	European and Mediterranean Plant Protection Organisation
	Organisation Européenne et Méditerranéenne pour la Protection des Plantes
--	**Guidelines on Pest Risk Analysis**
	Lignes directrices pour l'analyse du risque phytosanitaire
	Decision-support scheme for quarantine pests

PEST RISK ANALYSIS FOR *Bactrocera invadens*

Pest risk analysts: A preliminary draft has been prepared by José María Guitián Castrillón, Diana Catalan Ruescas and the EPPO Secretariat. This document has been reviewed by an Expert Working Group composed of: Marc De Meyer[1], Denis Félicité Zulma[2], Catherine Guichard[2], Jose Maria Guitián Castrillon[3]Alan MacLeod[4], Frédéric Plumelle[5], Serge Quilici[6], Nursen Üstün[7], Jean-François Vaysières[8] on 2009-12-07/10.

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Taxonomic studies have synonymized *Bactrocera invadens* with *Bactrocera dorsalis* (Shultz *et al.*, 2016). The pest is now listed under this name on the EPPO A1 List. The content of the PRA has not been changed.

Stage 1: Initiation

1 Give the reason for performing the PRA	Identification of a single pest	Since 2003, a new fruit fly species, morphologically very similar to *B. dorsalis*, has been reported spreading rapidly throughout Sub Saharan Africa. This new pest is attacking cultivated and local tropical fruits (eg. mangoes, guava, papaya, *Citrus* spp., etc.) . It was recently described and called *Bactrocera invadens* (Drew *et al*., 2005).
1b If other reason, specify		
2a Enter the name of the pest Pest name (what you enter here will appear as a heading)	Bactrocera invadens Drew, Tsuruta & White	
2b Indicate the type of the pest	arthropod	
2c if other, specify		
2d Indicate the taxonomic position	Diptera: Tephritidae	
3 Clearly define the PRA area	The EPPO region	
4 Does a relevant earlier PRA exist?	no	No PRA for *Bactrocera invadens* for the EPPO region exists. A PRA for the EPPO region on *Bactrocera zonata* had been performed by M. Bahdousheh, R. Baker, M. Katbeh, M. Bilal Arafat (see the EPPO Report of the PRA for *Bactrocera zonata*). A PRA had also been perfomed on this species by the Spanish NPPO. PRAs for the USA provide useful information: Cave GL (2008) *Musa* As A Host For *Bactrocera* (*Bactrocera*) *invadens* Drew, Tsuruta & White (Diptera: Tephritidae: Dacinae). USDA, APHIS. 5 p. USDA (2006a) Importation of *Mangifera indica* (L.) (mango) fruit from Ghana into the United States. A Qualitative, Pathway-Initiated Risk Assessment. USDA. 60 p. USDA (2006b) Importation of *Mangifera indica* (L.) (Mango) from Senegal into the United

		States. A Qualitative, Pathway-Initiated Risk Assessment. USDA. 46 p. USDA (2008) Importation of *Mangifera indica* (L.) (Mango) Fruit from the Economic Community of West African States into the Continental United States. 118 p. A PRA on *Bactrocera dorsalis* has also been performed by the USA. Only the establishment part of the analysis could be retrieved: Hennessey MK & Borchert DM (2006) Draft Area of the Conterminous United States Susceptible to Oriental Fruit Fly, *Bactrocera dorsalis*, Establishment. USDA-APHIS-PPQ-CPHST-PERAL. 5 p.
6 Specify all host plant species (for pests directly affecting plants) or suitable habitats (for non parasitic plants). Indicate the ones which are present in the PRA area.		*B. invadens* is highly polyphagous as it counts more than 40 cultivated and wild hosts in Benin (Vayssières *et al.*, 2009), and is expected to have as broad a host range as some other members in the *B. dorsalis* complex. All known hosts are recorded from Africa, there are no data available on hosts within the native range of *B. invadens* in Asia (Mwatawala *et al.*, 2009). Among major hosts are mango (*Mangifera indica*) and guava (*Psidium guajava*) (CABI, 2007), the list of hosts is presented in Appendix 1.
7 Specify the pest distribution		*B. invadens* is believed to be native to Asia. Following the discovery of this species in Kenya in 2003, R. A. I. Drew (Brisbane, Australia) was examining specimens collected in Sri Lanka in 1993 by K. Tsuruta (Yokohama, Japan) during his survey of that island. This species had previously been overlooked as unusual variants of several other species. However, their discovery confirms that the native range of *B. invadens* includes Sri Lanka, where it is not known to have any status as a pest. The native range is likely larger than currently assumed, since specimens may be misidentified as other representatives of the complex (de Meyer *et al*., 2009). It is not clear whether Buthan should be considered as part of the native area (de Meyer *et al*., 2009). **Asia:** Bhutan, India, Sri Lanka. Note: In India, the species occurs and it has been recorded for the first time in 2005 in Tamil Nadu in mango orchards, and it was particularly dominant in Chennai (Sithanantham *et al*., 2006). **Africa:** Angola, Benin (first found 2004-06), Burkina Faso (2005-05), Burundi (2008-11),

		Cameroon (2004-08), Central African Republic (2008-08), Chad, Congo (2005-11), Comoros (2005-08), Côte d'Ivoire (2005-05), Democratic Republic of Congo, Equatorial Guinea, Ethiopia (2004-07), Gabon, Gambia (2005-06), Ghana (2004-11), Guinea (2005-05), Guinea-Bissau (2005-07), Kenya (2003-02), Liberia (2005-07), Mali (2005-06), Mauritania (2007-08), Mayotte (France) (2007-03), Mozambique (2007-07), Namibia (2008-10), Niger (2005-08), Nigeria (2003-11), Senegal (2004-06), Sierra Leone (2005-07), Sudan (2004-05), Tanzania (2003-07), Togo (2004-10), Uganda (2004-07), Zambia (2008). Note: Its first place of discovery (i.e. Kenya) should not be assumed to be its point of entry into Africa, as it may have been overlooked in some areas.

Stage 2: Pest Risk Assessment - Section A : Pest categorization

init -	Continue with Pest Categorization	
8 Does the name you have given for the organism correspond to a single taxonomic entity which can be adequately distinguished from other entities of the same rank?	yes	*Bactrocera invadens* is a member of the Oriental fruit fly *B. dorsalis* (Hendel) complex that is native to Asia and includes several pest species. It is important to note that larvae of *B. invadens* cannot be distinguished from other species of the *B. dorsalis* complex and must be bred to adults in order to confirm their identification (White & Elson-Harris, 1992). Drew *et al*. (2008) provide morphological characteristics to differentiate adults of the main *Bactrocera dorsalis* complex species.
10 Is the organism in its area of current distribution a known pest (or vector of a pest) of plants or plant products?	yes (the organism is considered to be a pest)	In its native region (believed to be Sri Lanka), *B. invadens* is currently not recognized as a pest. In the circular No. UA/CPI/2005/01 from the Inter-African Phytosanitary Council, it has been rated as “a devastating quarantine pest” (FAO/IAIEA, 2005). Since its first report in 2003, *B. invadens* has become a significant pest of quarantine and economic importance in West and East Africa (Mwatawala *et al*., 2004; Vayssières *et al*., 2005; Ekesi *et al*., 2006). Researches in Benin (Vayssières *et al*., 2005), Kenya (Ekesi *et al*., 2006; Rwomushana *et al*., 2008) and Tanzania (Mwatawala *et al*., 2006) demonstrate that *B. invadens* can become dominant in mango monocultures (Vayssières *et al*., 2008; 2009).
12 Does the pest occur in the PRA area?	no	
14 Does at least one host-plant species (for pests directly affecting plants) or one suitable habitat (for non parasitic plants) occur in the PRA area (outdoors, in protected cultivation or both)?	yes	Among hosts of *B. invadens*, *Carica papaya*, *Citrus* spp. and *Mangifera indica* are grown in the EPPO region (see Appendix 2).
15a Is transmission by a vector the only means by which the pest can spread naturally?	no	Not applicable
16 Does the known area of current distribution of the pest include ecoclimatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and	uncertain	According to de Meyer *et al*. (2009), based on the distribution in its native range, most suitable areas for the establishment of *B. invadens* fall within the Equatorial climate categories (minimum temperatures > 18°C), with the species preferring hot and humid environments. Annual precipitation must be high although it does not have to be continuous. Comparing the distribution of *B. invadens* with the Köppen-Geiger climate classification (Kottek *et al*., 2006),

thrive (consider also protected conditions)?		most suitable areas identified fall within the Equatorial climate categories (minimum temperatures of 18°C), especially: - equatorial forest, fully humid - equatorial monsoon, defined as a climate with a short dry season, but with still sufficient moisture to keep the soil humid throughout the year. Such climates are not present in the EPPO region. Nevertheless, while comparing the potential distribution of *B. invadens* with congeners, it appears that *Bactrocera zonata*, having initially a tropical distribution has established in the Mediterranean basin (it is now recorded in Egypt, Iran and Jordan, and has been eradicated from Israel according to EPPO, 2002). A climatic prediction has been performed for *Bactrocera dorsalis* by Stephens *et al*. (2008) which shows that the projected distribution of the species includes much of the tropics and subtropics and extends into warm temperate areas such as southern Mediterranean Europe, and should extend northward with climate change. A detailed climatic study is required to evaluate the suitability of the PRA area (which is done further in this PRA).
17 With specific reference to the plant(s) or habitats which occur(s) in the PRA area, and the damage or loss caused by the pest in its area of current distribution, could the pest by itself, or acting as a vector, cause significant damage or loss to plants or other negative economic impacts (on the environment, on society, on export markets) through the effect on plant health in the PRA area?	yes	In West Africa, Vayssières *et al*. (2009) found that losses on mangoes stand at 17% in early April and exceed 70% at mid-June. Rwomushana *et al.* (2008) report that *Citrus* spp. are heavily infested in Kenya. As stated in question 10, since its first report in 2003, *B. invadens* has become a significant pest of quarantine and economic importance in West and East Africa (Mwatawala *et al*., 2004; Vayssières *et al*., 2005; Ekesi *et al*., 2006).
18 Summarize the main elements leading to this conclusion.	The pest presents a risk for the EPPO region	- Some of the hosts plants of *B. invadens* are major crops in the EPPO region (eg. *Citrus* spp.). - *B. invadens* is highly polyphagous. - The Inter-African Phytosanitary Council rated *B. invadens* as “a devastating quarantine pest”. - *Bactrocera invadens* is a fruit fly in the family of Tephritidae, and many members of this family, in particular in the *B. dorsalis* complex, are of tremendous quarantine concern worldwide. - Another harmful *Bactrocera* spp. similar to this pest, the peach fruit fly *B. zonata*, has been introduced in the EPPO region and it is spreading over the Middle East and North Africa.

Stage 2: Pest Risk Assessment - Section B : Probability of entry of a pest

1.1 Consider all relevant pathways and list them (one by line) **Relevant pathways are those with which the pest has a possibility of being associated (in a suitable life stage), on which it has the possibility of survival, and from which it has the possibility of transfer to a suitable host. Make a note of any obvious pathways that are impossible and record the reasons.**		The different pathways identified are: - Fruits of major hosts from countries where the pest occurs - Fruits of minor hosts from countries where the pest occurs - Plants for planting with growing medium attached (except seeds) from countries where the pest occurs - Fruits carried by passengers from countries where the pest occurs - Natural spread - Cut branches with fruits used for ornamental purposes from countries where the pest occurs - Growing media in non hosts plants for planting from countries where the pest occurs - Hitchhiker on commodities from countries where the pest occurs - Soil as a commodity from countries where the pest occurs - Soil attached to machinery from countries where the pest occurs The information provided for pathways are based on the situation in Africa. Data for the native region are missing. - **Fruits of major hosts from countries where the pest is known to occur** Fruits in trade infested with eggs, larvae and most rarely pupae represent the most likely pathway, although it is unknown how *B. invadens* was introduced from Asia to Africa (EPPO, 2005). According to the Europhyt database (EU Member states only), 1291 non European Tephritidae were intercepted on fruits and vegetables between 1993 and 2009, and 158 *Bactrocera* spp. were intercepted for the same period and the same commodities, according to the EUROPHYT Database. These records may be underestimated, as in the Roissy airport in France, 273 Tephritidae were intercepted for the year 2009; 175 larvae were raised at the adult stage, among which 39 were identified as *B. invadens*. Additionally, interceptions of B. invadens between 2007 and 2010 (as to May 2010) are as follow : 19 for 2010 from Cameroon and Togo; 39 in 2009 from Senegal, Mali, Kenya, Burkina-Faso, Côte d'Ivoire, Togo, Cameroon; 18 in 2008 from Cameroon, Côte d'Ivoire, Mali, Burkina-Faso, Senegal); 1 in 2007 from Cameroon (French NPPO, pers. com., 2010). Switzerland has recently intercepted *B. invadens* on mango consignments from Cameroon (EPPO, 2009). Since 2006 the UK (Fera) have intercepted and detected it 10 times; once in 2010 on *Psidium guajava* from Sri Lanka and nine times on Mango from Senegal (5), Gambia (2), Ghana (1) and Kenya (1). *B. invadens* may infest many host plants (more than 40 host species recorded in appendix 1), and this

highly polyphagous species is being found on an increasing number of hosts; the current host list is not considered as definitive. Although more host plants are likely to be reported, they are probably of minor significance in international trade.

The EWG considered that from the host list (see Appendix 1), the species that are:
- a regular host that is usually relatively highly infested;
- a major host for which a large proportion of the samples is infested, number of flies emerging is often very high.
Should be considered as major hosts.

The following species are considered as major hosts:
Annona muricata (Sour sop), *Carica papaya, Chrysophyllum albidum, Citrus x paradisi* (grapefruit), *Citrus reticulata, Citrus sinensis, Citrus x tangelo, Diospyros montana, Eriobotrya japonica, Fortunella japonica, Fortunella margarita, Irvingia gabonensis, Mangifera indica, Psidium guava, Psidium littorale, Spondias cytherea, Spondias mombin, Terminalia catappa, Thevetia peruviana, Vitellaria paradoxa.*

Detail is provided on these species:
- *Mangifera indica* (mangoes)
Mangoes are the most preferred host plants of *B. invadens* in Africa and show high infestation rates (Rwomushana *et al*., 2008; Vayssières *et al*., 2008; Kaboré, 2009). This commodity is largely imported into the EPPO region.

Psidium guajava (guava)
The status of guava as a major host of *B. invadens* has been widely confirmed in West and Central Africa (Vayssières *et al*., 2005; Mwatawala *et al*., 2006; Rwomushana *et al*., 2008). This commodity is largely imported into the EPPO region.

- *Carica papaya* (papayas or paw paws)
Carica papaya has been reported as an important host in Western Africa (Vayssières *et al*., 2005; 2009) and a minor host in Tanzania (de Meyer, pers. com., 2009). In Tanzania, Mwatawala *et al*. (2006; 2009) could not confirm these reports, but Rwomushana *et al*. (2008) observed that papaya was a preferred host in laboratory studies but did not record any field infestation. In an experiment, de Meyer (pers. com., 2009) found 6 positives out of 36 samples taken. This commodity is largely imported into the EPPO region.

- *Citrus* spp. *(citrus)*
Drew *et al*. (2005) listed citrus as hosts of *B. invadens* in Africa. *Citrus x paradisi* was reported among its preferred hosts (Mwatawala *et al*., 2006) and high infestations were observed on *C. reticulata* (mandarin), *C. sinensis* (sweet orange) in Tanzania (Mwatawala *et al*., 2006) and *C. limon* (lemon) in Kenya (Rwomushana *et al*., 2008). Subsequent research by Mwatawala *et al*. (2009) observed that although *Citrus* spp. show high incidence, in general, they show low infestation level. From this data, Mwatawala *et al*. (2009) concluded that citrus fruits do not constitute a favourable host for fruit fly pests in Central Tanzania. In the Guinean area of Benin, *Citrus x tangelo* is a major host while *C. sinensis* and *C. reticulata* are minor hosts (Vayssières *et al*., 2009). In the Sudanian area, *C. sinensis* is only a minor host for *B. invadens* (Vayssières *et al*., 2009). As a conclusion, given the heterogenous information, several species within the genus *Citrus* are considered major hosts.

- *Annona muricata, Eriobotrya japonica, Fortunella margarita* and *F. japonica* (kumquat), *Irvingia gabonensis, Psidium guajava, Psidium littorale, Spondias cytherea Spondias cytherea, Spondias mombin, Vitellaria paradoxa*
The EWG considered that all these species are major hosts, at least in one country of Africa, even if some behaviour of *B. invadens* might differ from a place to another.

The EWG analyzed which of these fruits were recorded to be traded.
Although being recorded as a major host, *Thevetia peruviana* does not produce edible fruits, and is not considered further in the pathway.
Although being recorded as major hosts, no international trade with the EPPO region for these fruits recorded to date: *Chrysophyllum albidum* (edible fruit with national market in Benin), *Diospyros montana, Terminalia catappa.*

Nevertheless, as markets may change, all other major hosts were considered, except *Thevetia peruviana.*

- Fruits of minor hosts from countries where the pest is known to occur
Fruits in trade infested with eggs, larvae and most rarely pupae represent the most likely pathway.

The EWG considered that from the host list (see Appendix 1), the species that are:
- an incidental host, with only one or a few records, usually with low infestation rate;
- a host that is used more regularly, but often with very low infestation rate. This can also be a host for

which there are only few positive rearings, but with considerable numbers of flies emerging.
should be considered as minor hosts.
The following species are considered as minor hosts:
Anacardium occidentale (Cashew), *Annona cherimola*, *Annona senegalensis*, *Annona squamosa (*sugar apple*), Averrhoa carambola* (star fruit), *Blighia* sp., *Capsicum annuum* (sweet pepper), *Capsicum frutescens* (chilli pepper), *Citrullus lanatus* (watermelon), *Citrus aurantium, Citrus grandis* (pomelo), *Citrus limon, Coffea arabica* (Arabica coffee) and *C. canephora* (Robusta coffee), *Cordia* sp. cf *myxa, Cordyla pinnata, Cucumis figarei, Cucumis* sp nr *metuliferus, Cucumis pepo,Cucumis sativus* (cucumber), *Cucurbita maxima, Cucurbita* spp. (pumpkins), *Flacourtia indica, Lycopersicon esculentum* (tomato), *Malus domestica* (apple), *Manilkara sapota* (bully tree), *Momordica cf trifoliata, Musa* spp. (banana), *Musa* x *paradisiaca, Persea americana* (avocado), *Prunus persica* (peach), *Sarcocephalus latifolius, Sclerocarya birrea, Solanum aethiopicum, Solanum anguivi, Solanum incanum, Solanum nigrum, Solanum sodomeum, Sorindeia madagascariensis, Strychnos mellodora, Sizygium cumini, Sizygium jambos, Sizygium malaccense* (Malay apple) and *Sizygium samarangense* and *Ziziphus mauritiana*.

The EWG analysed which of these fruits were recorded to be traded.
Although being recorded as minor hosts, *Solanum nigrum* and *Solanum sodomeum* do not produce edible fruits.

International trade with the EPPO region for these fruits considered as minor hosts is recorded:
Annona cherimola (cherimoya), *Averrhoa carambola* (star fruit), *Capsicum annuum* (sweet pepper), *Capsicum frutescens* (chilli pepper), *Citrullus lanatus* (watermelon), *Citrus aurantium, Citrus grandis* (pomelo), *Citrus limon, Cucumis* sp nr *metuliferus, Cucumis pepo, Cucumis sativus* (cucumber), *Cucurbita maxima, Cucurbita* spp. (pumpkins), *Lycopersicon esculentum* (tomato), *Malus domestica* (apple), *Manilkara sapota* (bully tree), *Musa* spp. (banana), *Musa* x *paradisiaca, Persea americana* (avocado), *Prunus persica* (peach), *Sizygium cumini, Sizygium jambos, Sizygium malaccense* (Malay apple) and *Sizygium samarangense.*

For some species further considered, details are available:
- *Capsicum annuum* (peppers) and C. *frutescens* (Chili pepper)
In Benin, Vayssières *et al*. (2005 & 2009) reported attacks of *B. invadens* in pepper and chilli pepper.

