be detrimental and of no use.

*Biological treatment*
Submersion of propagation material of *Dracaena* and *Yucca* spp. in a suspension of the nematodes *Steinernema feltiae, S. carpocapsae* and *Heterorhabditis bacteriophora* is probably effective. No data have, however, been found on the efficacy level and like the heat treatment this treatment is only applicable for certain plants for planting.

*Conclusion*
- Treatment protocols (methyl bromide, hot water) are available and approved by EPPO for cuttings of *Dracaena* and *Yucca* but not for other plant species and types of plant material. Methyl bromide has adverse affects on the ozone layer and will be phased out in the near future.
- Irradiation of plants that render the pest sterile without affecting the quality of the plants may be an option but needs more experimental testing and validation. Audit and certification systems would be needed to assure irradiation have been properly carried out.

**III. options that can be implemented after entry of consignments**

a. Detection during post-entry quarantine
Incubation of plants in a post-entry quarantine facility is a possibility. The quarantine period needed depends on the temperature. However, there are considerable differences in life cycle duration periods between studies. For example, Billen (1987) found a life cycle duration of 88 days at 15°C, whereas Du et al. (2006) found a life cycle duration of 110 days 19°C. At 25°C, the development time was about 58 days in Du (2006) and about 46 days in Bergmann et al. (2006) (Table 3.1). Possibly, differences in *O. sacchari* populations used can explain these differences. Generally, a post-entry quarantine period of three months at 20°C in combination with pheromone traps will be sufficient to detect most if not all infested consignments.

Table 3.1 Duration (in days) of different stages of *Opogona sacchari* according to different studies

| Source | Temperature (°C) | Larvae | Pupa | Pre-oviposition | Egg | Total development period |
|---|---|---|---|---|---|---|
| Billen, 1987 | 15 | 50 | 20 | No data | 12 | 88 |
| Du et al. , 2006 | 19 | 58.7 | 35.5 | 3.6 | 12.2 | 110.0 |
| | 22 | 35.3 | 16.2 | 3.9 | 9.8 | 65.2 |
| | 25 | 34.4 | 14.9 | 2.5 | 5.7 | 57.6 |
| | 28 | 29.8 | 11.8 | 4.0 | 5.1 | 50.7 |
| | 31 | 27.7 | 9.9 | 3.3 | 5.2 | 46.1 |
| | 34 | 27.7 | 10.4 | 6.0 | 4.7 | 48.9 |
| Bergmann et al., 2006 | 25 | 24.2 | 11.2 | 2.7 | 7.7 | 45.8 |

b. Certain end uses, limited distribution in the PRA area, or limited periods of entry
Not relevant for plants for planting.

c. Surveillance, eradication, containment
Light- and pheromone traps can be used for monitoring and trapping. Pheromone traps have become recently available facilitating easier (and therefore earlier) detection of *O. sacchari*, because of their specificity. Pheromone traps can also be used for mass trapping and mating disruption in eradication or containment programs although these applications have presently no registration in the EU. In greenhouses, eradication may be achieved by intensive control of adults (killing adults before they can lay eggs because eggs, larvae and pupae cannot or hardly be controlled by insecticides available in the EU). At 20°C, the pre-oviposition period is about 3-4 days and insecticide treatments (e.g. application of pyrethroids) should, therefore, be repeated at approximately 3-day-intervals. Plants that are known or suspected to be infested and also any other damaged/weaker plants (which have a higher chance of becoming infested) should be discarded. This intensive spray program may have to be continued for three months (life cycle duration from egg to adult is about 3 months at 20°C). Adults are most active between about 20:00 and 24:00 (Billen, 1987; Gianotti et al., 1977) and insecticides are best applied during the evening. When after this intensive spraying program no sign of the pest has been observed (i.e. no moths in traps or other signs) during a period of 3 months, the pest has likely been eradicated. Tulip bulbs could be used as baits for egg laying of *O. sacchari* as attract and kill method in the future but this method needs further experimentation (pers. comm.. B. Kummer, April 2013).