Citrullus lanatus (watermelons)
B. invadens is reported on watermelon in Tanzania (Mwatawala *et al*. 2006; 2009) and also in Benin

(Vayssières *et al*., 2005). Though Cucurbitaceae are not heavily infested by the pest, watermelons are significantly exported to the EPPO region. Until further research is done on the suitability of *C. lanatus* as host of *B. invadens*, the risk posed by these consignments should not be ignored.

- *Lycopersicon esculentum* (tomatoes)
Rwomushana *et al*. (2008) reared *B. invadens* from tomato in Kenya, so did Vayssières *et al.* (2009) in Benin, and de Meyer (pers. com., 2009) in Tanzania. Mwatawala *et al*. (2006) did not find infestation on this crop in Tanzania but in an experiment, de Meyer (pers. com., 2009) found 3 positive records out of 400 samples taken. The EPPO region is an importer of tomatoes.

- *Malus domestica* (apples) and *Prunus persica* (peaches)
Temperate fruits, such as apples, pears and peaches, are rarely infested by *B. invadens* (Mwatawala *et al*., 2009). Other Tephritidae (e.g. *Ceratitis rosa*) remain the predominant infesters for these fruits. The frequency and volume of the imports into the EPPO region are very low.

- *Persea americana* (avocados)
Mwatawala *et al*. (2009) reports that avocados are infested,but at low infestation rates.

Although considered as minor hosts, no international trade with the EPPO region for these fruits is recorded to date:
Anacardium occidentale (Cashew), *Annona senegalensis, Annona squamosa (*sugar apple*), Blighia* sp., *Coffea arabica* (Arabica coffee) and *C. canephora* (Robusta coffee), *Cordia* sp. cf *myxa, Cordyla pinnata, Cucumis figarei, Flacourtia indica, Momordica cf trifoliata, Sarcocephalus latifolius, Sclerocarya birrea, Solanum aethiopicum, Solanum anguivi, Solanum incanum, Strychnos mellodora,* and *Ziziphus mauritiana.*

For some species, details are available:

- *Annona spp.* (soursop, cherimoyas, sugar apples)
Annona senegalensis and *squarosa* are minor hosts in the Guinean zone of Benin (Vayssières *et al*., 2009), but in general, there is a lack of data on the international trade of *Annona* spp. Though these crops are commercially grown in some parts of the world, they are not regularly exported commodities.

- *Anacardium occidentale* (Cashew fruits)
B. invadens is recorded on *Annarcadium occidentale* in Benin (Vayssières *et al*. 2005 & 2009), and in

		Tanzania (de Meyer, pers. com., 2009). Only the apples may be infested. Cashew fruits are only imported as nuts and this transformation means that the parts potentially contaminated are removed, and the risk through this pathway is therefore very low. - *Coffea arabica* (Arabica coffee) and *C. canephora* (Robusta coffee) *C. arabica* and C. *canephora* are considered minor hosts in Eastern Africa according to Mwatawala *et al*., 2009 and de Meyer pers. com. (2009). Additionally, green coffee fruits imported is transformed in the country of export, the risk through this pathway is therefore very low. - *Cucurbitaceae* Mwatawala *et al*. (2009) observed that all major economic crops show a high infestation rates for *B. invadens*, with the exception of Cucurbitaceae (except for *Citrullus lanatus*, see above). *B. cucurbitae*, a specialized cucurbit species, is the clear dominant fruit fly in these crops. Species of the family are detaileld below: *(a) Cucumis sativus* (cucumbers) *B. invadens* has been reported on cucumber in Kenya (Rwomushana *et al*., 2008) and Tanzania (Mwatawala *et al*., 2009). However, in the studies carried out by Romushana *et al*., (2008), the level of pupal recovery of *B. invadens* from cucumber was the lowest among all fruits tested. In addition, the trade volume of cucumbers exports into the EPPO region is very small. *(b) Cucurbita spp.* (pumpkins) In Benin, West Africa, Vayssières *et al*. (2005) reported attacks on *Cucurbita* spp. (pumpkins). Mwatawala *et al*. (2009) observed that *B. invadens* is not the dominant species for cucurbit hosts, which do not show high infestation rates. In addition, the trade volume of pumpkins exports into the EPPO region is, at most, negligible. Nevertheless, as markets may change, all minor hosts are considered. **- Plants for planting with growing medium attached (except seeds) from countries where the pest is known to occur** Fruits on host plants could be infested with eggs, larvae and most rarely pupae of *Bactrocera invadens.* The entry of planting material (bushes and shrubs) with fruits is prohibited by some phytosanitary legislations in the EPPO region, but some of the main hosts are not prohibited.

		The main risk for plants for planting is when fruits are present on the plants. Neverthess, although the introduction of plants for planting with fruits is a closed pathway, the situation could change and it could be open. For instance, *Capsicum frutescens* with fruits used as an ornamental plant, or other plants could be imported. It should be noted that this species cannot be imported in the EU because of the general prohibition applied to Solanaceae from non Mediterranean countries. Even when the import of a plant species with fruit attached is prohibited there remains the possibility that pupae could be present in the growing media. This pathway had been mentioned during EPPO ad hoc workshops on Pest Risk Analysis of non-European fruit flies in 1993 and 1994. It is considered that the infestation by pupae of growing media from nearby infested plants in a well managed nursery is very unlikely, making the risk of plants for planting being contaminated lower. The Netherlands import planting material of *Annona* spp., *Averrhoa* spp., *Carica* spp., *Chrysophyllum* spp., *Coffea* spp., *Eriobotrya* spp., *Ficus* spp., *Garcinia* spp., *Mangifera indica, Musa* spp., *Prunus* spp., *Psidium guajava, Syzygium* spp., *Terminalia* spp., of which some are imported from countries where the pest occurs (*Coffea* spp., *Dracaena* spp., *Ficus* spp., *Terminalia* spp.) (see Appendix 4). But as these imports include seeds, tissue culture, cuttings, etc, not all records correspond to plants for planting with growing media and it is therefore difficult to extrapolate data from this list. The EWG considered that imported host plants may include: *Anacardium occidentale, Annona* spp., *Averrhoa carambola, Capsicum frutescens, Citrus spp., Eriobotrya japonica, Fortunella japonica, Fortunella margarita, Malus* spp., *Manilkara zapota, Prunus* spp., *Psidium* spp., *Solanum* spp., *Syzygium* spp., *Thevetia peruviana.* This list is only indicative as the species could extend its range to new hosts, and that detailed data on trade of ornamental plants from Africa is missing. It should be noted that the importation of some of these species is restricted in at least the EU countries: *Citrus* spp. (prohibition), *Eriobotrya* spp. (protected zone for fire blight), *Fortunella* spp., *Malus* spp., Solanaceae. The EWG considered that the following hosts are unlikely to be imported as plants for planting with growing medium: *Carica papaya, Chrysophyllum albidum, Citrullus lanatus, Coffea arabica, Coffea canephora.*

		- Fruits carried by passengers White & Elson-Harris (1992) report that many fruit fly outbreaks may be attributable to undetected imports of a few fruits in an airline passenger's baggage. This has also been recognized in later studies (Miller, 1997). Passengers could potentially bring back from countries they visit fruits that would be contaminated with *B. invadens*. Passengers in cars, trains, ferries and buses between tropical Africa and the Mediterranean area are also a pathway. Passengers bringing contaminated plants for planting are considered unlikely and are not considered further. The pathway "fruits carried by passengers" is considered further. **- Natural spread** *B. invadens* is supposed to have a high mobility (as Tephritidae, and *B. zonata* for instance, EPPO 2002). Natural spread could occur through stepping stones on the Nile between Sudan and Egypt. The same is true between Mauritania and Morocco. There are irrigated crops along the Nile in Northern Sudan, and *B. invadens* could fly along this corridor. South of Karthoum, *B. invadens* have been recorded in irrigated orchards, but the type of crop cultivated in Northern Sudan remains unknown to the risk assessors. As *B. invadens* is polyphagous, it is expected that at least one host is cultivated. The species could therefore progress naturally to the Mediterranean EPPO region. There is a new main road (N1 built in 2006 or 2007) between Nouakchott (in Mauritania) and Al Dahla (in Morocco, Western Sahara), followed by a road between Al Dahla and Agadir. Some oases are present along these roads, which would allow *B. invadens* to progress assuming that host plants are present. This pathway is considered moderately likely with a high uncertainty, and is considered to take a longer time than other pathways linked to international trade, hence not to happen in the immediate future. It will therefore not be considered further. **- Fruits of hosts in mail** Fruits of hosts can be sent in mail either by individual people or by private companies. This pathway is not considered further as it is considered unlikely due to the price of sending fruit by mail. Nevertheless, whilst admittedly a minor pathway this does exist as Fera PHSI intercepted 24 illegal imports of fruit in mail from July 2009 – April 2010, mainly Malus, Citrus and Mangifera (Paul Bartlett, pers comm.., 2010).

		- Cut branches with fruits used for ornamental purposes On flower markets, cut branches with fruits such as *Coffea arabica and Coffea canephora* are a new niche, used for ornamental purposes. This has been observed in Rungis (D. Félicité-Zulma, pers. com., 2009). This pathway is considered anecdotal and is not developed further. **- Hitchhiker on commodities** This is a theoretical pathway which has never been recorded. It is very unlikely that flying adults would hide in containers, they would usually rather fly away. This pathway is therefore considered very unlikely and is not considered further. **- Growing media in non host plants for planting** Pupae could be present in the growing media accompanying plants for planting which would have been grown in the vicinity of contaminated hosts. This pathway is considered to be very unlikely and is not considered further. **- Soil as a commodity** Pupae could be present in soil imported as a commodity. This pathway is usually prohibited and is not considered further. **- Soil attached to machinery** Pupae could be present in the soil attached to machinery. This pathway has never been reported for Tephritidae and is considered very unlikely and is therefore not considered further.
1.3 Pathway: 1		**Fruits of major hosts from countries where the pest occurs** All major hosts are considered, but detail is provided on species for which international trade is currently recorded. Nevertheless, it is kept in mind that markets could change and that new commodities could be exported. *Thevetia peruviana* does not produce edible fruits, and is not considered further in the pathway. International trade with the EPPO region is recorded for these fruits considered as major hosts: *Annona muricata (*Sour sop), *Carica papaya, Citrus x paradisi* (grapefruit), *Citrus reticulata, Citrus sinensis, Citrus x tangelo, Eriobotrya japonica, Fortunella japonica, Fortunella margarita, Irvingia gabonensis, Mangifera indica, Psidium guajava, Psidium littorale, Spondias cytherea, Spondias mombin,*

		Vitellaria paradoxa. No international trade with the EPPO region is recorded to date for these fruits considered as minor hosts, but the situation may change: *Chrysophyllum albidum* (edible fruit with national market in Benin), *Diospyros montana, Terminalia catappa.*
1.3a Is this pathway a commodity pathway?	yes	
1.3b How likely is the pest to be associated with the pathway at origin taking into account factors such as the occurrence of suitable life stages of the pest, the period of the year?	likely low	In countries where *B. invadens* is present, potential host plants are available all year and the pest can develop all year round (Mwatawala *et al.*, 2009). Consequently, suitable life stage of the pest are present when fruits mentioned above are present, and the association is likely. The EWG considered that the likelihood of association is lower for immature mangoes, or for cultivars fruiting ealier.
1.4 How likely is the concentration of the pest on the pathway at origin to be high, taking into account factors like cultivation practices, treatment of consignments?	likely medium	*Concentration* Concentration may vary according to hosts and to agro-ecological zones. *B. invadens* occus significantly on major hosts (see Appendix 1). Hosts and abundance of hosts vary between agro-ecological zones, and in Benin this variability is obvious between Northern and Southern parts of the country. The same results were observed in Togo (Vayssières *et al*., unpublished data). It should be noted that populations of *B. invadens* can occur in fluctuating quantities according to the season, but seem to be positively correlated with rainy seasons ((Mwatawala *et al.* 2009; Vayssières *et al*., 2009). Rainy seasons can vary, depending on the geographic region. This applies to Africa and data for other regions are missing. *Existing cultivation practices* <u>Treatments during the growing season</u>: treatment with plant protection products such as GF120 (Spinosad) has given good results in controlling *B. invadens* in mango orchards (Vayssières *et al.*, 2009). Nevertheless, such phytosanitary treatments are not very commonly applied in particular in small production units in contrast to commercial orchards. This Plant Protection Product is only registered by CILSS countries (Comité permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel). Costs of treatments is also a reason for lack of treatment in orchards. Treatments with GF120 (Spinosad) could nevertheless be an option for the future in combination with sanitation activities.

		Post harvest treatment: the cleaning and sorting of fruits, particularly mango are supposed to remove heavily infested fruits for which some signs of contamination are visible. Tephritidae (non European) are already present in these infested areas and post-harvest treatment is necessary before issuing of a PC to guarantee freedom.
1.5 How large is the volume of the movement along the pathway?	major low	Information is not available for all fruits of major hosts. Information of the trade of fruits of *Annona muricata* (Sour sop), *Eriobotrya japonica, Fortunella margarita, Irvingia gabonensis, Spondias cytherea, Spondias mombin, Vitellaria paradoxa* is missing. For the fruits of major hosts, information has been retrieved from 2 sources: FAOSTAT for the period 2001- and 2005 and EUROSTAT for the period 2008. Information on mangoes and guava is aggregated in both sources of information. There are inconsistencies between the 2 sources of information, and EUROSTAT is considered to be more accurate. Detailed tables are provided in Appendix 3. The main pathways are: - mangoes and guava from India, Ghana, Côte d'Ivoire, Senegal, Mali, Burkina Faso, Gambia, Cameroon, and Guinea; - papayas from India and Côte d'Ivoire, Ghana. - *Citrus* spp. from Zimbabwe and Swaziland. **FAOSTAT** Between 2001 and 2005, the EPPO member countries imported a total of 2.25 million tonnes of fruits of major hosts plants from countries where *B. invadens* is present (FAOSTAT, 2009), as shown in table 1.

Commodity	**2005**	**2004**	**2003**	**2002**	**2001**
Mangifera indica, Garcinia mangostana (Mangoes, mangosteens) & *Psidium guava* (guavas)	35006	27811	33384	18370	13511
Carica papaya (Papayas)	1185	144	436	639	432
Citrus spp.	27	161	65	56	50

Table 1. Fruits of major host plants imported into the EPPO region from 2001 to 2005 in tonnes from countries where *B. invadens* occurs.
Source: FAOSTAT, 2009

There were no data for some countries (Côte d'Ivoire, Guinea Bissau, etc.), but the amount imported being already major, these uncertainties could only add weight to the imports.

EUROSTAT
Table 2 below provides total amounts of traded fruits of major host plants into the European Community for 2008 from countries where the pest occurs.
See Appendix 3 for more details.

Commodity	Total in tonnes in 2008
Psidium guava (Fresh or dried guavas), *Mangifera indica* (mangoes) and *Garcinia mangostana* (mangostems)	**27431.6**
*Carica papaya (*Papaya)	**5894.3**
Citrus sinensis (Sweet orange)	**1231.9**
Citrus x paradisi (Grapefruit)	**0.2**

Table 2. Fruits of major host plants imported into the European Union in 2008 in tonnes
Source: EuroStat, 2009

The values of imports of these commodities also include in some cases dried material. The Comité de Liaison Europe-Afrique- Caraïbes-Pacifique (COLEACP) estimates that only about 10% of exported mango are dried in Burkina Faso, the volume of imported fresh mango therefore remains major.

1.6
How frequent is the movement along the pathway?

very often
low

Data on the frequency of imports is not available through the FAOSTAT database which provides data for the whole EPPO region. Data on frequency can be gathered for the European Union through Eurostat. See Appendix 3 for further details.

Guavas, mangoes and papayas are imported all year round from countries where *B. invadens* occurs, when Eastern and Western African countries are considered as a whole.

It is therefore considered that in general, commodities are imported very often.

The table below provides the amounts of imported commodities in tonnes for each month of 2008:

	Jan. 08	Feb. 08	Mar. 08	Apr. 08	May. 08	Jun. 08	Jul. 08	Aug. 08	Sep. 08	Oct. 08	Nov. 08	Dec. 08	Total

		Psidium guava (Fresh or dried guavas), *Mangifera indica* (mangoes) and *Garcinia mangostana* (mangostems)	64.4	62.1	162.4	1689.7	8249..4	9005.6	4773.4	792.5	284.4	2185.4	139.6	22.7	**27431.6**
		Carica papaya (Papaya)	779.2	593.9	408.6	559.3	675.1	476.6	141.4	132.2	415.1	633.1	497.3	582.5	**5894.3**
		Citrus sinensis (Sweet orange)	23	0	49.7	0	0	0	48	264	92.4	130.8	0	624	**1231.9**
		Citrus x paradisi (Grapefruit)	0	0	0	0	0.2	0	0	0	0	0	0	0	**0.2**
		Source: EuroStat, 2009													
1.7 How likely is the pest to survive during transport /storage?	very likely low	Eggs, larvae and rarely pupae are found inside the fruits and are protected from adverse conditions. It is therefore very likely that the pest will survive transport and storage conditions of fruits. The mangoes coming from subsaharian Africa are usually transported at temperatures around 9°C (between 7 and 11°C) in shipped container, and around 12°C by airplane (Guichard & Félicité-Zulma, pers. com., 2009). In passengers planes, the temperature is supposed to be at around 15°C (McGregor, 1987), and these conditions are suitable for *B. invadens* to survive as pre-imaginal stages. According to the Europhyt database (EU data only), 1291 non European Tephritidae were intercepted on fruits and vegetables between 1993 and 2009 in European countries, and 158 *Bactrocera* spp. were intercepted for the same period and the same commodities. The UK has identified *B invadens* from 10 consignments by rearing through adults from intercepted larvae (Paul Bartlett, pers. comm.., 2010). This indicates the capacity of survival of *Bactrocera* spp.													
1.8 How likely is the pest to multiply/increase in prevalence during transport /storage?	impossible/very unlikely low	Tephritidae are not recorded as reproducing during transport or long-period storage. Transport of fruits can be done by airplane for high quality fruits, it does not take more than 6 to 10 hours, and the species can therefore not reproduce. Through shipping, the transport takes a maximum of 11 days, according to the exporting country													

		(COLEACP, pers. com., 2009): - from Senegal: 5 to 6 days for EU southern ports, 6 to 7 days for EU northern ports. - from Côte d'Ivoire: 10 days for EU southern ports, 11 days for EU northern ports. Some hosts may be stored, but reproduction is unlikely.
1.9 How likely is the pest to survive or remain undetected during existing management procedures (including phytosanitary measures)?	likely low	**<u>In the European Union</u>** There are different cases according to the commodity imported: - Fruits of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, originating in third countries where *Tephritidae* (non-European) are known to occur on these fruits are covered by the point 16.5 in Annexe IV (special requirements which must be laid down by all Member States for the introduction and movement of plants, plants products and other objects into and within all Member States). Measures are pest free area, pest free place of production, visual inspection before and/or after export, and adequate treatment. - According to Annex V part B, fruits of *Annona* spp., *Cydonia* Mill., *Diospyros* L., *Malus* spp., *Mangifera* spp., *Passiflora* L., *Prunus* L., *Psidium* L., *Pyrus* L., and *Sizygium* spp. originating in non-European countries must be accompanied by a Phytosanitary Certificate (PC). No PC is required for other fruits. - According to Annex I, non European Tephritidae such as *Bactrocera dorsalis* are considered harmful organisms whose introduction into and spread within all Member States shall be banned. According to this Annex, all plants and plant products should be free from non European Tephritidae when imported in European countries. Nevertheless, there is some practical limitation to this requirement as in some EPPO countries only those plants and plant products which are accompanied by a PC are inspected at import. As no specific host lists are provided to exporting countries and no PC is required it is very difficult for exporting countries to inspect these exported consignments. In practice this requirement is consequently very difficult to comply with. As a conclusion, apart from Citrus fruits, the EU requirements for most fruits are a visual inspection of the consignement. The detection by visual inspection of fruits is difficult since the inspector would have to look for signs of oviposition punctures. It is broadly recognized in phytosanitary inspection that both *Anastrepha* spp. and *Bactrocera* spp. punctures are even more difficult to detect than *Ceratitis* spp (Spanish NPPO, pers. com., 2009). A proper inspection implies suspected fruit being cut open in order to look for larvae, and even if detected, larvae of *B. invadens* may be confused with other tephritid species. Nevertheless, fruit flies may easily go undetected even if the fruit is dissected (White & Elson-Harris, 1992). The older the infestation the better the chances of detection due to the fact that the fruit will show some

		symptoms (discoloration around punctures, brownish rings, visible dejections, etc.) (Vayssières *et al.*, 2008). The ease of detection also depends on the varieties (e.g. easier to see in yellow varieties of mango) and maturation stage of the fruit. As a conclusion, the EWG assumed that visual inspection does not give enough guaranties against Tephritidae. This is supported by existing legislation in many countries that do not rely solely on visual inspections of consignments for fruit flies (e.g. USA, China, Australia, Japan, South Korea, etc.). **In Algeria, Azerbaijan, Jordan, Morocco, Tunisia, Turkey, Ukraine** Tephritidae (Trypetidae) in general or *Bactrocera* spp. (without mentioning *B. invadens*) are prohibited at any stage of their development (as in Annex 1 of the Directive 2000/29). Nevertheless, no specific measures targeting hosts are in place. **Israel** Fresh fruits and vegetables, root crops, onions, garlic - are prohibited if the country of origin is in a tropical or subtropical region. **In Russia** In Russia, only *Ceratitis capitata* is listed as a pest which introduction should be banned, without mentioning precise measures on commodities. **Other EPPO countries** No information is readily available for other EPPO countries.
1.10 How widely is the commodity to be distributed throughout the PRA area?	very widely low	Mangoes & guavas, papayas, *Citrus* spp. are directly imported from producing countries where *B. invadens* occurs in all EPPO countries except Albania, Azerbaijan, Belarus, Bulgaria, Croatia, Guernsey, Jersey, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Moldova, Romania, Serbia, Slovenia and Uzbekistan (see Appendix 3 for details). Nevertheless, it is very likely that major importing countries such as France, Belgium and the Netherlands would re-export the commodities to other EPPO countries which do not directly import from producing countries. Main re-exporting European countries to new European countries in 2008 for mangoes in tonnes are listed below (source EUROSTAP, assembled by COLEACP):

	EE	LV	LT	PL	CZ	SK	HU	SI	CY	BG	MT	RO	Total
INTRA-UE	**182**	**272**	**1 735**	**2 569**	**2 943**	**816**	**494**	**305**	**75**	**82**	**15**	**444**	**9 932**

NL	106	248	**1 683**	**1 791**	**1 460**	172	218	67	51	77	13	416	**6 302**
DE	6			467	**1 320**	**380**	21		5				**2 199**
AT				5	3	7	248	132					**395**
ES	31	8	5	215	31								**290**
CZ				9		**257**	3					6	**275**
IT			1	12	60		2	**103**		1	2	12	**193**
FR			5	20	29		1	3	12			10	**80**
BE	11	7	31	48	1								**98**
SK					35		1						**36**
LT	28	6		1									**35**
Others	0	6	10	1	4	0	0	0	7	5	0	0	**3**
EXTRA-UE	**2**	**0**	**0**	**6**	**94**	**0**	**4**	**375**	**108**	**6**	**1**	**1**	**597**
IL								375	108				483
TH	2			5	72		4			4	1	1	89
BR													
Others	0			1	22		0	0	0	2	0	0	**25**
TOTAL	**184**	**272**	**1 735**	**2 575**	**3 037**	**816**	**498**	**680**	**183**	**88**	**16**	**445**	**10 529**

1.11 Do consignments arrive at a suitable time of year for pest establishment?	yes low	Major hosts such as mangoes and guava, as well as papaya are imported all year round (see Appendix 3).
1.12 How likely is the pest to be able to transfer from the pathway to a suitable host or habitat?	moderately likely low	Eggs and larvae, and rarely pupae of *B. invadens* might contaminate fruits of host plants. In all cases, at least one mated female or one female with one male will need to be present to start a breeding population. Each female can lay on average 700 eggs, depending on the host (Vayssières *et al.*, 2008a). It is therefore very likely that there will be both female(s) and male(s) within a single infested fruit. About 55% of eggs developed to the adult stage. After finding a partner and mating, the life cycle of the pest will be completed only in case females find hosts for oviposition. The successive and successful completion of all these events is required for pest transfer. Transport and storing of such commodities is not supposed to be as long as to allow the eggs or larvae to reach the adult stage. Additionally, in case the commodities are stored, the cold conditions to conserve the commodities are very likely to block the development of eggs or larvae.

		In the Mediterranean area, fruits of hosts are available all year round: - from September till June, *Citrus* spp. are available, - from October to November, mangoes are available - from May till September, fruits of other hosts are available. The probability to find a suitable host are higher in southern countries than in northern countries. In northern countries the risk of transfer is considered to be low.
1.13 How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) to aid transfer to a suitable host or habitat?	moderately likely low	The intended use of the commodities may be either fresh consumption or processing: *Fresh Consumption* Consignments of imported fruits and vegetables can be transported to be handled before being sold, and these places might be located in the vicinity of production areas to reduce transport fares, particularly in the Mediterranean area (eg. this is usually the case for *Citrus* spp. in the Mediterranean area). Additionally, hosts plants are common and are very likely to be present. Contaminated fruits may be discarded outdoors, allowing *B. invadens* to develop and fly away. When consignments of fruits and vegetables are transported to be sold on markets (particularly in the southern part of the EPPO region) and in supermarket, infested fruits could as well be discarded outdoors, allowing *B. invadens* to develop and fly away. When the infested fruits or vegetables are noticed by consumers, the species could only develop and fly away if the commodity is composted. The increasing interest in composting of plant waste by individuals increases this possibility. In general, it is supposed that the trash would be incinerated. *Processing* EFSA (2007) reports that fruits and vegetables intended for processing (e.g. for juice, jam, etc.) are less subject to inspections, but Plant Health regulation makes no such differentiation. As fruits and vegetables intended for processing are commonly of lower quality, they are therefore more susceptible to be infested. Eggs, larvae or pupae unnoticed will be destroyed during the processing. When noticed, the pest may survive if no effective waste disposal procedure is carried out. *Re-export* Consignments can be imported into the EPPO region to be re-exported outside the EPPO region (eg. mangoes in transit in Belgium to be re-exported to Japan). The transfer to a suitable host is very unlikely to take place.

		For northern countries the risk of transfer is considered to be low.

1.3 Pathway: 2		**Fruits of minor hosts from countries where the pest occurs** All minor hosts are considered, but detail is provided on species for which international trade is currently recorded. Nevertheless, it is kept in mind that markets could change and that new commodities could be exported. *Solanum nigrum* and *Solanum sodomeum* do not produce edible fruits and are not considered further. International trade with the EPPO region is recorded for these fruits considered as minor hosts: *Annona cherimola* (cherimoya), *Averrhoa carambola* (star fruit), *Capsicum annuum* (sweet pepper), *Capsicum frutescens* (chilli pepper), *Citrullus lanatus* (watermelon), *Citrus aurantium, Citrus grandis* (pomelo), *Citrus limon, Cucumis pepo, Cucumis sp nr metuliferus, Cucurbita maxima, Cucurbita* spp. (pumpkins), *Lycopersicon esculentum* (tomato), *Malus domestica* (apple), *Manilkara sapota* (bully tree), *Musa* spp. (banana), *Musa* x *paradisiaca*, *Persea americana* (avocado), *Prunus persica* (peach), *Sizygium cumini, Sizygium jambos, Sizygium malaccense* (Malay apple), *Sizygium samarangense.* No international trade with the EPPO region is recorded to date for these fruits considered as minor hosts, but the situation may change: *Anacardium occidentale* (Cashew), *Annona senegalensis, Annona squamosa (*sugar apple*), Blighia* sp., *Coffea arabica* (Arabica coffee) and *C. canephora* (Robusta coffee), *Cordia* sp. cf *myxa, Cordyla pinnata, Cucumis figarei, Cucumis sativus* (cucumber), *Flacourtia indica, Momordica cf trifoliata, Sarcocephalus latifolius, Sclerocarya birrea, Solanum aethiopicum, Solanum anguivi, Solanum incanum, Strychnos mellodora* and *Ziziphus mauritiana.*
1.3a Is this pathway a commodity pathway?	yes	
1.3b How likely is the pest to be associated with the pathway at origin taking into account factors such as the occurrence of suitable life stages of the pest, the period of the year?	moderately likely medium	See answer for pathway 1. Although Cave (2008) reports that unripe *Musa* spp. is an important hosts, M. Billah (University of Ghana) could not confirm nor refute this information. In Africa, it appears that mature green and undamaged bananas can be attacked; information on infestation of immature bananas is missing (de Meyer, pers. com., 2010).

		In Cameroon, a fruit producing company reported some damages by *B. invadens* on fruit banana (JF Vayssières, pers. com., 2009).
1.4 How likely is the concentration of the pest on the pathway at origin to be high, taking into account factors like cultivation practices, treatment of consignments?	moderately likely medium	*Concentration* Concentrations vary according to hosts (see appendix 1) and are likely to be moderate on minor hosts. *Existing treatments* See answer pathway 1.
1.5 How large is the volume of the movement along the pathway?	major low	Information has been retrieved from 2 sources: FAOSTAT for the period 2001- 2005 and EUROSTAT for the period 2008. There are inconsistencies between the 2 sources of information, and EUROSTAT is considered to be more accurate. **FAOSTAT** Between 2001 and 2005, the EPPO member countries imported a total of 2.25 million tonnes of fruits of host plants from countries where *B. invadens* is present (FAOSTAT, 2009). Detailed tables are provided in Appendix 3. The main pathways are: - bananas from Cameroon and Côte d'Ivoire; - tomatoes from Senegal; - and watermelons from Senegal. Table 1 gives an overview of the consignments of fruits of minor hosts imported into the EPPO region from countries where *B. invadens* occurs.

Table 1. Fruits of minor hosts imported into the EPPO region from 2001 to 2005 in tonnes

Commodity	**2005**	**2004**	**2003**	**2002**	**2001**
Musa spp. (Bananas)	267 049	295 604	540 669	472 578	446 270
Cucumis sativus (Cucumbers & gherkins)	498	4537	16 496	20 571	13 839
Lycopersicon esculentum (Tomatoes)	6 409	5 058	3 409	2 747	2 115
Citrullus lanatus (Watermelons)	641	322	129	0	101
Malus domestica (Apples)	195	85	0	0	0
Persea americana (Avocados)	48	19	7	4	16

Prunus persica (Peaches & nectarines)	0	10	0	0	0
Cucurbita spp.& *Cucumis pepo* (Pumpkins, squash & gourds)	0	0	0	0	0

Source: FAOSTAT, 2009

There were no data for some countries (Côte d'Ivoire, Guinea Bissau, etc.), but the amount imported being already major, these uncertainties could only add weight to the imports.

EUROSTAT

Table 2 below provides total amounts of traded fruits of minor hosts into the European Community that might be contaminated by *B. invadens* from countries where the pest occurs.
See Appendix 3 for more details.

Commodity	Total in tonnes in 2008
Musa spp. (Bananas)	**542 530.7**
Persea americana (Avocados)	**11 964.3**
Lycopersicon esculentum (Tomatoes)	**8 823.6**
Cucumis sativus (Cucumbers)	**9.6**

Table 2. Fruits of minor host plants imported into the European Union in 2008 in tonnes
Source: EuroStat, 2009

1.6
How frequent is the movement along the pathway?

very often
low

Data on frequency of imports are not available through the FAOSTAT database which provides data for the whole EPPO region, but data on frequency can be gathered for the European Union through Eurostat. See Appendix 3 for further details.

Bananas and avocados are imported all year round. Tomatoes are imported almost all year round except from July to Octobre, while cucumbers are only imported between June/July and Septembre.
It is therefore considered that in general, commodities are imported very often.
The table below provides the amounts of imported fruits of minor hosts in tonnes into the European Community for each month of 2008:

	Jan. 08	Feb. 08	Mar. 08	Apr. 08	May. 08	Jun. 08	Jul. 08	Aug. 08	Sep. 08	Oct. 08	Nov. 08	Dec. 08	Total
Musa spp. (Bananas)	62195.6	29736.4	42913.4	55808.9	45237	38398.6	39704.2	31344.4	43959.6	59469.4	48681.8	45081.4	**542530.7**
Persea	2.2	100	834.3	1271	2366.3	1376.3	861.6	2386.2	1517.6	969.6	119.3	159.9	**1196.3**

		americana (Avocados)												
		Lycopersicon esculentum (Tomatoes)	2008.8	1564.8	2117.3	1315.8	362.5	306.9	0	29.4	0	0	39	1079.1	**8823.6**
		Cucumis sativus (Cucumbers)	0	0	0	0	0	8.5	0	0.2	0.3	0.2	0.2	0.2	**9.6**

1.7 How likely is the pest to survive during transport /storage?	very likely low	See answer for pathway 1. The transport of bananas between the moment the banana is cut and the moment it arrives takes about 15 days. Bananas are transported at 13-14°C. These conditions are suitable for *B. invadens* to survive as pre-imaginal stages.
1.8 How likely is the pest to multiply/increase in prevalence during transport /storage?	impossible/very unlikely low	See answer for pathway 1.
1.9 How likely is the pest to survive or remain undetected during existing management procedures (including phytosanitary measures)?	likely low	See answer for pathway 1
1.10 How widely is the commodity to be distributed throughout the PRA area?	very widely low	Tomatoes, avocados, bananas etc. are directly imported from producing countries where *B. invadens* occurs in all EPPO countries except Albania, Azerbaijan, Belarus, Bulgaria, Croatia, Guernsey, Jersey, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Moldova, Romania, Serbia, Slovenia and Uzbekistan (see Appendix 3 for details). Nevertheless, it is very likely that major importing countries such as France, Belgium the the Netherlands would re-export the commodities to other EPPO countries which do not directly import from producing countries.
1.11		These hosts, and particularly bananas are imported all year round (see Appendix 3).

Do consignments arrive at a suitable time of year for pest establishment?	yes low	
1.12 How likely is the pest to be able to transfer from the pathway to a suitable host or habitat?	moderately likely low	See answer for pathway 1.
1.13 How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) to aid transfer to a suitable host or habitat?	moderately likely low	See answer for pathway 1. Bananas will be imported green to mature. The storage before the ripening phase in chambers does not last more than 15 days at temperatures ranging from 13-14°C to a maximum of 18-19°C, and shall not affect the life cycle of *B. invadens*.

1.3 Pathway:		**Plants for planting with growing medium attached (except seeds)**
1.3a Is this pathway a commodity pathway?	yes	There is much uncertainty on this pathway due to the limited experience on this topic among the EWG members. The EWG considered that imported host plants include may include: *Anacardium occidentale, Annona* spp., *Averrhoa carambola, Capsicum frutescens* (this plant could be imported with fruits) *Citrus* spp. (not traded in the EU), *Eriobotrya japonica* (imported with growing media and possibly fruits), *Fortunella japonica, Fortunella margarita, Malus* spp., *Manilkara zapota, Prunus* spp., *Psidium* spp., *Solanum* spp., *Syzygium* spp., *Thevetia peruviana.* This list is only indicative as the species could extend its range to new hosts, and that detailed data on trade of ornamental plants from Africa is missing.
1.3b How likely is the pest to be associated with the pathway at origin taking into account factors such as the occurrence of suitable life stages of the pest, the period of the year?	unlikely High Moderately likely for hosts	There is no information available to evaluate this question. Theoretically the association is possible if the following events occur: - plants for planting are grown in a nursery in an infested environment and fruits develop on the plant. - *B. invadens* lay eggs in the fruits. - For other hosts, larvae could be dropped in the growing medium. Fruited plants are generally prohibited of import in the EU. - For hosts introduced with fruits, contaminated fruits could stay on the plant, and the larvae could drop in the growing medium as well. For such species, the likelihood is the same as for plants grown for fruits (see

	introduced with fruits High	same answer pathway 2). It is considered that the infestation by pupae of growing media from nearby infested plants in a well managed nursery is unlikely.
1.4 How likely is the concentration of the pest on the pathway at origin to be high, taking into account factors like cultivation practices, treatment of consignments?	unlikely High Moderately likely for hosts introduced with fruits High	*Concentration* Concentrations vary according to hosts (see appendix 1) and are likely to be high on major hosts, and moderate on the minor hosts. *Treatments* Trees in nurseries are not treated against fruit flies as they do not damage the plant itself but fruits. Moreover, in the case of plants cultivated for ornamental purposes on which the pest would be present at low concentrations, it is likely that the pest would remain unnoticed and untreated. However treatments may be applied for other pests that would have impacts on fruit flies, but no information was available to the EWG. No study has been conducted to evaluate the concentration of the pest on the pathway. For plants for planting with fruits, fruits should be removed before exports, which lowers the risk, as the only contamination would consist in pupae in the growing media.
1.5 How large is the volume of the movement along the pathway?	minimal high	Data on plants for planting have been searched in Eurostat. Quantities of plants for planting imported into the European Union in 2007 and 2008 in tonnes, with countries ordered by importance of volumes for 2008 are as follows (more detail is available in Appendix 4):

Exporter	Total 2007 in tonnes	Total 2008 in tonnes
NETHERLANDS	2055.2	2214.2
BELGIUM	214.2	326.9
GERMANY	342	282.7
FRANCE	96.2	33.5
ITALY	102.9	19.2
SWEDEN	1.6	6.8
UNITED KINGDOM	4.1	6

		SPAIN 4.3 5.6 PORTUGAL 0.3 1.4 CYPRUS 0.1 0.8 GREECE 2 0.8 DENMARK 0 0.7 POLAND 3.3 0.6 BULGARIA 0 0.3 CZECH REPUBLIC 0.2 0.3 HUNGARY 0.2 0.2 AUSTRIA 0.4 0 ROMANIA 0.1 0 **Total** **2827.1** **2900** Source: Eurostat, 2009 These figures represent all the plants for planting imported from countries where *B. invadens* occur, and the host plants used for ornamental purposes only represent a small fraction of these figures. Not all of these consignments are plants for planting with growing media. The volume of the movement is therefore considered to be minimal.
1.6 How frequent is the movement along the pathway?	often medium	Imports of plants for planting into the European Union from countries where *B. invadens* is present occur every month. The figures are shown for 2008 in tonnes: **Jan-08** **Feb-08** **Mar-08** **Apr-08** **May-08** **Jun-08** **Jul-08** **Aug-08** **Sep-08** **Oct-08** **Nov-08** **Dec-08** **European Union** 261.2 304.8 241.8 212.6 206 210.8 274.4 219.5 228 239.6 226.3 275 Source: Eurostat, 2009 These figures represent all the plants for planting imported from countries where *B. invadens* occur, and the host plants used for ornamental purposes represent a small fraction of these figures. Not all of these consignments are plants for planting with growing media, the EWG concluded that the frequency should be ranked as “often”.
1.7 How likely is the pest to survive	very	Eggs and larvae are found inside the fruits and are protected from adverse conditions. Pupae present in the growing media could also survive.

during transport /storage?	likely low	It is therefore very likely that the pest will survive transport and storage conditions of living plants for planting with growing media. Large plants are usually transported at temperatures comprises between 10 and 16°C, which are appropriate for *B. invadens* (Franco Finelli, pers. com., 2010). No interceptions have been recorded on this pathway, but on the other hand, pupae in growing media are usually not looked for.
1.8 How likely is the pest to multiply/increase in prevalence during transport /storage?	very unlikely low	The species is multivoltine (i.e. several generations/year) with an average life span of about 3 months, and pupal development lasts about 12 days (Ekesi *et al*., 2006). Plants for planting with growing media are unlikely to be transported by airplanes and would arrive in the EPPO region through shipping. Through shipping, it takes a maximum of 11 days, according to the exporting country (COLEACP, pers. com., 2009): - from Senegal: 5 to 6 days for EU southern ports, 6 to 7 days for EU northern ports. - from Côte D'Ivoire: 10 days for EU southern ports, 11 days for EU northern ports Pupae present in the soil could emerge during the transport, and the adults would soon start looking for the nourishment it needs to reach sexual maturity, couple and lay eggs (CTA, 2007). Since the plants for planting are host plants without fruits, a fecundated female could not lay eggs. Nevertheless, in the transport conditions (darkness and temperature), it is unlikely that the species would be actively fly and mate.
1.9 How likely is the pest to survive or remain undetected during existing management procedures (including phytosanitary measures)?	likely low	**<u>In the European Union</u>** There are different cases according to the commodity imported: - Annex III (Part A) point 16 mentions that the introduction of plants of *Citrus* spp., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds originating in third countries shall be prohibited in all member states. - According to Annex III (part A, point 13), the introduction of plants of *Solanaceae* intended for planting originating from Third countries, other than European and Mediterranean countries shall be prohibited in all Member States. - According to Annex I, non European Tephritidae such as *Bactrocera dorsalis* are considered harmful

organisms whose introduction into and spread within all Member States shall be banned. According to this Annex, all plant and plant products should be free from non European Tephritidae when imported in European countries.