In areas where *O. sacchari* can establish outdoors, eradication will be difficult because of its wide host range, but especially, because the pest may have spread over longer distances before it is being detected. If the pest is being detected at an early stage (e.g. limited to the plants on which is has been introduced), eradication may still be possible. The pest does not seem to spread naturally over long distances and may stay within 100 meters from the planting material from which they emerged. However, the main problem with eradication/containment programs will be timely detection of infested plants before adults have emerged.

### 3.3 Current phytosanitary legislation (Council Directive 2000/29/EC)

*O. sacchari* is listed as a IAII quarantine pest in Council directive 2000/29/EC. There are no specific requirements for import or trade of plants for planting from areas where the pest is present. Plants for planting need to be inspected at import but visual inspections are not very effective as shown by the numerous introductions and findings of *O. sacchari* after import of plants (see part 2.2 of the present PRA). There are no plant passport requirements for many of the plant species that have been found infested in the EU. Official and unofficial data indicate that infested lots are regularly traded. Thus, the

EU-legislation has not been very effective in the prevention of new introductions nor spread of *O. sacchari* by import and trade of plants for planting, respectively.

### 3.4 Selection of and conclusions on risk reduction options

<u>Options to reduce the likelihood of introduction and spread</u>
Three options have been identified which can reduce the risk to a very low level (options I-III) and are discussed below. In addition, a fourth option (option IV) is also discussed which has a much lower protection level but will interfere less with trade.

*Option I: pest free area*
Plants for planting should originate from areas that are free of the pest. This option is highly effective. Pheromone traps are available to determine pest freedom of the area. This option will greatly interfere with trade because *O sacchari* has a very wide host range and is present in countries from which many plants are imported into the EU. It could lead to an import stop of large numbers of plants for planting which have been imported since many years (see the entry-section). It will also interfere with trade within the PRA area because the pest is already present in several countries in the EU (Annex II).

*Option II: pest free production place or site*
Plants for planting should originate from a pest free production site as guaranteed by complete physical protection and regular inspections. This option will probably like option I greatly interfere with trade because implementation of physical barriers which exclude *O. sacchari* may not be feasible in the exporting countries. This option could, therefore, like option I lead to an import stop of large numbers of plants for planting which have been imported since many years (see the entry-section). Establishment of pest free production place or site may also be difficult in areas in southern Europe where the pest may be present outdoors or may easily spread between greenhouses during spring and summer.

*Option III: pre- or post-entry quarantine*
Before transport or after arrival, plants for planting should be placed under complete physical protection for a minimum period of 3 months at a minimum temperature of 20˚C. Pheromone traps could be placed in the quarantine area to detect any moths. Plants for planting can be released when no sign of the pest has been observed during these 3 months. In case of an infestation, the whole plant lot will have to be destroyed and insecticides need to be applied to eradicate the pest. This option will also have a major impact on trade because consignments can be very large and usually arrive on a daily basis. (Most) greenhouse companies do not have the facilities to place each consignment under quarantine.

*Option IV: regulating plants for planting moving in trade*
This option regulate *O. sacchari* only for plants moving in trade without any specific requirements for the production or treatment of the commodity. This option will not be able to prevent new entries nor spread within the EU because of the cryptic nature of the pest, but will provide a certain level of protection. For example, companies which regularly trade infested lots could be enforced to take control or cultural measures to reduce the probability of association of the pest. This option is not expected to change the risk of *O. sacchari* significantly as compared to the current measures in the PRA area. *O. sacchari* is already present in many places in the PRA area (Annex II).

<u>Options after introduction</u>
Pheromone traps are available which enable detection of moths even at low population densities. Eradication of the pest from greenhouses is possible by removal and destruction of (suspected) infested plants and repeated insecticide treatments. In

southern Europe, the pest may be able to establish outdoors. Eradication of outdoor populations may be difficult to achieve and the probability of eradication will largely depend on the early detection of the pest.

**Conclusions on risk reduction options**

Current official measures

*O. sacchari* is a quarantine pest in the EU, but official measures to prevent entry or stop spread have not been very effective mainly because of the cryptic and polyphagous nature of the pest. The pest has been present in the EU for several decades, but there are no plant passport requirements for many of its host plants to control movement within the EU.