- According to Annex IV (part A, section 1, point 34), soil and growing medium attached to plants originating from non European countries (other than Algeria, Egypt, Israel, Libya, Morocco and Tunisia, this measure therefore applies to countries where *B. invadens* is present) consisting in whole or in part of soil or solid organic substances such as parts of plants, humus including peat or bark or any solid inorganic substance, intended to sustain the vitality of the plants should be:
  - free from organic matter and soil, free from insects and harmful nematode or subject to appropriate heat treatment at the time of planting
  - maintained free from harmful organisms since planting.

Theoretically these measures should prevent any in of the growing medium of imported plants from pupae of *B.invadens*. It should be noted that repeated detection of plant parasitic nematodes in growing media attached to plants shows the lack of implementation in practice of such requirements. Repeated interceptions are provided by EUROPHYT. See also EPPO reporting services 2009/056, 2009/100, 2009/121, 2009/144, , 2009/183, 2009/201.

- According to Annexe IV (Part A, section 1, point 39), trees and shrubs, intended for planting, other than seeds and plants in tissue culture, originating in third countries other than European and Mediterranean countries:
  - are clean (i.e. free from plant debris) and free from flowers and fruits,
  - have been grown in nurseries,
  - have been inspected at appropriate times and prior to export and found free from symptoms of harmful bacteria, viruses and virus-like organisms, and either found free from signs or symptoms of harmful nematodes, insects, mites and fungi, or have been subjected to appropriate treatment to eliminate such organisms.
- According to Annexe IV (Part A, section 1, point 40), deciduous trees and shrubs, intended for planting, other than seeds and plants in tissue culture, originating in third countries other than European and Mediterranean countries should be dormant and free from leaves.

No specific procedure is prescribed for detecting pupae in growing media (Petter, pers. Com., 2010). The detection of pupae (4-5 mm) in growing media is difficult as the pupae has the same color as the soil, unless specific techniques are being used such as the ones for nematodes, and this will depend on the quantity of soil attached to the plant for planting. As a conclusion, the EWG assumed that visual inspection

		does not give enough guaranties against larvae of Tephritidae present in growing media of plants for planting. **In Algeria, Azerbaijan, Jordan, Morocco, Tunisia, Turkey, Ukraine** Tephritidae (Trypetidae) in general or *Bactrocera* spp. (without mentioning *B. invadens*) are prohibited at any stage of their development (as in Annex 1 of the Directive 2000/29). Nevertheless, no specific measures targeting hosts are in place. **Israel** Tropical and subtropical fruit trees and fruit shrubs and parts thereof, including fresh fruits, excluding dried fruits, almonds nuts of all kinds, copra, cured dates commercially packed are prohibited. **In Russia** In Russia, only *Ceratitis capita* is listed as a pest which introduction should be banned, without mentioning precise measures on commodities. **Other EPPO countries** No information is readily available for other EPPO countries.
1.10 How widely is the commodity to be distributed throughout the PRA area?	widely low	According to Eurostat (see Appendix 5), plants for planting with growing media originating from countries where *B. invadens* is present are imported to (by order of importance of quantities of imports) the Netherlands, Belgium, Germany, France, Italy, Sweden, the United Kingdom, Spain, Portugal, Cyprus, Greece, Denmark, Poland, Bulgaria, Czech Republic, Hungary, Austria, Romania. It is very likely that major importing countries such as the Netherlands would re-export the commodities to other EPPO countries which do not directly import from producing countries.
1.11 Do consignments arrive at a suitable time of year for pest establishment?	yes low	Plants for planting with growing media are imported all year round (see Appendix 4).
1.12 How likely is the pest to be able to transfer from the pathway to a suitable host or habitat?	likely low	In all cases, at least one mated female or one pair will need to be present to start a breeding population. Plants for planting are imported by nurseries, and may be stored outdoors and are likely to be placed near other host plants which can be infested by adults emerging from the imported plants. When the plant for planting is stored indoor, the risk is lower that the species would develop and fly away. In the Mediterranean area, fruits of hosts are available all year round:

		- from September till June, *Citrus* spp. are available, - from October to November, Mangoes are available - from May till September, fruits of other hosts are available.
1.13 How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) to aid transfer to a suitable host or habitat?	likely low	Plants for planting are imported by nurseries, and may be planted outdoors in private and public gardens, or on road sides. These plants are likely to be placed near other host plants which can be infested by adults emerging from the imported plants. When the plant for planting is used indoor, the risk is lower that the species would develop and fly away.

1.3 Pathway: 4		**Fruits carried by passengers**
1.3a Is this pathway a commodity pathway?	yes	
1.3b How likely is the pest to be associated with the pathway at origin taking into account factors such as the occurrence of suitable life stages of the pest, the period of the year?	likely medium	In countries where *B. invadens* is present, potential host plants are available all year and the pest can develop all year round (Mwatawala *et al.*, 2009). Consequently, suitable life stage of the pest are present when fruits mentioned above are present, and the association is likely. White & Elson-Harris (1992) report that many fruit fly outbreaks may be attributable to undetected imports of a few fruits in an airline passenger's baggage. This has also been recognized in later studies, as pre-departure interceptions in Puerto Rico from 1994 to 1996 revealed the presence of *Anastrepha* spp. in mangoes in 158 different occasions (Miller, 1997). Additionally, Liebhold *et al*. (2006) report that infested fruits appear to be most commonly found in the baggage of passengers arriving from developing countries, which is the situation of many countries where *B. invadens* is known to occur. Passengers could potentially bring back from countries they visit fruits that would be contaminated with *B. invadens*. Passengers in cars, trains, ferries and buses between tropical Africa and the Mediterranean area are also a pathway, and this pathway is further considered. In mangoes, most egg-laying takes place at the pre-ripening and ripening stages, making *B. invadens* less likely to be present in fruits to be carried by passengers than commercially traded fruits, as they might bring mature fruits.
1.4 How likely is the concentration of the pest on the pathway at origin to be	very likely medium	*Concentration* Concentrations vary according to hosts (see appendix 1) and are likely to be high on major hosts, and moderate in minor hosts. Populations of *B. invadens* can occur in fluctuating quantities according to the

high, taking into account factors like cultivation practices, treatment of consignments?		season, but seem to be positively correlated with rainy seasons ((Mwatawala *et al.* 2009; Vayssières *et al*., 2009). When the rainy season occurs depends on the geographic region. This applies to Africa and data for other regions are missing. The general public (passengers) could bring fruits of mango, guava or any fruits as host bought in markets or taken in private orchards. These plants are, therefore, less subject to controls than commercially imported plants. Fruit might even be untreated. Thus, the concentration of the pest might be even higher than in commercial consignments. Passengers are not trained to recognize pests on fruits and may overlook the pest. *Treatment* Fruits carried by passengers might come from domestic markets or private orchards. In the vast majority of cases, they would not have been officially inspected and certified for export by the NPPO in the country of origin. Consequently, the product may not meet the quality and plant health standards required for the international trade of fresh fruits. If it is grown in a private garden, no pest management, washing or sorting takes place during its production. Thus, the concentration of the pest might well be higher than in commercial consignments.
1.5 How large is the volume of the movement along the pathway?	moderate high	There are many flights between the EPPO region and Africa, and many connections linked with past history. Additionally, there is a train between Egypt and Sudan. It is supposed that there are some bus lines between Senegal and Mauritania, and Mauritania and Morocco. People may also travel by cars. Although there are many passengers crossing borders, not all passengers will bring back fruits after visiting countries where the pest occurs. Pre-departure interceptions in Puerto Rico from 1994 to 1996 revealed the presence of *Anastrepha* spp. in mangoes in 158 different luggage even though it is absolutely forbidden (APHIS, 1997). In France, tropical fruit importers report that they cannot sell some niche species to retailers because of the competition with passengers (D. Félicité Zulma, pers. com., 2009). Additionally, communities originating from countries where *B. invadens* occurs have a cultural heritage which includes giving fruit as gifts, including (even especially) when the recipient is going away. Therefore they bring back fruits. Tourists bring back fruit as a souvenir from countries they visit.
1.6 How frequent is the movement along	occasional	Information is lacking on the frequency of passengers bringing fruits. The EWG considered that the frequency should be ranked at least “occasionally”.

the pathway?	ly high	
1.7 How likely is the pest to survive during transport /storage?	very likely low	Eggs, larvae and most rarely pupae are found inside the fruits and are protected from adverse conditions. Baggage conditions are adequate for larval development. However, survival also depends on the way of transport: sea, car and ferries travels are sufficiently slow to think that infested fruit would have been consumed or discarded in transit; therefore, airline traffic is considered more important (Joomaye *et al*., 1999; Caton & Griffith, 2005).
1.8 How likely is the pest to multiply/increase in prevalence during transport /storage?	impossibl e/very unlikely low	The species is multivoltine (i.e. several generations/year) with an average life span of about 3 months, and pupal development lasts about 12 days (Ekesi *et al*., 2006). The passengers' travel is not likely to last more than a few days, which does not allow the species to reproduce.
1.9 How likely is the pest to survive or remain undetected during existing management procedures (including phytosanitary measures)?	very likely low	In EU countries, according to Council Directive 2000/29/EC, provided that there is no risk of harmful organisms spreading in the Community, small quantities of fruits, when intended for non-industrial and non-commercial purposes, or for consumption during transport need not be subject to custom supervision or plant health inspection. The NPPOs of the EU member states have the authority to limit the quantity allowed per passenger. Nevertheless, there is usually no implementation of such supervision, nor publicity on this measure. It is supposed that generally the same applies for non EU countries (except for Israel).
1.10 How widely is the commodity to be distributed throughout the PRA area?	very widely low	Passengers travel in the whole EPPO region.
1.11 Do consignments arrive at a suitable time of year for pest establishment?	yes low	Passengers travel all year round.
1.12 How likely is the pest to be able to transfer from the pathway to a suitable host or habitat?	moderatel y likely medium	See answer pathway 1. In the Mediterranean area, fruits of hosts are available all year round: - from September till June, *Citrus* spp. are available, - from October to November, Mangoes are available

		- from May till September, fruits of other hosts are available.
1.13 How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) to aid transfer to a suitable host or habitat?	moderately likely medium	The species could only develop and fly away if the commodity is composted or thrown outdoors. The increasing interest in composting of plant waste by individuals increases this possibility. A single infested fruit could develop a population. The risk is low in cities, but is higher in the countryside.
1.14c The overall probability of entry should be described and risks presented by different pathways should be identified		**<u>Fruits of major and minor hosts</u>** **EU countries and non EU countries** Major hosts such as *Mangifera indica* (mango), *Psidium guajava* (guava), *Carica papaya* (papaya) and *Citrus* spp. (citrus) represent a **likely pathway** for the entry of *B. invadens*. The concentration of the pest on these fruits is considered to be high. Uncertainty is low. It is **likely** that major hosts provide a pathway for the entry of *B. invadens.* In the majority of cases, *Citrus* spp. fruits are imported into the EU by fulfilling the requirement of visual inspection (see EU 2000/29, Annex IV, section I, point 16.5 on non European-Tephritidae), leading to no difference with other commodities regulated by Annex V (Part B) as visual inspection is not considered to give enough guaranties against Tephritidae. For any other option on *Citrus* spp. (free place area, free place of production and adequate treatment), the likelihood of entry would be lower. Minor hosts such as *Capsicum annuum, Capsicum frutescens, Citrullus lanatus, Cucumis melo, Cucumis sativus, Cucurbita* sp., *Lycopersicum esculentum, Malus domestica, Musa* sp. and *Persea americana, Prunus persica* (peach) represent a **moderately likely** pathway. The concentration of the pest on these fruits is considered to be lower than on major hosts. Uncertainty is low. **Israel** No risk, as it is already covered by the existing regulation. **<u>- Plants for planting with growing media (except seeds)</u>** The uncertainty on this pathway is high.

		EU countries and non EU countries For non EU EPPO countries, the regulation is supposed to be aligned with the EU regulation. It is **moderately likely** that plants for planting with fruits could provide a pathway for the entry of *B. invadens*, but it is currently a closed pathway for many EPPO countries. It is **unlikely** that plants for planting with growing media of hosts provide a pathway for the entry of *B. invadens*, entering as pupae in the growing media. In the EU, as long as plants of *Solanaceae*, *Citrus* spp. and *Fortunella* spp. are prohibited, they do not provide a pathway of entry for *B. invadens.* **Israel** No risk, as it is already covered by the existing regulation. **- Fruits carried by passengers** It is **moderately likely** that infested fruits carried by passengers provide a pathway of entry for *B. invadens.* **- Natural spread** It is **unlikely** that *B. invadens* could enter the Mediterranean EPPO region by natural means in the near future. It is to be noted that the establishment in any Mediterranean third country, or the Canary Islands would increase the risk of entry from all pathways, especially Citrus and tomato fruit imports and plants for planting (some current restrictions would no longer apply, e.g. no prohibition for Solanaceae).

Stage 2: Pest Risk Assessment - Section B : Probability of establishment

1.15 Estimate the number of host plant species or suitable habitats in the PRA area. Answer given to question 6 :	many low	*B. invadens* appears to be highly polyphagous as it counts more than 40 cultivated and wild hosts. Major hosts cultivated in the EPPO region are *Mangifera indica, Citrus* spp., *Psidium guajava*, and *Carica papaya.* Minor hosts cultivated in the EPPO region are: *Citrullus lanatus, Cucumis sativus, Capsicum annuum,*

Capsicum frutescens, Cucurbita sp., *Lycopersicum esculentum, Malus domestica, Musa* spp., *Persea americana,* etc.

The total areas in hectares producing fruits and vegetables hosts of *Bactrocera invadens* in the EPPO region and neighbouring countries for 2008 are shown below:

Country	**Producing area in ha in the EPPO region and surrounding countries in 2008**
Malus domestica (Apples)	1699828
Persea americana (Avocados)	33208
Musa spp. (Bananas)	88071
Capsicum spp. (Chillies and peppers, green)	309170
Citrus spp.	17192
Cucumis sativus (Cucumbers & gherkins)	402616
Mangifera indica, Garcinia mangostana (Mangoes, mangosteens) & *Psidium guava* (guavas)	135031
Carica papaya (Papayas)	522
Prunus persica (Peaches & nectarines)	491923
Cucurbita spp.& *Cucumis pepo* (Pumpkins, squash & gourds)	233344
Lycopersicon esculentum (Tomatoes)	1700416
Citrullus lanatus (Watermelons)	784872

Source: FAOSTAT.
Details by country are available in Appendix 2.

Some of these species and many other hosts are used as ornamental plants in the EPPO region and can be planted in public and private gardens: *Anacardium occidentale, Eriobotrya japonica, Fortunella margarita,* etc. (see appendix 1).

		Moreover, the species is currently enlarging its host range in Africa (see Appendix 1) (Vayssières *et al*., 2005), and it could also adapt to additional hosts (e.g. stone fruits such as peaches) when arriving in the EPPO region.
1.16 How widespread are the host plants or suitable habitats in the PRA area? (specify)	widely low	The crops quoted above are cultivated in many EPPO countries: Algeria, Austria, Belgium, Bosnia & Herzegovina, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Jordan, Malta, Morocco, Netherlands, Norway, Poland, Portugal, Russia, Slovakia, Spain, Sweden, Switzerland, Tunisia, Turkey, Ukraine, UK. Nevertheless, the major hosts are mainly found in the Southern part of the EPPO region such as *Citrus* spp., mango, papayas, etc. Hosts plants introduced for ornamental purposes are likely to be planted outdoors in the Mediterranean area only, due to climatic requirement of these species. See appendix 2 for details. Some of the hosts (e.g. Citrus) are considered widely distributed in the Mediterranean area.
1.17 If an alternate host or another species is needed to complete the life cycle or for a critical stage of the life cycle such as transmission (e.g. vectors), growth (e.g. root symbionts), reproduction (e.g. pollinators) or spread (e.g. seed dispersers), how likely is the pest to come in contact with such species?	N/A low	
1.18a Specify the area where host plants (for pests directly affecting plants) or suitable habitats (for non parasitic plants) are present (cf. QQ 1.15-1.17). This is the area for which the environment is to be assessed in this section. If this area is much smaller than the PRA area, this	The southern part of the EPPO region.	In the southern part of the EPPO region (particularly Citrus producing countries) , major hosts (*Citrus* spp., *Mangifera indica*, etc.) and minor hosts (such as *Capsicum* spp., *Citrullus lanatus, Cucumis* spp., *Lycopersicum esculentum*, *Musa* spp. are cultivated outdoors as crops (see Appendix 1 and 2). These species and other hosts might be used as ornamental plants in public and private gardens and in road sides. Hosts may therefore be present both in cultivated fields and/or in gardens all year round and might allow *B. invadens* to complete its life cycle all year round. Indeed, in the Mediterranean area, fruits of hosts are available all year round:

fact will be used in defining the endangered area.		- from September till June, *Citrus* spp. are available, - from July to November, mangoes are available, - from May till September, fruits of other hosts are available. Additionally, females have a rather high longevity and can wait a few months for susceptible fruits to become available.
1.18b How similar are the climatic conditions that would affect pest establishment, in the PRA area and in the current area of distribution?	moderately similar medium	A climatic prediction analysis has been performed with NAPPFAST, which concludes that entire Africa has a high potential for the establishment of *B. invadens*. The model estimated lowest number of generations per year in southern and northern parts of Africa (having a Mediterranean type climate); however, *B. invadens* may have as many as 6 generations per year in those areas. For continental US, 0 to 5 generations were predicted (Hurt & Takeuchi, 2006). Cold temperatures and low relative humidity are considered the most important abiotic parameters that would affect *B. invadens* establishment. Because of the fact that the species continues to spread, the limits of its climatic tolerance are not yet precisely known. The hottest and most humid parts of the Mediterranean Basin, more or less corresponding to the citrus growing area, are considered to be the most at risk. According to a CLIMEX analysis (see Appendix 5), the countries of the Mediterranean basin that are considered to be particularly at risk (including non EPPO countries) as *B. invadens* could establish: Algeria, Egypt, Jordan, Israel, Lybia, Morocco, and Tunisia. In other Mediterranean countries, establishment is not expected. *B. invadens* could be regularly introduced as a contaminant of fruits and have detrimental impacts through transient populations. The species could develop 5 generations in Albania, France (Corsica), Cyprus, Croatia, Greece (Crete), Italy (Sardinia, Sicily), Lebanon, Portugal, Spain, Syria, Turkey. This is expected to be localized excursions, as the building up of population would be low. Spain is particularly at risk as the species could spread naturally if it was established in Morocco. The tolerances of the species to cold temperatures, as well as to dry conditions remain the 2 major uncertainties. The species could adapt to new conditions in the Mediterranean and have a wider distribution than the one descibed above.
1.19	no	Considering that the species spends most of its development phase inside fruits, abiotic factors other than

How similar are other abiotic factors that would affect pest establishment, in the PRA area and in the current area of distribution?	judgement low	climatic conditions are probably of minor importance for establishment. The species seems to prefer low elevations both in India (21-60 m) (Sithanantham et al., 2006) and in Kenya (Ekesi et al., 2006), but altitudes are rather linked to climatic requirements in this case. There are no information on soil preference for the part of the life cycle of the species that is spent into the soil.
1.20 If protected cultivation is important in the PRA area, how often has the pest been recorded on crops in protected cultivation elsewhere?	never low	So far, *Bactrocera invadens* has not been recorded under glasshouses.
1.21 How likely is it that establishment will occur despite competition from existing species in the PRA area, and/or despite natural enemies already present in the PRA area?	very likely low	In all examples of competitive interactions worldwide, it was observed that *Bactrocera* spp. used to displaced *Ceratitis* spp., while the reverse was never observed (Duyck *et al*., 2004). Mwatawala *et al*. (2009) report that in Tanzania, *B. invadens* seems to dominate the native *Ceratitis cosyra, C. rosa* and *C. capitata* in orchard fruits in terms of abundance, host range and infestation rate. At higher elevation, *Ceratitis rosa* was the dominant species. So it is much probable that the presence of *Ceratitis capitata* in the endangered area would not prevent the establishment of *B. invadens*. In Africa, the presence of some natural enemies such as weaver ants (van Mele et al., 2009) did not affect the establishment of *B. invadens*.
1.22 To what extent is the managed environment in the PRA area favourable for establishment?	moderately favourable medium	*Cultivation practices of crops* Organic production might be more favorable for the establishment of *B. invadens* because less or no pesticides would be used. The harvesting of *Citrus* spp. may sometimes be not profitable anymore in the Mediterranean basin, leading to temporal abandon of orchards management, which is favorable to *B. invadens* establishment. Irrigation of crops is likely to create more favorable environments to *B. invadens*. *Hosts used as ornamental and domestic plants in public and private gardens and road sides* Species used as ornamental and domestic plants in public and private gardens and road sides are not managed nor harvested, and are difficult to survey and inspect. According to EFSA (2007), like for many polyphagous Tephritidae, highest densities should be attained in gardens where there are many different kinds of ripe fruits available for successive generations and where there is no control.
1.23	likely	*Hosts cultivated as crops*

How likely is it that existing pest management practice will fail to prevent establishment of the pest?	low	Insecticides already used against *C. capitata* could have some effect on *B. invadens* (EFSA, 2007) but would probably not prevent its establishment. The revisions of the Council Directive 91/414/EEC have resulted in the strict reduction of authorized substances used to control fruit flies, so there are only few active ingredients available to control tephritids at present in the EU. *Hosts used as ornamental and domestic plants in public and private gardens and road sides* In public and private gardens and road sides, it is unlikely that individuals would use phytosanitary products. Moreover as *B. invadens* does not damage the plant, it is very unlikely that treatments would be undertaken. In the EU, in urban areas, there are only a few substances available to control Tephritidae and in public places, it is even prohibited to use such substances.
1.24 Based on its biological characteristics, how likely is it that the pest could survive eradication programmes in the PRA area?	likely low	*B. invadens* is a pest that could only be eradicated if detected at an early stage and Methyl Eugenol (ME) is a highly suitable attractant for early detection. ME can also be used for eradication using male annihilation techniques. For instance, the eradication of, *B. zonata* has been successfully undertaken in Israel (EPPO website, 2009) and *B. dorsalis* was eradicated from Mauritius in 1996 (Seewooruthun *et al*., 2000). Such actions, however, require rigorous operational standards and massive investments, even if undertaken within hours after pest introduction and detection (Ekesi *et al*., 2006). Israel, Tunisia and Spain use Methyl Eugenol traps at ports of entry, and Morocco shall use them as well (NPPOs, pers com., 2009). In areas without Methyl Eugenol traps, detection is difficult. Outbreaks could be mistaken with *Ceratitis capitata*. In gardens, the species could remain unnoticed.
1.25 How likely is the reproductive strategy of the pest and the duration of its life cycle to aid establishment?	likely medium	Ekesi *et al.* (2006) studied the demographic parameters of *B. invadens* and the results did not greatly differ from those reported by Vargas *et al*. (1984) for *B. dorsalis*. The reproductive strategy of *B. invadens* is thus characterized by: - High fecundity ratio: average net fecundity and net fertility were 794.6 and 608.1 eggs, respectively (Ekesi *et al*., 2006). - Short life cycle: on artificial diet, development of immatures lasted 25 days at 28±1 º C; egg incubation required 1.2 days; larval development 11.1 days and puparia-adult development 12.4 days. Daily population increase was 11%; the mean generation time was 31 days and the population was estimated to double in 6 days at 28±1 º C (Ekesi *et al*., 2006).

		- Efficient mate finding: mating is aided by mated female attraction to male pheromones, which is a common behaviour of tephritids. Nevertheless, uncertainties remain on the population dynamics in the wild, as the data collected correspond to laboratory experiments, as well as on the potential adaptation of the species to different geographical areas.
1.26 How likely are relatively small populations to become established?	likely high	It is assumed that in principle one female and one male fly are sufficient to establish a new population. This is particularly the case because *B. invadens* males can attract females mates with pheromones, a common mating behaviour in the Tephritidae (Cayol *et al*., 2002 in EFSA, 2007). However, if the size of the initial population is too small, some genetic effects might limit the viability of the population.
1.27 How adaptable is the pest? Adaptability is:	moderate high	*B. invadens* is a polyphagous species, and is able to develop on a large range of fruits, including fruits of genus and species not present in its native region. *B. invadens* has spread very rapidly throughout sub Saharan Africa but the range of climates where it can occur is probably not yet known. African populations display high level of genetic diversity associated with limited geographical structure (Khamis *et al*., 2009), and genetic diversity shows a potential for adaptability. It is unknown if *B. invadens* can develop resistance to plant protection products.
1.28 How often has the pest been introduced into new areas outside its original area of distribution? Specify the instances if possible in the comment box.	occasionally low	The species originates from Asia (Sri Lanka, India) and it is not clear whether Buthan should be considered as part of its native area (de Meyer *et al*., 2009). The species has only been introduced to the African continent (and the Comoros) where it has spread to 32 countries.
1.29a Do you consider that the establishment of the pest is very unlikely ?	no	Establishment is likely in Algeria, Egypt, Jordan, Israel, Lybia, Morocco, and Tunisia.
1.29b How likely are transient populations to occur in the PRA area through natural migration or entry through man's activities (including intentional release into the environment)?	Very likely Medium	Transient populations could spread naturally or enter through the trade of fruits and the transport of persons every year from places where it would have established. The species could develop 5 generations in Albania, France (Corsica), Cyprus, Croatia, Greece (Crete), Italy (Sardinia, Sicily), Lebanon, Portugal, Spain, Syria, Turkey.

1.29c The overall probability of establishment should be described.		The probability of establishment of *B. invadens* is **high** in the Southern part of the EPPO region as: - many cultivated hosts are available in the Southern part of the EPPO region; - succession of fruits from suitable hosts is available all year round; - climatic conditions seem suitable in at least some parts of EPPO countries. The countries of the Mediterranean basin that are considered to be particularly at risk (including non EPPO countries) as *B. invadens* could establish: Algeria, Egypt, Jordan, Israel, Lybia, Morocco, and Tunisia. In other Mediterranean countries, establishment is not expected. *B. invadens* could be regularly introduced as a contaminant of fruit and have detrimental impacts through transient populations. Indeed, the species could develop 5 generations in Albania, France (Corsica), Cyprus, Croatia, Greece (Crete), Italy (Sardinia, Sicily), Lebanon, Portugal, Spain, Syria, Turkey. This is expected to be localized excursions, as the building up of population would be low. Spain is particularly at risk as the species could spread naturally if it was established in Morocco. - the species seems to prefer hot and humid environments but further research is needed on the potential of the species to survive into dryer and/or colder environments; - there are few active ingredients available to control tephritids, and the current management methods would not prevent the establishment of *B. invadens*; - eradication of the pest (outdoors) is very difficult without early detection and rapid emergency response; - *B. invadens*, as most tephritids, is characterized by a high fecundity and a short life cycle. The EPPO workshop on non European fruit flies held in 1993 concluded that fruit flies are not considered to present a risk in glasshouse crops in Northern Europe. The EWG was unable to confirm this statement due to uncertainties concerning the range of authorized active ingredients under changing EU regulation or disruption of biological control practices in greenhouses. The risk of a greenhouse getting infested in Northern Europe by *B. invadens* remains very unlikely and is not considered further in the PRA. In the Southern region, the risk of glasshouses being infested is low, and very uncertain. The uncertainty on the establishment of *B. invadens* in the Southern EPPO region remains medium and are mainly associated with the suitability of climatic conditions.

Stage 2: Pest Risk Assessment - Section B : Probability of spread

1.30 How likely is the pest to spread rapidly in the PRA area by natural means?	likely high	Since 2003 the species has spread to 32 African countries. *B. invadens* was not detected during surveys performed in Kenya and Tanzania in 2000, suggesting that it was not established in 2000, or only present in very low numbers. Its first place of discovery (i.e. Kenya) should not be assumed to be its point of entry into Africa, as it may have been overlooked in some areas. *B. invadens* may have spread about 6500 km in about 7 years from the Eastern African coast, to the Western one, but it may also be the result of multiple introductions at different geographical locations and man induced spread (Khamis *et al*., 2009). The species was named "*invadens*" on the basis of its rapid invasion of the African continent. *Bactrocera* species can be attracted to Methyl Eugenol up to 0.8 km away from suitable hosts (White and Elson-Harris, 1994) which suggests that *B. invadens* would be able to fly at least between adjacent fruit crops. Studies have shown that sterilized *B. zonata* were recaptured til 40 km from the point of their release (Qureshi *et al.*, 1975) The flying ability of *B. invadens* is supposed to be higher than *Ceratitis cosyra* and *C. capitata* in Africa (JF Vayssières, pers. com., 2009) The continuous presence of hosts in the endangered area facilitates the spread. After the Citrus harvest period, *B. invadens* might not find major hosts, and females would have to look for other hosts, enhancing the spread of the species.
1.31 How likely is the pest to spread rapidly in the PRA area by human assistance?	likely low	*B. invadens* could be spread by human assistance in the endangered area predominantly through the movement of contaminated fruits of host plants. Trade routes between North Africa and Southern Europe are very important for *Citrus* spp., as well as for other hosts produced in North Africa. There is also a huge movement of people potentially carrying infested fruits.
1.32 Based on biological characteristics, how likely is it that the pest will not be contained within the PRA area?	likely medium	Containment measures might be successful only if an eradication program is immediately started after detection of the first outbreak (see Q. 1.23). Effective tools exist for early detection with Methyl Eugenol. There are available tools to contain the populations such as suppression measures and internal quarantine, but implementation would be costly. Hosts plants are available, and polyphagy would make the containment more difficult. *Bactrocera* spp. have a highly-developed flying ability (0.8 km away from likely hosts

		according to White and Elson-Harris, 1994) which allows it to spread easily and also to re-infest the orchards quickly after treatment (Vayssières *et al*., 2008). The reproductive strategy of the pest is very effective. Man induced spread through the transport of fruits would be very difficult to control.
1.32c The overall probability of spread should be described.		Considering the situation in Africa, the probability of spread of the pest is very high, and the uncertainty is low.

Stage 2: Pest Risk Assessment - Section B : Conclusion of introduction and spread and identification of endangered areas

1.33a Conclusion on the probability of introduction and spread. (Your conclusions from the previous modules will appear in the box below.)		The probability of establishment of *B. invadens* is **high** in the Southern part of the EPPO region as: - many cultivated hosts are available in the Southern part of the EPPO region - the countries of the Mediterranean basin that are considered to be particularly at risk (including non EPPO countries) as *B. invadens* could establish: Algeria, Egypt, Jordan, Israel, Lybia, Morocco, and Tunisia. In other Mediterranean countries, establishment is not expected. *B. invadens* could be regularly introduced as a contaminant of fruit and have detrimental impacts through transient populations. Indeed, the species could develop 5 generations in Albania, France (Corsica), Cyprus, Croatia, Greece (Crete), Italy (Sardinia, Sicily), Lebanon, Portugal, Spain, Syria, Turkey. This is expected to be localized excursions, as the building up of population would be low. Spain is particularly at risk as the species could spread naturally if it was established in Morocco. The tolerances of the species to cold temperatures, as well as to dry conditions remain the 2 major uncertainties. The species could adapt to new conditions in the Mediterranean and have a wider distribution than the one descibed above. - there are few active ingredients available to control tephritids. - eradication of the pest (outdoors) is very difficult - *B. invadens*, as most tephritids, is characterized by a high fecundity ratio, fast life cycle. The uncertainty on the establishment of *B. invadens* in the Southern EPPO region is medium, mainly due to the uncertainty on climatic requirements of the species. The EPPO workshop on fruit flies held in 1993 concluded that fruit flies are not considered to present a risk in glasshouse crops in Northern Europe. The EWG was unable to confirm this statement due to uncertainties of the range of authorized active ingredients under changing EU regulation or interruption of biological control. The risk of a greenhouse getting infested in Northern Europe by *B. invadens* remains very unlikely and is not considered further. In the Southern region, the risk of glasshouses being infested is low, and very uncertain. Considering the observations in Africa and the particular situation in the endangered area, the probability of spread of the pest is high, and the uncertainty is low.

		The overall probability of entry is high, with a low to medium uncertainty.
1.33b Based on the answers to questions 1.15 to 1.32 identify the part of the PRA area where presence of host plants or suitable habitats and ecological factors favour the establishment and spread of the pest to define the endangered area.		The endangered area fits with the area economically most at risk: the horticultural, citrus and fruit-growing areas within Algeria, Egypt, Jordan, Israel, Lybia, Morocco, and Tunisia. In other Mediterranean countries, establishment is not expected. *B. invadens* could be regularly introduced as a contaminant of fruit and have detrimental impacts through transient populations. Indeed, the species could develop 5 generations in Albania, France (Corsica), Cyprus, Croatia, Greece (Crete), Italy (Sardinia, Sicily), Lebanon, Portugal, Spain, Syria, Turkey. This is expected to be localized excursions, as the building up of population would be low. Spain is particularly at risk as the species could spread naturally if it was established in Morocco. The tolerances of the species to cold temperatures, as well as to dry conditions remain the 2 major uncertainties. The species could adapt to new conditions in the Mediterranean and have a wider distribution than the one descibed above. It also includes trees planted as amenity trees in private and public areas and vegetable gardens.

Stage 2: Pest Risk Assessment - Section B : Assessment of potential economic consequences

2.1
How great a negative effect does the pest have on crop yield and/or quality to cultivated plants or on control costs within its current area of distribution?

major
low

B. invadens is currently considered as one of the major pests in Africa (Mwatawala *et al.*, 2009). In general, *B. invadens* is displacing indigenous fruit flies in Africa (Ekesi *et al*., 2006). Quantitative data on crop losses are only available for mango and citrus species.

Mangoes
CTA (2007) considers that because of attacks by *Ceratitis cosyra* and *Bactrocera invadens*, harvest losses on mangoes that are held down to 10% at the beginning of the growing season can reach 80% by the end of the season. Sampling of infested fruits at regular intervals during the mango season indicates that late cultivars are attacked much more than early ones.
In Western Africa, Vayssières *et al*. (2008b) also found that for the cultivars Amélie (Gouverneur), Eldon, Dabschar, Kent, Smith, Keitt and Brooks together, losses stand at 15% in early April and exceed 69% at mid-June (the end of the mango season). Average losses were measured on a dozen of orchards in Borgou in Benin in 2005 and 2006 (see table 1).

Cultivars of mango	Losses in % in 2005	Losses in 2006 in %	Average losses in % for 2005 and 2006
GOUVERNEUR	14,8	15,8	15,3
ELDON	44	49,4	46,7
AMELIOREE	50,5	47,3	48,9
DABSCHAR	50,7	47,9	49,3
KENT	51,6	47,5	49,6
SMITH	54,5	55,5	55,0
KEITT	62,8	60,8	61,8
ALPHONSE	65	64,2	64,6
BROOKS	65,5	73,1	69,3

Table 1: losses on mango production in Benin expressed in percentages for different varieties for the years 2005 and 2006, experiment performed by JF Vayssières.

Losses attributed to Tephritidae had been extrapolated at the hectare scale on the basis of sampled mangoes and losses recorded on this sample. Losses were estimated to vary between 0.34 t/ha, and 6.5 t/ha (from 15% till 69%), depending on the cultivar (Vayssières *et al*., 2008). Oviposition in the fruit can lead to a number of pathogens attacks that can also accelerate the damage to the fruit (Vayssières *et al*., 2008).

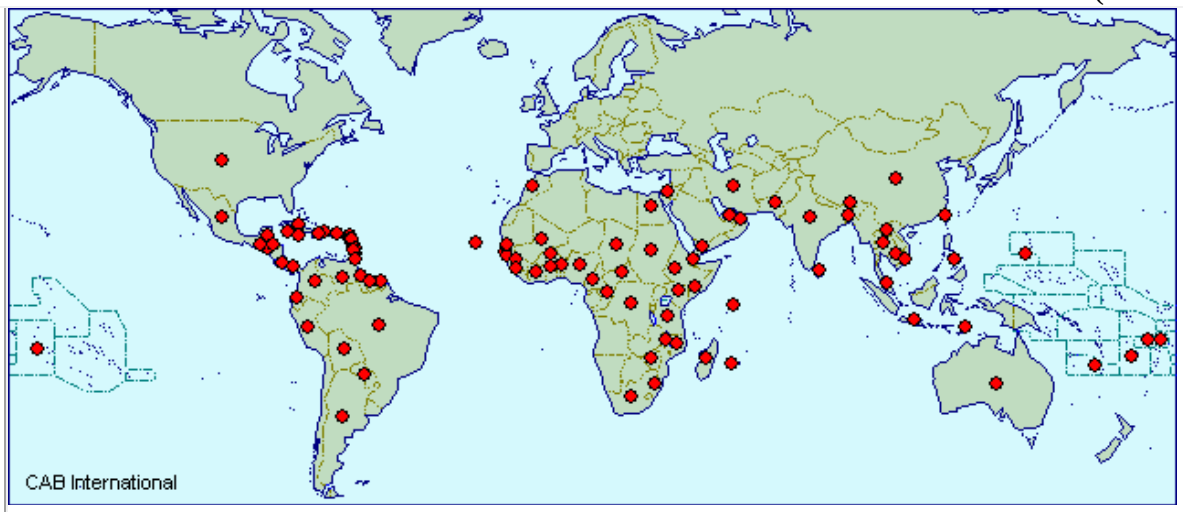
Citrus spp.
In Kenya, Rwamushana *et al*. (2008) reported heavy infestations on *Citrus limon, C. reticulata* and *C. sinensis.* It is extrapolated that heavy infestations could have impacts on the crop.
The level of infestation depends on Citrus hosts (see Appendix 1) as well as on the agro-ecological zone.
In South Benin, from all citrus fruits sampled in 2008-2009, emerged fruit fly species were mostly *B. invadens* (98.3%) and the resulted damages depended on the locality and the *Citrus* species. In 2008, the recorded incidence on mandarin (*Citrus reticulata* Blanco) was 46.7% and 36.7% in orchards of Amoussa (Glo locality) and Monou (Sakété), respectively. On Tangelo (*Citrus x tangelo*), the incidence was 33.3% recorded in Amoussa's orchard. On sweet orange (*Citrus sinensis*) (cv Valencia) the incidence was 30%, 20%, 20% and 17.8% in orchards of Amoussa, Agban (Allada), Houéssou (Allada) and Monou, respectively. In terms of infestation rates of number of pupae per kg of fruit, the recorded damages on mandarin were 25.6 and 22.4 in orchards of Monou and Amoussa, whereas these damages on Tangelo were 19.7 in Amoussa's orchard. On sweet orange, the infestation rates were 8.7, 7.0, 5.3 and 3.0 in orchards of Amoussa, Monou, Agban and Houéssou. This incidence level due mostly to *B. invadens* is an indication that, in South Benin, *B. invadens* is the most destructive and economically important fruit fly in Citrus resulting in great yield losses (see table 2 for average losses for 2 years). As the crop is an important income provider for the producers and then for the country, a proper control method elaboration is needed at any cost to reduce the yield losses, increase income and alleviate poverty.
In other countries such as Ghana, Guinea, Togo and Senegal the situation was the same as in Benin and was sometimes even worse. In central Tanzania, *C. paradisi* seems to be the more heavily infested species.