Options to reduce the probability of introduction and spread

Three options have been identified which will largely reduce the risk of introduction and spread of *O. sacchari* by import and trade of plants for planting:

I. Host plants should originate from a pest free area,
II. Host plants should originate from a pest free place or site of production. In areas where the pest is present outdoors, complete physical protection will be needed to ensure pest freedom.
III. Pre- or post-entry quarantine.

Each of these three options will largely interfere with trade. A fourth option identified will have a much lower protection level but interfere much less with trade:

IV Regulating of plants moving in trade.

This option does not require specific growing conditions or treatments. This option is not expected to change the risk of *O. sacchari* significantly as compared to the current situation in the PRA area.

Eradication

After introduction of the pest in a greenhouse, eradication is possible. Eradication of outdoor populations which may occur in southern Europe may be difficult and may only be feasible at early detection.

## 4. Uncertainties

The main uncertainties in the present PRA are:

- The current distribution of *O. sacchari* in Europe and other continents.
- The suitability of the climate in southern EU for establishment of *O. sacchari* and the potential impact of the pest in the open.
- Natural spread distances

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# Annex I: Rating guidance

**Probability of entry (including transfer to a suitable host or habitat)**

| Rating level | Description |
|---|---|
| Low | On an average less than 1 "entry" in 10 years |
| Medium | On an average 1 "entry" per 5 – 10 years |
| High | On an average 1 "entry" per 2 - 4 years |
| Very high | On an average 1 or more "entries" per year |

**Establishment and probability if introduction**

A description of the potential area of establishment is asked. In addition, the assessors should indicate where the pest can likely, probably and/or may establish in a certain area reflecting a low, medium and high uncertainty, respectively.

A rating is asked for the probability of introduction (the probability of entry and establishment). For this the same rating levels and rating guidance as for the "probability of entry" are used (see above). The probability of introduction will depend on the probability of entry, the suitability of the environment for establishment and the biology of the pest.

**Spread**

No rating is asked but a description of the rate of spread after introduction.

**Impact**

Rating guidance derived from the EPPO (European and Mediterranean Plant Protection Organisation) decision-support scheme for Pest Risk Analysis PM5/3(5) (http://www.eppo.int/QUARANTINE/Pest_Risk_Analysis/PRA_intro.htm)

**2.6.1 What is the economic impact of the pest in its current area of distribution?**

| Rating level | Description |
|---|---|
| Minimal | no yield and/or quality losses recorded. |
| Minor | yield and/or quality losses recorded but pest is fully controlled by non-targeted measures and control costs cannot be distinguished from normal plant protection costs. |
| medium | yield and/or quality losses are limited, some targeted measures needed, but additional control costs are limited. |
| Major | yield and/or quality losses are considerable, targeted measures are frequently needed and the treatment is costly. |
| massive | yield and/or quality losses are severe; high mortality of plants may also occur which can only be reduced by very expensive measures. |

**2.6.2 What is the potential direct economic impact in the PRA area?** *(without any control measures)*

| Rating level | Description |
|---|---|
| Minimal | no yield and/or quality losses are expected. |
| Minor | yield and/or quality losses are expected but they cannot be distinguished from normal variation |
| medium | yield and/or quality losses are limited but they exceed normal variation, some targeted measures may be necessary |
| Major | yield and/or quality losses can be considerable, targeted measures may frequently be needed |
| massive | yield and/or quality losses will be severe; and/or high mortality of plants is expected |

**2.6.4 What is the expected direct economic impact when the pest would become introduced?** *(with the use of control measures)*

| Rating level | Description |
|---|---|
| Minimal | no yield and/or quality losses expected |
| Minor | yield and/or quality losses are expected or cannot be distinguished from normal variation |
| medium | yield and/or quality losses are limited |
| Major | yield and/or quality losses can be considerable |
| massive | yield and/or quality losses will be severe; high mortality of plants is expected. |

**2.6.5 What is the expected impact on export markets for the PRA area?**

| Rating level | Description |
|---|---|
| Minimal | no effect on market size is expected |
| Minor | the effect on market size is negligible and cannot be distinguished from normal variation |
| medium | some effects on market size are expected |
| Major | considerable effects on market size are expected |
| massive | severe effects on market size are expected |

**2.6.6 What is the expected environmental impact in the PRA area?**

No rating guidance.