	Guinean zone	**Sudanian zone**
***Citrus tangelo* (Tangelo)**	34%	?
***Citrus reticulata* (Mandarin)**	22%	6%
***Citrus sinensis* (Sweet orange)**	25%	12%
***Citrus x paradisii* (Grapefruit)**	?	10%

Table 2: performed losses assessments on *Citrus* species in Benin between November 2007 and November 2009 in the Guinean and the Sudanian zones. *Bactrocera invadens* represents about 90% of the damages observed. Results are expressed in percentages of losses of production, studies implemented by JF Vayssières *et al.* (unpublished data).

		Guava High infestations levels have been reported in Benin, Cameroon, Togo, Côte d'Ivoire, Guinea, Tanzania, etc. (Abanda *et al*., 2008, Vayssières *et al*., 2009; Mwatawala *et al*., 2009). The impacts are considered to be high on guava. *Papaya* In Benin, infestation levels are high in the South (Vayssières *et al*., 2009). In Tanzania, although Mwatawala *et al*. (2009) could not find positive records on papaya, de Meyer *et al*. (pers. com., 2009) found a few positive records (6 positive ones out of 36 samples taken). *Musa* spp. In Kenya, Rwamushana *et al.* (2008) reported infestations on *Musa* spp. Infestations have also been reported from other countries (eg. Sudan, Tanzania, Cameroon, Benin), but only at low levels but this should be further investigated. *Tomatoes* In Tanzania, although Mwatawala *et al*. (2009) could not find positive records on tomatoes, de Meyer *et al*. (pers. com., 2009) found a few positive records (3 positive ones out of 400 samples taken). In Benin incidental records were found on tomatoes in the North and in the South during the whole tomato season (JF Vayssières, pers; com., 2009). The infestation level is low. The impacts on tomatoes are therefore considered low. *Avocado* Infestations are considered to be low in Benin and in Tanzania. Though low infestations have been recorded on probably ripe fruits in Tanzania of the Hass variety, it is likely that the stage of early harvesting for export trade prevents infestations by *B. invadens* (de Meyer, pers. com. 2009). Other hosts Impacts on minor hosts such as apples, watermelons, peaches and peppers are low in the current range of the species.
2.2 How great a negative effect is the pest likely to	major high	Production figures in the EPPO region have been taken from FAOSTAT, but these figures do not always seem reliable. The production of host plants takes mostly place in the endangered

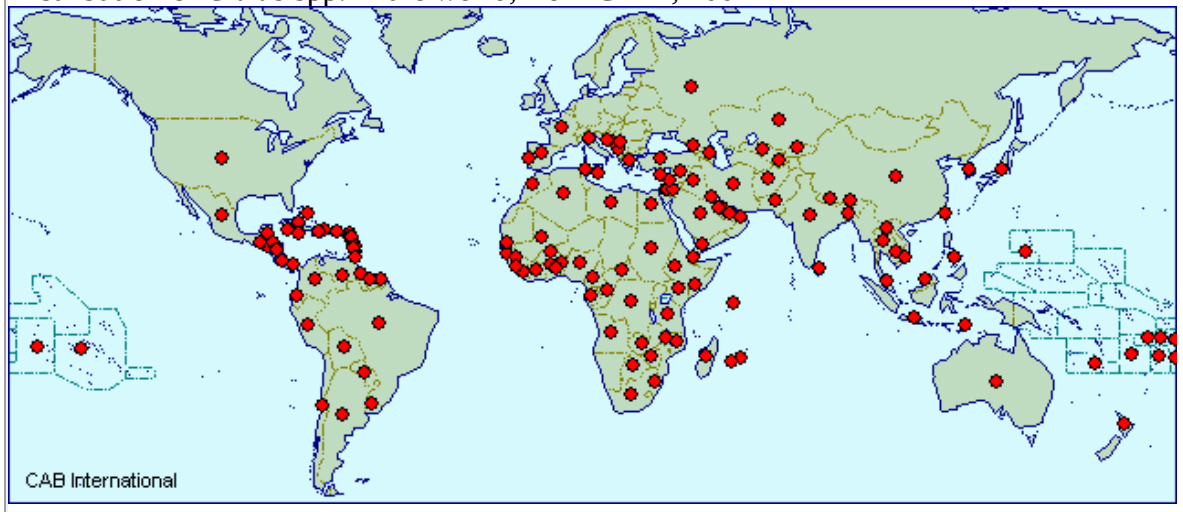
have on crop yield and/or quality in the PRA area without any control measures?		area (see Appendix 2). In this section, no distinction is made between potential impacts for the areas where the species could establish, and where the species could be transient. After incidental introduction, transient populations could develop 5 generations per year. Impacts in areas where populations are only transient will be lower, as the populations would build up slowly, and damage would only be localized. Tephritidae populations easily build up to levels at which significant damage is caused to host plants, which are widely cultivated within the endangered area. From the information available up to now, major hosts and minor hosts can be distinguished, nevertheless, in case of establishment of *B. invadens* in the endangered area, the status of the hosts might change (e.g. stone fruits such as peaches could become a major host in the endangered area). The countries of the endangered area produces 100% of bananas, mangoes, papayas, citrus and avocados that are produced in the EPPO region; almost 95% of peaches and nectarines; and nearly 80% of peppers and 75% of tomatoes. According to EFSA (2007), the cooler conditions in the endangered area and the fact that there is better integrated pest management (IPM) practice and crop hygiene in orchards reduces the impacts compared with the ones recorded in the current range of the pest. These figures do not include home-garden production, which could be substantial, but for which no information is available. *Major hosts* *Mangoes* According to FAOSTAT, 37 852 tonnes of mango are cultivated in the EPPO region, mainly in Israel (37,827 tonnes) and Morocco (25 tonnes). This crop is not as important in the EPPO region as it is in Africa. The EWG noted that FAOSTAT does not report mango production in Spain, while such production occurs, particularly in the Canary Islands (JM Guitián Castrillón, pers. com., 2009). Distribution of *Mangifera indica* in the world, from CABI, 2007



Legend: red dots indicate that the species is widespread

Citrus spp.
Citrus spp. is a major crop in the EPPO region and is produced all around the Mediterranean area (Morocco, Spain, Italy, Greece, Turkey, etc.). See table 1.

Distribution of *Citrus* spp. in the world, from CABI, 2007



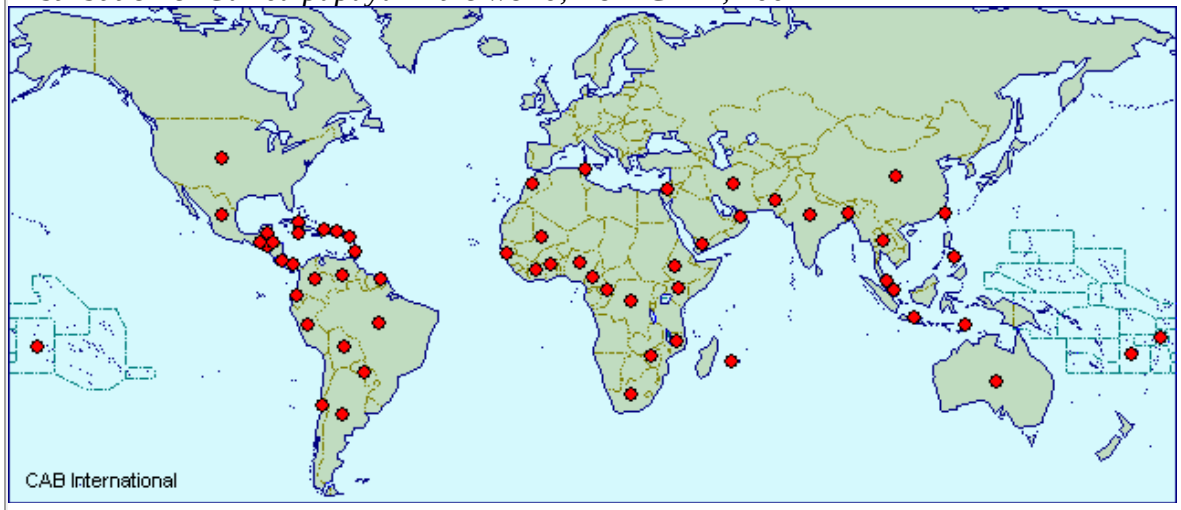
Legend: red dots indicate that the species is widespread

Papaya
Papayas are only produced in Israel, Morocco, Tunisia according to FAOSTAT. See Table 1.

Commodity	TOTAL produced in tonnes in 2007 in the EPPO region
Citrus	16,215,868
Papayas	425

Table 1: Production in tonnes of Citrus species and papayas in the EPPO region for 2007
Source: FAOSTAT. Details by country are available in Appendix 2.

Distribution of *Carica papaya* in the world, from CABI, 2007



Legend: red dots indicate that the species is widespread

The EWG considered that in the absence of control measures, the impact on major hosts (mango, citrus species and papayas) in the endangered would be high.

Minor hosts
Impacts on minor hosts such as apples, watermelons, peaches and peppers are low in the current range of the species. The production in tonnes for 2007 in the EPPO region of crops at risk are provided in table 2.

		<table><tr><th>Commodity</th><th>Production in the EPPO region in tonnes in 2007</th></tr><tr><td>*Lycopersicon esculentum* (Tomatoes)</td><td>36,593,790</td></tr><tr><td>*Malus domestica* (Apples)</td><td>18,888,307</td></tr><tr><td>*Citrullus lanatus* (Watermelon)</td><td>11,301,569</td></tr><tr><td>*Cucumis sativus* (Cucumbers & gherkins)</td><td>7,943,042</td></tr><tr><td>*Capsicum* spp. (Chillies and peppers, green)</td><td>5,626,987</td></tr><tr><td>*Prunus persica* (Peaches & nectarines)</td><td>5,307,329</td></tr><tr><td>*Cucurbita spp.*& *Cucumis pepo* (Pumpkins, squash & gourds)</td><td>3,839,177</td></tr><tr><td>*Musa* spp. (Bananas)</td><td>567,062</td></tr><tr><td>*Persea americana* (Avocados)</td><td>243,851</td></tr></table> Table 2: Total of produced fruits and vegetables hosts of *Bactrocera invadens* in the EPPO region in tonnes for 2007. Source: FAOSTAT. Details of production of minor hosts by country are available in Appendix 2. Ollier et al. (2009) provides the summary results of the EU-27 orchard survey. It highlights that 206 957 ha are cultivated in peaches, mainly in Greece, Spain, France and Italy, and that 67 369 ha are cultivated in apricost, mainly in Spain, France and Italy (See appendix 2 for details).
2.3 How easily can the pest be controlled in the PRA area without phytosanitary measures?	with much difficulty low	In the endangered area, control practices are aimed at key fruit fly species (e.g. *Ceratitis capitata* in the Mediterranean Basin, *Rhagoletis* spp.). If the population of *B. invadens* is very low, it will probably be affected by measures targeted against these pests. Otherwise, it would need specific control measures, including plant protection products. In most countries, the use of insecticides would be a limiting factor since it is restricted by environmental regulations and phytosanitary products residue testing. In the EU, application of insecticides in private and public areas is generally limited or even completely forbidden. Thus, chemical control will not be a feasible measure in private gardens and amenity lands in some countries of the endangered area due to environmental and human health legislations.

2.4 How great an increase in production costs (including control costs) is likely to be caused by the pest in the PRA area?	moderate low	Production costs will rise due to increases in control costs and surveillance by the producers. Nevertheless, the use of plant protection products is not likely to increase significantly since it is already high to control local fruit flies, and is restricted by environmental regulations and phytosanitary products residue testing. Anyway, the cost of surveillance would be increased as the traps with Methyl Eugenol should be used in addition to trimedlure to monitor male populations.
2.5 How great a reduction in consumer demand is the pest likely to cause in the PRA area?	minor medium	If consumers would buy an infested fruit, they may switch to other fruits, which would cause a reduction in the consumer demand. Additionally, the introduction of *B. invadens* might imply an increase in the number of treatments. It could cause a reduction in demand due to the public awareness about the presence of phytosanitary products residues in fruits.
2.6 How important is environmental damage caused by the pest within its current area of distribution?	minimal medium	*B. invadens* is not harmful for the tree/plant itself, it only damages the production of fruits. No environmental impacts have been recorded.
2.7 How important is the environmental damage likely to be in the PRA area (see note for question 2.6)?	minimal medium	It is expected that *B. invadens* would have no direct environmental impacts in the EPPO region, as it had no impact in its current range. As *B. invadens* only damages the production of fruits, and not the viability of the plant, it is unlikely to have high impacts on the survival of wild or protected plants. On the other hand, more treatments with phytosanitary products should be carried out if the pest occurs, particularly if eradication is attempted, which could affect the environment in the endangered area.
2.8 How important is social damage caused by the pest within its current area of distribution?	major low	Mango is a major commercial commodity in Africa and some countries are highly dependant on mango exports to generate jobs and revenues and to maintain people in rural areas. *B. invadens* was recorded for the first time on the African mainland in 2003 (Lux *et al*., 2003) and has already become a pest species of major concern to growers. East African fruit production is mainly done by small holders and most fruits are supplied to the local urban market (Lux, 1999). Phytosanitary products are expensive and cannot be affordable to small holders (Mwatawala *et al*., 2008). Presence of high populations of fruit fly species leads to economic losses for the small holders, as well as a reduced source of essential dietary components especially vitamins and minerals to local populations (Vayssières *et al*., 2008). In Western Africa, phytosanitary pressure led to uprooting mango plantations in one area (Borgou) in Benin (Vayssières *et al*., 2007).

2.9 How important is the social damage likely to be in the PRA area?	moderate high	The economy of certain localities in the endangered area within the horticultural and fruit growing areas is largely based on fruit industry which offers employment possibilities for the local population (eg. Morocco, Tunisia, etc.). The establishment of *B. invadens* in these areas could cause financial hardship. In some countries of the endangered area, these fruits supply an essential addition to local nutrition.
2.10 How likely is the presence of the pest in the PRA area to cause losses in export markets?	very likely/certain low	It is expected that third countries would react to the presence or establishment in the EPPO region as already occured for African exports. In Africa, indirect losses resulting from quarantine restrictions imposed by importing countries to prevent entry and establishment of unwanted fruit fly species can be enormous (De Meyer *et al*., 2009). Some countries such as South Africa have already banned certain imports from Kenya, Uganda, Mozambique and Ghana due to the threat that *B. invadens* represents (S. Muchemi, pers. comm.; E. Niyibigira, pers. com.; both references quoted by Rwomushana *et al*., 2008). Similar impacts can be expected if *B. invadens* would be present in the PRA area. For instance, Spain has bilateral agreements regarding fruit flies with United States, Mexico, Australia, New Zealand, South Africa, South Korea, China, Japan, Taiwan, etc. Each of these agreements would be at risk if *B. invadens* would occur in Spain. Other Citrus exporting countries such as Morocco, Italy, etc. would also be affected. The Comité de Liaison Europe-Afrique- Caraïbes-Pacifique (COLEACP) mentions that during 6 month in 2006, 23 mangoes consignments originating from West Africa to the EU were infested by *B. invadens* and were destroyed, each consignment representing 30 000 euros (referring to a 40' sea freighted container). In Côte d'Ivoire, Senegal, Mali and Burkina Faso, the export season to the EU for mango has been reduced as the export are stopped at the start of the rainy season to prevent invasions, and the quantities exported have significantly decreased (C Guichard, pers. com., 2009, based on Eurostat data). The USA have already restricted the import of several fruits and vegetables originating in countries where *B. invadens* is known to occur. In the USA, a federal import quarantine order for host materials of *Bactrocera invadens* (Diptera, Tephritidae) taken on the 29 December 2008 and updated on the 8th of May 2009 restricted the entry of fruits and vegetables of *Musa* spp., *Mangifera indica, Carica papaya, Cucumis melo, Solanum lycopersicum, Capsicum annuum, Cucurbita pepo, Citrus limonum* and *Citrus aurantiifolia* from countries where *B. invadens* occurs (APHIS, 2009).

2.16 Referring back to the conclusion on endangered area (1.33) : Identify the parts of the PRA area where the pest can establish and which are economically most at risk.		The countries of the Mediterranean basin that are considered to be particularly at risk (including non EPPO countries) as *B. invadens* could establish: Algeria, Egypt, Jordan, Israel, Lybia, Morocco, and Tunisia. In other Mediterranean countries, establishment is not expected. *B. invadens* could be regularly intrudoced as a contaminant of fruit and have detrimental impacts through transient populations. The species could develop 5 generations in Albania, France (Corsica), Cyprus, Croatia, Greece (Crete), Italy (Sardinia, Sicily), Lebanon, Portugal, Spain, Syria, Turkey. This is expected to be localized excursions, as the building up of population would be low. Spain is particularly at risk as the species could spread naturally if it was established in Morocco. Crops particularly at risk are mangoes, citrus species and papaya, and there is an uncertainty on the potential impacts of others crops which are currently minor hosts in its current range: bananas, watermelon, cucumber, peppers, pumpkins, avocados, apples, tomatoe, etc. It is suspected that in the endangered area, peaches or other stone fruits could become major hosts. The overall uncertainty on the economic impact is considered medium to high.

Stage 2: Pest Risk Assessment - Section B : Degree of uncertainty and Conclusion of the pest risk assessment

2.17 Degree of uncertainty : list sources of uncertainty		The overall level of uncertainty is considered as medium to high. *Host species* *B. invadens* seems to increase its host range in Africa, and it is unknown whether it would adapt to alternative hosts (eg. stone fruits) present in the endangered area. There is no indication of the species' host range in its native range. *Climatic requirements* There is a lack of data on the limiting factors of the species (e.g. cold and drought resistance) and its ability to establish in temperate areas. *Spread capacity* There is no precise data available on the ability of flight of *B. invadens,* and there is also an uncertainty on the succession of available hosts at different seasons in the endangered area. *Impact on crops* There is a major uncertainty on the potential impacts on the following crops in the endangered area: bananas, watermelon, cucumber, peppers, pumpkins, tomatoes, avocados, papayas, stone fruits etc. *Interceptions* No information is available for non EU EPPO countries, except for Switzerland *Adaptability* The potential adaptability of the pest is unknown. This includes the possibility of adaptation to protected cultivation, as several of the hosts are commonly grown protected in the EPPO region, whereas this is rarely the case in those areas where the pest is known to be present at this time.
2.18 Conclusion of the pest risk assessment		The endangered area fits with the area economically most at risk: the horticultural, citrus and fruit-growing areas within Algeria, Egypt, Jordan, Israel, Lybia, Morocco, and Tunisia. In other Mediterranean countries, establishment is not expected. *B. invadens* could be regularly introduced as a contaminant of fruit and have detrimental impacts through transient populations. Indeed, the species could develop 5 generations in Albania, Corsica, Crete,

		Croatia, Greece, Italy (Sardinia, Sicily), Lebanon, Portugal, Spain, Syria, Turkey. This is expected to be localized excursions, as the building up of population would be low. Spain is particularly at risk as the species could spread naturally if it was established in Morocco. It also includes trees planted as amenity trees in private and public areas and vegetable gardens. The Inter-African Phytosanitary Council rated *B. invadens* as "a devastating quarantine pest'" in their circular No. UA/CPI/2005/01. The results of the Pest Risk Assessment stage confirm that this new species is of high phytosanitary risk to the EPPO region, especially to the Mediterranean Basin including Portugal. *B. invadens* is an appropriate candidate for pest risk management. *B. invadens* poses a considerable threat to the agriculture and exports of the countries where it occurs and ultimately to their trading partners and local/regional consumers.