**2.6.7 What is the expected social impact in the PRA area?**

The maximum rating level should be taken from "landscape effects" and "loss of employment"

| Rating level | Description landscape effects |
|---|---|
| Minimal | damage to landscape has no consequences for landscape value |
| Minor | some plants which are not scene setting are damaged or die |
| medium | some scene setting plants are damaged or die |
| Major | a substantial part of the scene setting plants are damaged or die |
| massive | the majority of the scene setting plants die |

| Rating level | Description loss of employment |
|---|---|
| Minimal | no loss of employment due to economic impact occurs |
| Minor | some loss of employment due to economic impacts may occur, but cannot be distinguished from normal loss of employment |
| medium | loss of employment due to economic impacts occurs to a limited extent |
| Major | considerable loss of employment and bankruptcy due to economic impacts occurs |
| massive | due to economic impacts, the majority of the affected producers go bankrupt and their employees loose there job |

## Annex II :Distribution of *Opogona sacchari*

**Distribution worldwide**

| Continent | Country | Source |
|---|---|---|
| **Africa** | Cape Verde | EPPO, 2011b |
| | Madagascar | EPPO, 2011b |
| | Mauritius | EPPO, 2011b |
| | Morocco | EPPO, 2011b |
| | Nigeria | EPPO, 2011b |
| | Reunion | EPPO, 2011b |
| | Saint Helena | EPPO, 2011b |
| | Seychelles | EPPO, 2011b |
| | South Africa | EPPO, 2011b |
| | | |
| **Asia** | China | EPPO, 2011b |
| | Japan | EPPO, 2011b |
| | | |
| **Europe** | Germany | EPPO, 2011b |
| | Italy | EPPO, 2011b |
| | Netherlands | EPPO, 2011b |
| | Poland | EPPO, 2011b |
| | Portugal | EPPO, 2011b |
| | Spain | EPPO, 2011b |
| | Switzerland | EPPO, 2011b |
| | | |
| | | |
| **America** | Barbados | EPPO, 2011b |
| | Bermuda | EPPO, 2011b |
| | Brazil | EPPO, 2011b |
| | Costa Rica | http://www.sfe.go.cr/Plagas%20y%20Enfermedades/Planes_de_Accion/ Plan_de_accion_opogona.pdf (last access 15th May 2012) |
| | Guadeloupe | EPPO, 2011b |
| | Honduras | EPPO, 2011b |
| | Peru | EPPO, 2011b |
| | USA (Florida and Hawaii) | EPPO, 2011b |
| | Venezuela | EPPO, 2011b |

**Distribution in the EU**
Information was obtained from the EPPO PQR-database (EPPO, 2011b) unless indicated otherwise.

Austria
No information found

Belgium
Recent information about the situation in Belgium (pers. comm. H. Casteels, June 2012, ILVO, Belgium):

An infestation was found on a glasshouse company growing *Areca* sp., *Dieffenbachia* sp., *Ficus* sp. and some other plant species in 2010; especially, *Areca* sp. was heavily infested. Another infestation was found on a glasshouse company in 2011. Especially

*Yucca* sp. was found infested at this company. At both companies, the plants had been imported from the Netherlands. The following measures were applied:

1. Infested plants including roots with soil were burnt
2. Plants from lots in which infestations had been found were only allowed to leave the glasshouse (I) after a minimum of 6 weeks with pesticide applications as indicated below (point 5) and (II) no adults had been found during 2 weeks, and (III) no sign of the pests were observed on the plants.
3. Other host plants were allowed to leave the glasshouse when: (I) no adults had been found during 2 weeks, and (II) no sign of the pests were observed on the plants.
4. The glasshouse was monitored using pheromone traps (4 traps/ha) until 4 months after the last sign of the pest had been observed. UV-traps were also used.
5. The following pesticides were applied to control adults, larvae and eggs at hatching:
    - Adults: crop treatment with Baytroid EC-50 (cyfluthrin) twice a week
    - Larvae: 4 soil treatments with Vydate (oxamyl) at a 14-days interval
    - Eggs: crop treatment with Dimilin SC-48 (diflubenzuron) once a week until 2 weeks after the last finding of adults in the traps.