Stage 3: Pest Risk Management

3.1 Is the risk identified in the Pest Risk Assessment stage for all pest/pathway combinations an acceptable risk?	no	

3.2a Pathway :		**Fruits of major and minor hosts from countries where the pest occurs** **Major and minor hosts are considered together as the measures are the same.**
3.2 Is the pathway that is being considered a commodity of plants and plant products?	yes	
3.12 Are there any existing phytosanitary measures applied on the pathway that could prevent the introduction of the pest? (if yes, specify the measures in the box notes)	no	Most EPPO countries have general regulations against non-European *Tephritidae,* but specific phytosanitary measures against *B. invadens* do not exist. As an example, the EU takes a common set of measures against non-European Tephritidae (i.e. Council Directive 2000/29/EC) (see question 1.14 for more details).
3.13 Can the pest be reliably detected by a visual inspection of a consignment at the time of export, during transport/storage or at import?	yes in combination possible measure in combination: visual inspection.	The EWG assumed that visual inspection does not give enough guaranties against Tephritidae, and that opinion is shared by NPPOs belonging to countries where fruit flies are considered a risk (eg. China, Australia, Japan, South Korea, etc.) (see Q 1.9 of pathway 1). *Bactrocera* spp. are regularly intercepted based on visual inspections.
3.14 Can the pest be reliably detected by testing (e.g. for pest plant, seeds in a consignment)?	no	Current status of tephritid taxonomy relies almost exclusively on adult characters and, in general, it is not possible to identify *Bactrocera* spp. with certainty from larval characteristics.
3.15 Can the pest be reliably detected during post-entry quarantine?	no	Such investigation would render fresh fruit consignments worthless, and this measure is not feasible.
3.16 Can the pest be effectively destroyed in the consignment by treatment (chemical, thermal,	yes in combination	The treatments approved by the USDA/APHIS for other *Bactrocera* species, (i.e. *B. cucurbitae*, *B. dorsalis*, *B. philippinensis*, *B. tryoni* and *Bactrocera* spp.) depending on the commodity and the country of origin, are:

irradiation, physical)?	possible measure in combination: specified treatment.	- Irradiation - Vapor heat treatment (T103-b-1; T103-d; T103-e; T106-b-1; T106-b-2; T106-b-3; T106-b-4; T106-b-5; T106-b-7; T106-b-8; T106-c; T106-d; T106-d-1) - Cold treatment (T107-d; T107-h; T107-j) - Hot water immersion (T102-d; T102-d-1) - High temperature forced air (T103-b-1) - Fumigation (MB) at NAP—tarpaulin or chamber (T101-c-1; T103-b-1) - Fumigation plus Cold treatment (T108-a; T108-a-1; T108-a-2; T108-a-3; T108-b; T109-d-1) *Irradiation* Irradiation consists of exposing the commodity to gamma-emitting isotopes such as Cobalt-60 or Cesium-137 or to electron beams (beta rays) produced by linear accelerators to sterilize organisms that may contaminate commodities. Currently, the only approved treatment by the USDA/APHIS is irradiation. Irradiation, applied at an APHIS-approved facility, is possible for all commodities from all countries, and it is listed in the APHIS treatment manual for all fruit flies as T-105-a-1 with 150 Gray (minimum absorbed dose). Irradiation is an approved quarantine treatment for *Ceratitis capitata* and *Sternochetus mangiferae*. It may be effective against *Bactrocera invadens*, but research is required to demonstrate its efficacy (Mehdizadegan, 2006). In the EU, fruits may be irradiated (see Official journal of the European Union, Commission Decision of 2009/C 283/02 of 24 of November 2009) but this should be in an approved irridiation facility so irradiation is not a feasible measure (see Commission Decision of 7 October 2004). As irradiation only sterilizes insects and does not kill them, presence of these living insects remain a concern for some countries. *Vapor-Heat treatment* Vapor Heat Treatment (VHT) is also referred to as high humidity air heating. This process involves heating air that is nearly saturated with moisture and passing the air stream across the fruit. When the temperature of the mango fruit is at or below the dew point, condensation of atmospheric moisture occurs on the surface of the fruit. In this way, fruit are heated by conductive energy transfer. The heat from the fruit surface is transferred toward the fruit centre (Jordan, 1993). Commercial facilities operate in Okinawa, the Philippines, Thailand, the United States and Australia, and protocols are being used for mangoes (Sunagawa *et al*., 1987; Merino *et al.*, 1985; Unahawutti et al., 1986; Armstrong, 1996 and Heather). The VHT disinfestation protocols accepted for mango access to the high-value markets in Japan include:

46°C fruit core temperature held for 10 min for Philippine 'Carabao' mango; 46.5°C fruit core temperature held for 30 min for Taiwanese 'Irwin' and 'Haden' mangoes; 46.5°C fruit core temperature held for 10 min for Thailand 'Nang Klang Wun' mangoes and 47°C fruit core temperature held for 10 min for 'Nam Doc Mai', 'Pimsen Dang' and 'Rad' mangoes. The protocol accepted by the Japanese authorities for entry of Australian 'Kensington' mangoes into Japan is a fruit core temperature of 47°C held for 15 min (Heather *et al.*, 1997). Mexican 'Manila' mangoes are allowed entry into the USA with a 43.3°C 6 h treatment (Anonymous, 1994; Kitigawa, 1994 and Johnson and Heather, 1995). It is unknown whether such facilities could treat the fruits to be exported from Africa.

Cold treatment
Cold treatment involves maintaining fruits near freezing conditions for an extended period.
The response of *B. invadens* to cold treatment is not expected to differ greatly from other *Bactrocera* spp. The phytosanitary treatments for fruit flies, especially cold treatments, are being subject to a conscientious revision by experts and NPPOs in order to determine their efficacy at specimen level (see ISPM No. 28 *Phytosanitary Treatments for Regulated Pests*). The EWG considered that this treatment is not applicable to tropical fruits as it destroys them, but could be used for Citrus fruits and pome fruits. This measure alone could be efficient in areas of low prevalence of the pest.

Hot water
Hot water treatment consists of submerging the fruit in circulating water for an extended period of time. For mangoes, a specific treatment for *Ceratitis capitata* requires the fruit be submerged at least 10 cm below the water surface at 46°C for 65 to 110 minutes (USDA, 2008). Treatments with hot water have been reported to give a good control of *B. dorsalis* on mangoes (Verghese *et al*., 2004). In Burkina, experiments were carried out during the mango season 2008 in terminal fruitier of Bobo, and showed promising results to be confirmed through new experiments (article in preparation, Vayssières, pers. com., 2009).

Hot air
Hot air treatments involve enclosing mangoes in a chamber and then introducing air heated to 50°C into the chamber (USDA, 2008). This technique is used in Mexico on mango infested with *Anastrepha* spp. (Jacobi et al., 2001). Research is required to show efficacy on *B. invadens*.

		Fumigation This measure is possible although not allowed in some EU countries, e.g. the EU prohibited Methyl bromide in March 2010. Substitutes for this substance are still under study. The most promising methods for the time being appear for mango to be irradiation, hot water treatment and vapor heat treatment.
3.17 Does the pest occur only on certain parts of the plant or plant products (e.g. bark, flowers), which can be removed without reducing the value of the consignment? (This question is not relevant for pest plants)	no	
3.18 Can infestation of the consignment be reliably prevented by handling and packing methods?	yes in combination possible measure in combination: specific handling/packing methods	After harvest, inspection of fruits before packing and sorting can reduce the infested mangoes in consignment (USDA, 2006b), but this does not provide any guaranty of absence of quarantine pests.
3.19 Could consignments that may be infested be accepted without risk for certain end uses, limited distribution in the PRA area, or limited periods of entry, and can such limitations be applied in practice?	No	The Northern EPPO region could accept consignments without risk, especially in winter. Note that because there is free movement of consignments within the EU, there are no guaranties that the infested fruits would not be sent to the endangered area. That limitation does not apply to the Northern non EU countries.
3.20 Can infestation of the commodity be reliably prevented by treatment of the crop?	yes in combination	A whole Integrated Pest Management has been developed in various African countries: see Ekesi and Billah, 2009 and Vayssières *et al*., 2008 & 2009, which comprises: - fruit fly monitoring around the production site - sanitation - male annihilation techniques - biocontrol (3 different agents) - ploughing

		- agronomic practices - cultural practices, removal of reservoir hosts - bait station Bagging is not applicable in most cases for the moment as it is time consuming and expensive, and could only be used on high value crops and trees of moderate size. However, the use of these techniques alone cannot guaranty a total absence of infestations.
3.21 Can infestation of the commodity be reliably prevented by growing resistant cultivars? (This question is not relevant for pest plants)	no	Some mango varieties might be less susceptible to infestations, but further research is needed to confirm this statement. Even if these varieties are less susceptible, they are not resistant.
3.22 Can infestation of the commodity be reliably prevented by growing the crop in specified conditions (e.g. protected conditions such as screened greenhouses, physical isolation, sterilized growing medium, exclusion of running water, etc.)?	no	The fruit could be grown in a pest exclusionary structure but it is not an affordable measure.
3.23 Can infestation of the commodity be reliably prevented by harvesting only at certain times of the year, at specific crop ages or growth stages?	yes in combination possible measure in combination: specified age of plant, growth stage or time of year of harvest	In Côte d'Ivoire, Senegal, Mali, Burkina Faso, Togo, and Benin some producers harvest mangoes at an early stage in order to avoid massive infestation linked to a more advanced maturity stage of the fruit (C Guichard, pers. com., 2009). In these countries, the exporting season for mango stops when the rainy season starts because outbreaks of *B. invadens* occur during the rainy season.
3.24 Can infestation of the commodity be reliably prevented by production in a certification scheme (i.e. official scheme for the production of healthy plants for planting)?	no	

3.25 Has the pest a very low capacity for natural spread?	no	
3.26 Has the pest a low to medium capacity for natural spread?	no	
3.27 The pest has a medium to high capacity for natural spread	yes Possible measure: pest-free area.	*Bactrocera* species can be attracted to Methyl Eugenol up to 0.8 km away from likely hosts (White and Elson-Harris, 1994) which suggests that *B. invadens* would be able to fly at least between adjacent fruit crops. *B. zonata* is able to fly distances around 40 km (Qureshi *et al*., 1975). The possibility of flying of *B. invadens* is supposed to be higher than the ones of *Ceratitis cosyra* and *C. capitata* in Africa (JF Vayssières, pers. com., 2009).
3.28 Can pest freedom of the crop, place of production or an area be reliably guaranteed?	yes	Pest freedom of an area and pest free place of production with a buffer zone are considered feasible in areas where the pest is present in low prevalence. Distinction should be made between 2 situations in which *B. invadens* is or not recorded in the larger area. In areas other than of low prevalence, pest free place of production should be combined with post harvest treatment adapted to the imported fruit, in a systems apparoach. Requirements for a pest free area for fruit flies are described in ISPM n°26. <u>Places of low prevalence</u> <u>Pest free place of production</u> According to ISPM n°10, point 2.2.1, the characteristics of *B. invadens* are not totally suitable to ensure an adequate degree of security for the establishment of a free place of production as it can spread over long distances either naturally or through human assistance, it is polyphagous, it has a high rate of reproduction, and it has longevity. The EWG considered that the option of pest free place of production should be considered although the EPPO scheme does not recommend it. Indeed, there are sensitive methods for detection and the management measures do not interfere with detection. The measures required to determine a free place of production are: - absence of any detection in ME traps in places of production and the vicinity during a period to be determined: (*OPTION a*) since the beginning of the last complete cycle of vegetation/ *(OPTION b)* ME traps could be restricted to the seasons when susceptible hosts are present in the place of production and its vicinity.

		- possibility to consider a buffer zone: the size should be adapted to the flying ability of the pest, the potential existence of natural barriers, and the presence of hosts. Such situations could occur in the sub Saharan area, even in Mali. Otherwise, the setting of a buffer zone is not considered feasible due to the flying ability of the pest over long distances, and its polyphagy. - monitoring of traps should be done on a weekly basis to be done under the authority of the NPPO. - sanitation with the removal of fallen fruits should be mandatory. - in addition, examination of no sign of the pest is observed on the fruits before harvest at the place of production should take place under the authority of the NPPO. Places other than of low prevalence Pest free place of production part of a systems appraoch The same measures of pest free place of production apply, as decribed above, but these should be combined with appropriate post harvest treatment, depending on the fruits. For *Citrus* spp. and pome fruits, cold treatment could be used.
3.29 Are there effective measures that could be taken in the importing country (surveillance, eradication) to prevent establishment and/or economic or other impacts?	yes Possible measures: internal surveillance and/or eradication campaign	Trapping is a particularly important method for the early detection of outbreaks and should be used as a component of the early warning systems within the PRA area. ME traps could be used for monitoring the presence of this invasive pest. Many countries that are free of *Bactrocera* spp., e.g. certain states of the USA and New Zealand, maintain a grid of ME traps, at least in ports and airports (CABI, 2007). In case of any detection, attempts at eradication should be immediately implemented. However, these measure would not guaranty the prevention of establishment of the pest and given the enormous areas of orchards at risk would be prohibitively expensive of resources.
3.31 Does each of the individual measures identified reduce the risk to an acceptable level?	no	
3.32 For those measures that do not reduce the risk to an acceptable level, can two or more measures be combined to reduce the risk to an acceptable level?	yes	The following measures reduce the risk to an acceptable on their own: - pest free area - pest free place of production in areas of low prevalence - appropriate post-harvest treatment (e.g. cold treatment for *Citrus* spp. and pome fruits) in areas of low prevalence

		- systems approach in areas other than of low prevalence (comination of pest free place of production and adequate post-harvest treatment).
3.32b List the combination of measures		As described by USDA (2006b): For areas other than of low prevalence: **Systems Approach, ISPM no. 14.** A systems approach requires two or more measures that are independent of each other, and may include any number of measures that are dependent from each other. Measures can be applied pre and post harvest wherever the NPPO can oversee and ensure compliance. Suggested measures against the fruit flies of concern are: These measures are considered much more effective in a area wide approach of pest management. *Pre-harvest:* Integrated Pest Management measures (see Q. 3.20) Bagging of fruits when feasible *Harvest:* Harvest at earliest possible maturity level *Post-harvest:* Inspection of fruits before packing and sorting out injured fruits and proper disposal of waste Cold tretament for *Citrus* spp. and pome fruits, or adequate treatment of the commodity (see Q. 3.16). *Surveillance in the importing country* Visual inspection at ports of entry Trapping should be employed in the endangered area and attempts at eradication in case of detection.
3.34 Estimate to what extent the measures (or combination of measures) being considered interfere with international trade.		The option “pest free areas” will have a large effect on international trade since this option prohibits trade from areas where the pest is present. Pest free place of production and the systems approach are less restrictive.

3.35 Estimate to what extent the measures (or combination of measures) being considered are cost-effective, or have undesirable social or environmental consequences.		Similar requirements are implemented in EPPO countries for exports to third countries because of *Ceratitis capitata,* and for imported fruits that might be attacked by *Bactrocera* spp. (e.g. Australian exportats to Reunion Island). Pest free areas This option would affect imports from areas where the pest occurs, particularly Africa. Major exporters for the major hosts are mainly situated in Latin America, and importers in the EPPO region could find alternative sources there to replace African exporters. Nevertheless, imports of fruits from other countries more distant than Africa could increase carbon emissions for transport, but considering the high costs of monitoring and management of fruit flies on a territory, this measure remains cost effective for the EPPO countries. Additionally, most EPPO countries are committed to achieve the United Nations Millennium Development Goals, and this measure could affect the effectiveness of the economic development of these countries. In areas of low prevalence Pest free place of production This measure is difficult to implement. The management and maintenance of a buffer zone might increase the price of the fruits. There are few expected social or environmental consequences in EPPO countries, but it depends on the number of places of production that can be effectively implemented. A few number of possible places of production would have similar consequences as a pest free area. Systems approach The management at the place of production and post harvest quarantine treatment might increase the price of the fruits. Fumigation would have negtiva impacts on the environment.
3.36 Have measures (or combination of measures) been identified that reduce the risk for this pathway, and do not unduly interfere with international trade, are cost-effective and have no undesirable social or environmental consequences?	yes	- Pest free area - Pest free place of production in areas of low prevalence - Adequate post-harvest treatment (e.g. cold treatment for *Citrus* spp. or pome fruits) in areas of low prevalence - Systems approach in areas other than of low prevalence (pre-harvest, harvest and post-harvest quarantine measures)

3.2a Pathway :		**Plants for planting with growing medium attached (except seeds)**
3.2 Is the pathway that is being considered a commodity of plants and plant products?	yes	
3.12 Are there any existing phytosanitary measures applied on the pathway that could prevent the introduction of the pest? (if yes, specify the measures in the box notes)	no	Most EPPO countries have general regulations against non-European *Tephritidae*, but specific phytosanitary measures against *B. invadens* do not exist. As an example, the EU takes a common set of measures against non-European *Tephritidae* (i.e. Council Directive 2000/29/EC) (see question 1.14 for more details).
3.13 Can the pest be reliably detected by a visual inspection of a consignment at the time of export, during transport/storage or at import?	no	The pupae could be hidden in the growing media.
3.14 Can the pest be reliably detected by testing (e.g. for pest plant, seeds in a consignment)?	no	
3.15 Can the pest be reliably detected during post-entry quarantine?	yes possible measure: import under special licence/permit and post-entry quarantine.	*B. invadens* is attracted to the ME traps, and it is very likely that the pest would be trapped if present in the consignment. On an artifial diet, Ekesi *et al*. (2006) report puparia-adult development of *B. invadens* takes 12.4 days at 28°C (+-1). Plants for planting with roots are shipped, they are rarely exported by air planes. They are assumed to be shipped at lower temperatures, but no information could be found on this point. The transport would have lasted between 5 to 13 days according to the countries of export and import (see question 1.8). The quarantine period will depend upon the temperature during transport and in the quarantine area, but shall last at least 10 days. There are no evidence for diapause or delayed emergence for *B. invadens*. Nevertheless, such measure might be considered as not practical for the trade of ornamental plants.
3.16 Can the pest be effectively destroyed in the consignment by treatment (chemical, thermal, irradiation, physical)?	No	Phytosanitary treatment on the growing media could kill the pupae, but no expertise was available on this point within the EWG.