<u>Bulgaria</u>
No information found

<u>Cyprus</u>
No information found

<u>Czech republic</u>
Absent, pest eradicated

<u>Denmark</u>
Absent, pest eradicated

<u>Estonia</u>
Absent (no information found)

<u>Finland</u>
Absent, intercepted only

France
Absent, pest eradicated (EPPO, 2011b)

More recent information based on a survey of professional associations and official plant protection organization kindly provided through J.M. Ramel (Anses, France, December 2012):

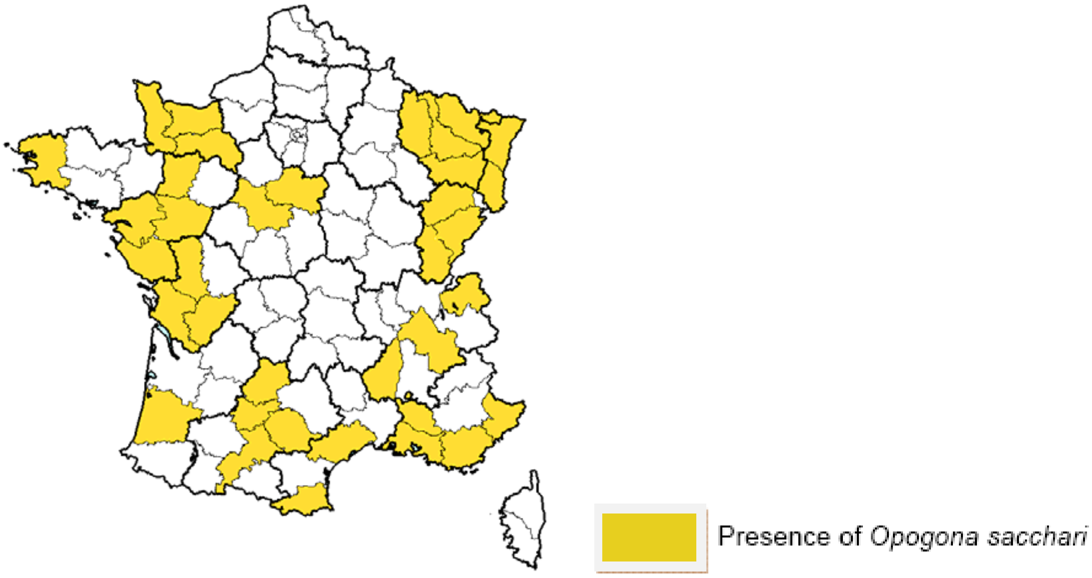



Fig. II.1 Distribution map of *Opogona sacchari* in France (source: LSV, December 2012) produced from samples by SRAL (Regional Services for Food Safety)

*O. sacchari* is present in greenhouses growing ornamental host plants throughout the country and especially found on *Dracaena*, *Yucca*, *Beaucarnea* and *Pachira* spp. (Fig. II.1). The pest has been found outdoors in southern France (Provence Alpes Côte d'Azur) in palm trees. Only heavily infested dead or dying palm trees have been detected outdoors. There is yet no evidence that the pest can establish (i.e. reproduce and initiate persistent populations outdoors) but it is considered likely.

Control and monitoring measures applied are light traps, pheromone traps, sticky traps, destruction of infested plants (or even whole plants lots) and pesticide treatments.

In general, infested plants are regularly detected. Infested plants have been found supplied by companies from other EU-countries. Detailed inspections results from Fredon Alsace in garden centres and among producers:

| | Garden centres | | Producers | |
|---|---|---|---|---|
| Year | No. of inspections | No. infested plants | No. of inspections | No. infested plants |
| 2005 | 1 | 8 | 0 | - |
| 2006 | 35 | 64 | 0 | - |
| 2007 | 18 | 30 | 8 | 67 |
| 2008 | 15 | 11 | 8 | 40 |
| 2009 | 16 | 18 | 4 | 17 |

Infested plants were destroyed but not the whole lot. Since 2010, there is no information about the current phytosanitary situation in Alsace.

Germany
Present, single cases; under eradication (EPPO, 2005)
Present, few occurrences (EPPO, 2011b)

More recent information (pers. comm. G. Schrader, JKI, 3rd May 2013):
In 2011, *O. sacchari* was found in Berlin and Saxony. In Berlin, the infested plants were potted green plants in retail: 4 plants of *Guzmania* sp., 12 *Sanseveria* sp., 21 *Dracaena fragrans*, 30 *Dracaena marginata*. Some of the plants were heavily infested. In Saxony, infested plants were mostly tropical trees in a greenhouse (*Artocarpus communis*, *Ravenala madagascariensis*) and *Musa* sp. The pest has been found in dead wood, too. Measures: In Berlin, the infested plants have been destroyed and quarantine has been imposed for the remaining plants of the consignments. Biological control measures are applied. Pheromone traps are used for further monitoring. In Saxony, transfer of plants from the greenhouse is forbidden and plant debris is regulated. Most infested plants came from the Netherlands, only the plants of Sanseverinia sp. originated in Germany.

In 2010, *O. sacchari* was found in Saxony: on *Pachira* sp. in a greenhouse of a trading company. Four plants were infested, which were discovered because of the dieback of plant parts. Living larvae and adults have been found (identified visually). When the pests were found 16 plants of the same consignment had already been sold and could not be traced back. Also these plants originated in the Netherlands. Light traps have been installed in the relevant company and regularly official inspections in the company are planned.

In December 2012, the pest was found in a greenhouse of a zoo in Mecklenburg-Western Pomerania. The pest was identified morphologically. The infested plants (*Pandanus spiralis*) had been delivered to the greenhouse in September 2012. It is presumed that the pest was introduced into the greenhouse with these plants. Trace-back investigations are ongoing. Quarantine measures have been imposed since 19th December 2012. The infested plants have been destroyed by burning. The whole greenhouse is under supervision of the official plant protection service. Pheromone traps are used for the monitoring.

In the last years, *Opogona sacchari* was found several times at several locations in Berlin, Thuringia, Mecklenburg-Western Pomerania, and Saxony. All these findings could be connected with imported plants, some of them in trading companies and others in greenhouses of botanical gardens.

Greece
Absent, pest eradicated

Hungary
Absent, pest eradicated

Ireland
No information found

Italy
Introduced in the 1970s, fairly widespread in glasshouses in the south. Pest status: present, restricted distribution (EPPO, 2011b).

Porcelli & Parenzan (1973) have described the presence of *O. sacchari* on *Strelitzia* inside greenhouses and outdoors. Adults were present throughout the year.

Additional information (pers. comm. G. Rotundo, University of Molise, Italy, 10th October 2012):
*Opogona sacchari* is present in greenhouses in Sicily, Puglia and Campania. No infestation has been reported outside of greenhouses. The insect has not been found in greenhouses in the regions Molise and Abruzzo.

Latvia
No information found

Lithuania
No information found

Luxembourg
No information found except one report of Meyer (2008) on the finding of the pest in a plant bought by a private person: 12 adult specimen were reared from a *Pachira* plant.

Malta
No information found

Netherlands
Present, restricted distribution (EPPO, 2011b)
Present, only in protected cultivation (nVWA, 2011)

More detailed information from the NPPO (June 2012):
*O. sacchari* is present in several glasshouses at low prevalence. These glasshouses use plants/planting material originating from third countries where *O. sacchari* is present outdoors. In case of a notification by another EU-member state the following measures are applied to the glasshouse from which the plants originated (NVWA, 2011):

- Host plants may only leave the glasshouse after they have been found free of the pest after a visual inspection.
- Inspections are continued on a weekly basis during a period of 6 weeks. When *O. sacchari* is not found during this period, the inspections are discontinued, otherwise inspections are continued until the pest has not been found any more during a period of 6 weeks.

Poland
Present, outbreaks are occasionally reported, under official control (EPPO, 2006)
Present, few occurrences (EPPO, 2011b)

Portugal
Present, few occurrences
Azores: present, no details
Madeira: present, no details

Romania
No information found

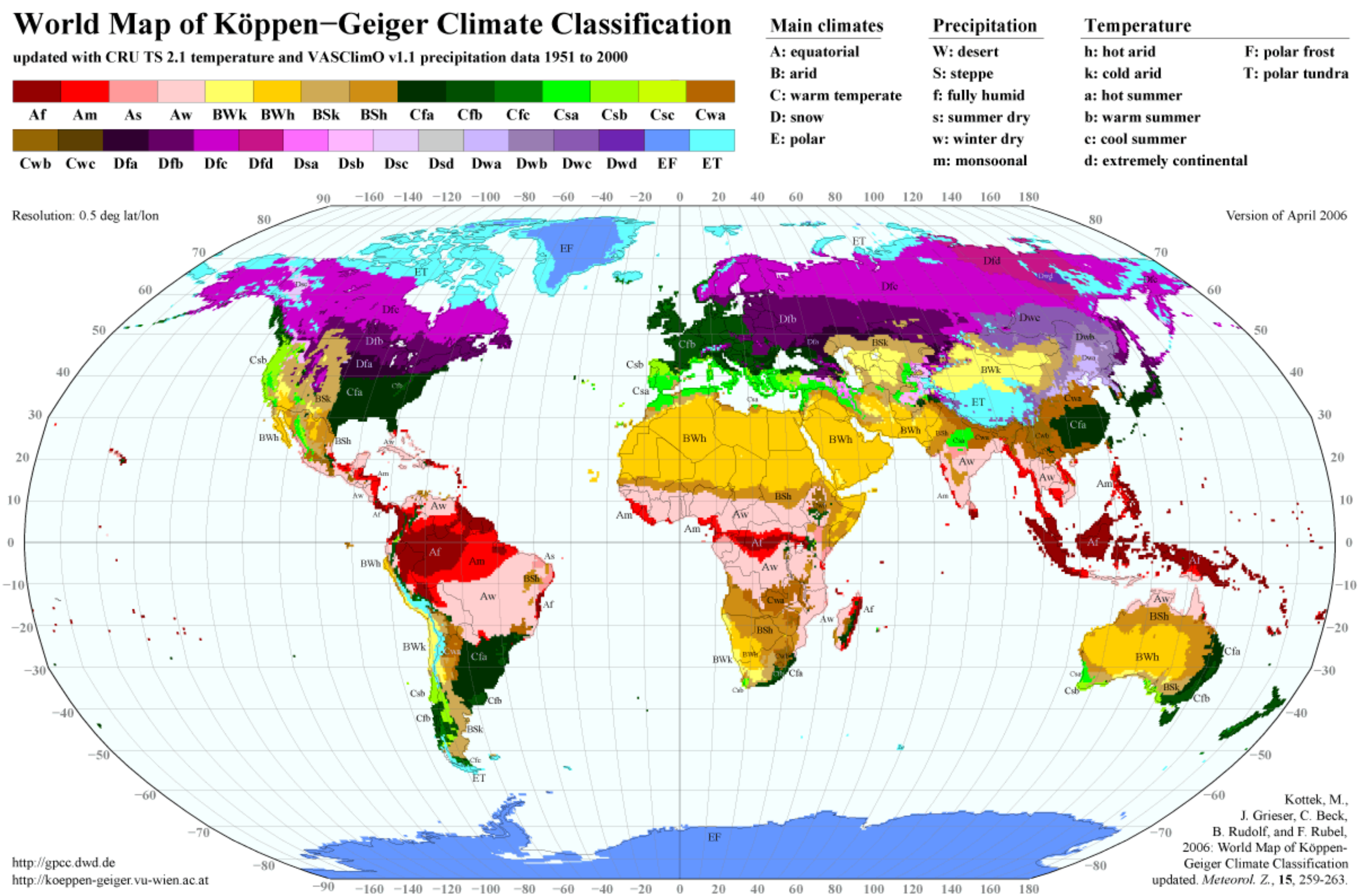
Slovakia
Absent, no pest records (EPPO, 2005)

Slovenia
No information found

Spain
Present on the Canary islands since long time ago, not on mainland Spain (pers. comm. J.M. Guitian Castrillon, August 2012).

Sweden
Absent, intercepted only

United Kingdom
Absent, pest eradicated




Köppen World Map (http://koeppen-geiger.vu-wien.ac.at/)