3.17 Does the pest occur only on certain parts of the plant or plant products (e.g. bark, flowers), which can be removed without reducing the value of the consignment? (This question is not relevant for pest plants)	Yes	Fruits could be removed from plants for plantings with growing media, 1 month before to avoid larvae to be present in the soil.
3.18 Can infestation of the consignment be reliably prevented by handling and packing methods?	no	
3.19 Could consignments that may be infested be accepted without risk for certain end uses, limited distribution in the PRA area, or limited periods of entry, and can such limitations be applied in practice?	no	The Northern EPPO region could accept consignments without risk, especially in winter. Note that because there is free movement of consignments within the EU, there are no guaranties that the infested plants for planting would not be sent to the endangered area. That limitation does not apply to the Northern non EU countries.
3.20 Can infestation of the commodity be reliably prevented by treatment of the crop?	no	For ornamental plant with fruits, a systemic insecticide could potentially be used to kill the eggs, larvae and pupae, but it is not considered reliable.
3.21 Can infestation of the commodity be reliably prevented by growing resistant cultivars? (This question is not relevant for pest plants)	no	
3.22 Can infestation of the commodity be reliably prevented by growing the crop in specified conditions (e.g. protected conditions such as screened greenhouses, physical isolation, sterilized growing medium, exclusion of running water, etc.)?	Yes	Growing the plants for planting under protection is considered to provide a sufficient prevention. When grown outdoors, even if the consignment is grown according to the EPPO phytosanitary procedure PM 3/54 "Growing plants in growing media prior to export" with inorganic growing media, or treated organic growing media, or inspection of the organic medium, the growing media could be contaminated with pupae from infested fruits.
3.23 Can infestation of the commodity be reliably prevented by harvesting only at certain times of the year, at specific crop ages or growth stages?	yes possible measure: specified age of plant,	If the plant for planting is too young to produce fruit, it does not present any risk of infested soil. This needs to be attested with a certificate. If the plant for planting is exported outside its fruiting season, it does not present any risk of infested soil. This needs to be attested with a certificate. The consignment must be free from fruits, and fruits should have been removed from the plant

	growth stage or time of year of harvest	for planting 1 month before import, this is the time needed for the pupae-adult development. Pupae would have therefore become adults and would have flown away. This needs to be attested with a certificate.
3.24 Can infestation of the commodity be reliably prevented by production in a certification scheme (i.e. official scheme for the production of healthy plants for planting)?	no	
3.25 Has the pest a very low capacity for natural spread?	no	
3.26 Has the pest a low to medium capacity for natural spread?	no	
3.27 The pest has a medium to high capacity for natural spread	yes Possible measure: pest-free area.	
3.28 Can pest freedom of the crop, place of production or an area be reliably guaranteed?	yes	Pest freedom of an area and free place of production with a buffer zone are considered feasible. Distinction should be made between 2 situations in which *B. invadens* is or not recorded in the larger area. Requirements for a pest free area for fruit flies are described in ISPM n°26. <u>Pest free place of production</u> According to ISPM n°10, point 2.2.1, the characteristics of *B. invadens* are not totally suitable to ensure an adequate degree of security for the establishment of a free place of production as it can spread over long distances either naturally or through human assistance, it is polyphagous, it has a high rate of reproduction, and it has longevity. The EWG considered that the option of pest free place of production should be considered although the EPPO scheme does not recommend it. Indeed, there are sensitive methods for detection and the management measures do not interfere with detection. Areas with climatic conditions which do not favor the reproduction of the fly would be preferable to set a pest free place of production.

		The measures required to determine a free place of production are: - absence of any detection in ME traps in places of production and the vicinity during a period to be determined: (*OPTION a*) since the beginning of the last complete cycle of vegetation/ *(OPTION b)* ME traps could be restricted the to seasons when susceptible hosts are present in the place of production and its vicinity. - possibility to consider a buffer zone: the size should be adapted to the flying ability of the pest, the potential existence of natural barriers, and the presence of hosts. Such situations could occur in the sub Saharan area, even in Mali. Otherwise, the setting of a buffer zone is not considered feasible due to the flying ability of the pest over long distances, and its polyphagy. - monitoring of traps should be done on a weekly basis to be done under the authority of the NPPO. - sanitation with the removal of fallen fruits should be mandatory. - in addition, examination of no sign of the pest is observed on the fruits before harvest at the place of production should take place under the authority of the NPPO. <u>Places of low prevalence</u> In this case, the same requirement apply, but rather than having a total absence of the pest, a threshold of captures of the pest in traps need to be established and a system approach may be required.
3.29 Are there effective measures that could be taken in the importing country (surveillance, eradication) to prevent establishment and/or economic or other impacts?	yes Possible measures: internal surveillance and/or eradication campaign	Trapping is a particularly important method for the early detection of outbreaks and should be used as a component of the early warning systems within the PRA area. ME traps could be used for monitoring the presence of this invasive pest. Many countries that are free of *Bactrocera* spp., e.g. certain states of the USA and New Zealand, maintain a grid of ME traps, at least in ports and airports (CABI, 2007). In case of any detection, attempts at eradication should be immediately implemented. However, these measure would not guaranty the prevention of establishment of the pest.
3.31 Does each of the individual measures identified reduce the risk to an acceptable level?	yes	- Import with post entry quarantine with ME traps. - Age of plants if it is too young to give fruits, if it is not a fruiting season, or if the fruits have been removed 1 month prior export, attested by a certificate.

		- Removal of fruits 1 month prior export, attested by a certificate. - Protected cultivation - Pest free place of production - Pest free area
3.34 Estimate to what extent the measures (or combination of measures) being considered interfere with international trade.		The option “pest free areas” will have a large effect on international trade since this option prohibits trade from areas where the pest is present. Age of the plant and period of introduction as well as removal of fruits on the plant for planting to export may interfere with trade.
3.35 Estimate to what extent the measures (or combination of measures) being considered are cost-effective, or have undesirable social or environmental consequences.		<u>Pest free areas</u> See answer Pathway 1. <u>Post entry quarantine</u> This option is the less cost effective for the importer as it implies that importing nurseries will have to invest in a quarantine area. <u>Pest free place of production</u> This measure is difficult to implement and costly. The management and maintenance of a buffer zone might increase the price of the fruits. There are few expected social or environmental consequences in EPPO countries, but it depends on the number of places of production that can be effectively implemented. A few number of possible places of production would have similar consequences as a pest free area. <u>Age of the plant, period of introduction and removal of fruits on the plant for planting prior to export</u> Removal of fruits 1 month prior export, attested by a certificate. Protected cultivation These options is very cost effective and has no social or environmental impact.
3.36 Have measures (or combination of measures) been identified that reduce the risk for this pathway, and do not unduly interfere with international trade, are cost-effective and have	yes	- Age of the plant and period of introduction attested through a certificate, and removal of fruits on the plant for planting attested through a certificate prior export - Removal of fruits 1 month prior export, attested by a certificate. - Protected cultivation - Post-entry quarantine with ME traps (see comment in Q 3.35)

no undesirable social or environmental consequences?		- pest free place of production - Systems approach in areas other than of low prevalence (pest free place of production combined with age the plant, ior removal of fruits 1 month prior export, or protection cultivation). - Pest free area

3.2a Pathway :		**Fruits carried by passengers**
3.2 Is the pathway that is being considered a commodity of plants and plant products?	yes	
3.3 Is the pathway that is being considered the natural spread of the pest? The answer to question 1.30 is : The pest is to spread rapidly in the PRA area by natural means.	no	
3.9 Is the pathway that is being considered the entry with human travellers?	yes	
3.29 Are there effective measures that could be taken in the importing country (surveillance, eradication) to prevent establishment and/or economic or other impacts?	no	Populations could establish anywhere in private gardens or in cities and it is impossible to conduct surveys throughout the whole PRA area.
3.31 Does each of the individual measures identified reduce the risk to an acceptable level?	yes	- Inspection of human travelers, their luggage - Publicity to enhance awareness - fines or incentives
3.34 Estimate to what extent the measures (or combination of measures) being considered interfere with international trade.		The measures do not interfere with trade.
3.35		Inspection of luggage and requirement of a Phytosanitary certificate will imply more resources

Estimate to what extent the measures (or combination of measures) being considered are cost-effective, or have undesirable social or environmental consequences.		to be made available for inspection. This has a cost for importing countries. These measures are likely to be politically unacceptable. Nevertheless, these measures have beneficial effects in raising awareness on the dangers of bringing fruits from an area to another and to prevent the entry of other potential invasive species.
3.36 Have measures (or combination of measures) been identified that reduce the risk for this pathway, and do not unduly interfere with international trade, are cost-effective and have no undesirable social or environmental consequences?	yes	Possible measures are: - the requirement of a phytosanitary certificate for passengers traveling with fruits - publicity to enhance public awareness on pest risks. - fines and incentives
3.41 **Consider the relative importance of the pathways identified in the conclusion to the entry section of the pest risk assessment**		Fruits of major hosts : high risk, uncertainty is low Fruits of minor hosts moderate risk, uncertainty is low Passengers carrying fruits: moderate risk, uncertainty is medium Plants for planting with growing media (except seeds) low risk, uncertainty is high
Conclusion of Pest Risk Management. Summarize the conclusions of the Pest Risk Management stage. List all potential management options and indicate their effectiveness. Uncertainties should be identified.		**Fruits of major hosts: high risk, uncertainty is low** Pest free area Or Adequate post-harvest treatment (e.g. cold treatment for Citrus spp. or pome fruits) (see Q 3.16). Or Pest free place of production (including absence of detection in traps, possibility to include a buffer zone) in areas of low prevalence. Or Systems Approach (with pre-harvest, harvest, and adequate post harvest measures, e.g. cold treatment for *Citrus* spp. or pome fruits, as well as visual inspection at import and monitoring in the importing country) in areas others than of low prevalence. **Fruits of minor host: moderate risk, uncertainty is low**

		Pest free area Or Adequate post-harvest treatment (e.g. cold treatment for Citrus spp. or pome fruits) (see Q 3.16). Or Pest free place of production (including absence of detection in traps, possibility to include a buffer zone) in areas of low prevalence. Or Systems Approach with pre-harvest, and adequate harvest post harvest measures, as well as visual inspection at import and monitorign in the importing country) in areas others than of low prevalence. **Passengers carrying fruits: moderate risk, uncertainty is medium** The requirement of a phytosanitary certificate for passengers traveling with host plants Or Prohibition on the carriage of living host plants. Or Publicity to enhance public awareness on pest risks. Or Fines and incentives **Plants for planting with growing media (except seeds): low risk, uncertainty is high** Pest free area Or Pest free place of production (including absence of detection in traps, possibility to include a buffer zone) Or Or Removal of fruits 1 month priori to export, attested by a certificate Or Age of plants if it is too young to give fruits, if it is not a fruiting season, or if the fruits have been removed 1 month prior export, attested by a certificate. Or Protected cultivation Or

		Post-entry quarantine with ME traps (see comment in Q 3.35)

Appendix 1

Recorded hosts of *Bactrocera invadens*

Major and minor recorded hosts of *Bactrocera invadens* are listed below.
Legend:
+ : an accidental host, only one or a few records. Usually with low infestation rate
++: a host that is used more regular but often with very low infestation rate (as we observed in avocado or in most Citrus for example). Also sometimes host for which we only have a few positive rearing but then with considerable numbers of flies emerging
+++: a regular host that is usually relatively highly infested
++++: major host. Large proportion of the samples is infested, number of flies emerging is often very high.

The following species are considered **major hosts** because in at least one area they have been recorded either as:
- a regular host that is usually relatively highly infested
- a major host for which a large proportion of the samples is infested, number of flies emerging is often very high.

Species	Family	Common name	Reference(s)	Region E : East W : West	Information*	Use
Annona muricata	Annonaceae	Sour sop	Vayssières *et al.*, 2009 ; Ekesi *et al*., 2006; Mwatawala *et al.*, 2006; Rwomushana *et al*., 2008; Mwatawala *et al.*, 2009	E&W	++ in N Benin, +++ in S Benin ++ in Tz + in Kenya	Ornament, RHS plant finder, 2004
Carica papaya	Caricaceae	papaya	Drew *et al*., 2005; Vayssières *et al.*, 2005 ; Vayssières *et al*., 2009	W	+++ in S Benin + in Tz (unpubl data)	Crop, Eurostat; Ornament, RHS plant finder, 2004
Chrysophyllum albidum	Sapotaceae	African or white star apple	Vayssières et al., 2005; Vayssières et al., 2009	W	+++ in N&S Benin	/
Citrus x paradisi	Rutaceae	grapefruit	Vayssières *et al*., 2009; Mwatawala *et al*., 2006; Mwatawala *et al.*, 2009	E&W	+ in N Benin ++/+++ in tz	Crop, Eurostat; Ornament, RHS plant finder, 2004
Citrus reticulata	Rutaceae	Mandarin, tangerine	Vayssières *et al.*, 2005; Vayssières *et al*., 2009; Mwatawala *et al*., 2006; Rwomushana *et al*., 2008;Mwatawala *et al*., 2009	E&W	+ in N Benin, +++ in S Benin ++ in Tz ++ in Kenya	Crop, Eurostat; Ornament, RHS plant finder, 2004
Citrus sinensis	Rutaceae	sweet orange	Vayssières *et al*., 2005; Vayssières *et al*., 2009; Mwatawala *et al*., 2006; Rwomushana *et al*., 2008; Mwatawala *et al*., 2009	E&W	++ in N Benin, +++ in S Benin ++ in Tz ++ in Kenya	Ornament, RHS plant finder, 2004
Citrus x tangelo	Rutaceae	tangelo	Vayssières et al., 2009;	W	++++ in S Benin	Crop, Eurostat; Ornament, RHS plant finder, 2004

Diospyros montana	Ebenaceae	mountain persimmon	Vayssières *et al*., 2005; Vayssières *et al*., 2009	W	+++ in S Benin	/
Eriobotrya japonica	Rosaceae	loquat	Mwatawala *et al*., 2006; Mwatawala *et al*., 2009	E	++++ in Tz	Ornament, RHS plant finder, 2004
Fortunella japonica	Rutaceae	kumquat	JY Rey, pers. com., 2009 in Senegal	W	++++ in Senegal	
Fortunella margarita	Rutaceae	kumquat	Mwatawala *et al*., 2009 JY Rey, pers. com., 2009 in Senegal	E&W	+++ in Tz ++++ in Senegal	Ornament, RHS plant finder, 2004
Irvingia gabonensis	Irvingiaceae	African wild mango	Vayssières *et al*., 2009	W	+++ in N Benin, ++++ in S Benin	/
Mangifera indica	Anacardiaceae	mango	Drew *et al*., 2005; Vayssières *et al*., 2005; Vayssières *et al*., 2009 ; Rwomushana *et al*., 2008; Mwatawala *et al*., 2009	E&W	++++ in N & S Benin ++++ in Tz ++++ in Kenya	PPP index
Psidium guajava	Myrtaceae	guava	Drew *et al*., 2005; Vayssières *et al*., 2005; Vayssières *et al*., 2009; Ekesi *et al*., 2006; Mwatawala *et al*., 2006; Rwomushana *et al*., 2008; Mwatawala *et al*., 2009	E&W	++++ in N Benin ++++ in Tz +++ in Kenya	Crop, Eurostat; Ornament, RHS plant finder, 2004
Psidium littorale	Myrtaceae	strawberry guava	Mwatawala *et al*., 2009	E	++++ in Tz	Ornament, RHS plant finder, 2004
Spondias cytherea	Anacardiaceae	jew plum	Mwatawala *et al*., 2006; Mwatawala *et al*., 2009	E	+++ in Tz	PPP index
Spondias mombin	Anacardiaceae	tropical plum	Vayssières *et al*., 2009 IITA, unpublished data	W	+++ N Benin	/
Terminalia catappa	Combretaceae	tropical almond	Vayssières *et al*., 2009; Ekesi *et al*., 2006; Rwomushana *et al*., 2008; Mwatawala *et al*., 2009	E&W	++++ in S Benin ++++ in Tz ++++ in Kenya	PPP index
Thevetia peruviana	Apocynaceae	lucky nut	Mwatawala *et al*., 2009	E	+++ in Tz	Ornament, RHS plant finder, 2004
Vitellaria paradoxa	Sapotaceae	sheanut	Vayssières *et al*., 2009	W	++++ in N Benin	/

The following species are considered **minor hosts** as they are recorded either as:
- an incidental host, with only one or a few records. Usually with low infestation rate;
- a host that is used more regularly, but often with very low infestation rate. This can also be a host for which there are only few positive rearings, but with considerable numbers of flies emerging.

Species	Family	Common name	Reference(s)	Region E : East W : West	Information*	Use
Anacardium occidentale	Anacardiaceae	cashew	Vayssières *et al*., 2005; Vayssières *et al*., 2009	W	++ in North Benin + in Tz (unpubl data)	PPP index
Annona cherimola	Annonaceae	cherimoya	Rwomushana *et al*., 2008; Mwatawala et al., 2009 ;	E	++ in Tz +++ in Kenya	Ornament, RHS plant finder, 2004
Annona senegalensis	Annonaceae	Wild custard apple	Vayssières *et al*., 2009	W	+ in N Benin	PPP index
Annona squamosa	Annonaceae	sugar apple	Rwomushana *et al*., 2008	E	+ in Kenya	PPP index
Averrhoa carambola	Oxalidaceae	starfruit	Vayssières *et al*., 2009	W	+ in N Benin, ++ in S Benin + in Tz (unpubl data; single record)	PPP index
Blighia spp.	Sapindaceae		IITA, unpublished data	W	+ in Benin	?
Capsicum annuum	Solanaceae	Sweet pepper	Vayssières *et al.*, 2005	W	- in Tz	Crop, Eurostat; Ornament, RHS plant finder, 2004
Capsicum frutescens	Solanaceae	chili pepper	Vayssières *et al*., 2009	W	+ in N Benin	Ornament, RHS plant finder, 2004
Citrullus lanatus	Cucurbitaceae	watermelon	Mwatawala *et al*., 2006; Mwatawala *et al*., 2009	E	++ in Tz	Crop, Eurostat;
Citrus aurantium	Rutaceae	Sour orange	IITA, unpublished data	W	+ in Benin	PPP index
Citrus grandis	Rutaceae	pomelo	Mwatawala *et al.*, 2009	E	+ in Tz	Crop, Eurostat;
Citrus limon (=C. limonum)	Rutaceae	lemon	Ekesi *et al.*, 2006; Mwatawala *et al.*, 2006; Rwomushana *et al.*, 2008 Mwatawala *et al.*, 2009	E	++ in Tz ++ in Kenya	Crop, Eurostat; Ornament, RHS plant finder, 2004
Coffea arabica	Rubiaceae	arabica coffee		E	+ in Tz (unpubl data)	PPP index
Coffea canephora	Rubiaceae	robusta coffee	Mwatawala *et al*., 2009	E	+ in Tz	PPP index
Cordia sp. cf *myxa*	Boraginaceae	Assyrian plum	Rwomushana *et al*., 2008	E	+ in Kenya	?
Cordyla pinnata	Caesalpiniaceae	Cayor pear tree	Vayssières *et al*., 2009	W	+ in N Benin	/
Cucumis figarei	Cucurbitaceae	hyena's watermelon	Mwatawala *et al*., 2006; Mwatawala *et al*., 2009	E	+ in Tz	/
Cucumis sp nr metuliferus	Cucurbitaceae			E	+ in Tz	?
Cucumis pepo	Cucurbitaceae	gourd	IITA, unpublished data	W	+ in Benin	Crop, Eurostat;

Cucumis sativus	Cucurbitaceae	cucumber	Mwatawala *et al*., 2006; Mwatawala *et al*., 2009	E	+ in Tz	Crop, Eurostat; PPP index
Cucurbita maxima	Cucurbitaceae		IITA, unpublished data	W	+ in Benin	Crop, Eurostat;
Cucurbita spp.	Cucurbitaceae	pumpkin	Mwatawala *et al*., 2009	E	+ in Tz	Crop, Eurostat;
Flacourtia indica	Flacourtiaceae	governor's plum	Mwatawala *et al*., 2006; Mwatawala *et al*., 2009	E	+/++ in Tz	PPP index
Lycopersicon esculentum	Solanaceae	tomato	Vayssières *et al*., 2009; Ekesi *et al*., 2006; Rwomushana *et al*., 2008	E&W	+ in N Benin + in Tz + in Kenya	Crop, Eurostat;
Malus domestica	Rosaceae	apple	Mwatawala *et al*., 2009	E	+ in Tz	Ornament, RHS plant finder, 2004
Manilkara zapota	Sapotaceae	Bully tree	Vayssières *et al*., 2009;	W	++ in S Benin	PPP index
Momordica cf trifoliata	Cucurbitaceae			E	+ in Tz	Ornament, RHS plant finder, 2004
Musa sp. AAA	Musaceae	banana	Vayssières *et al*., 2009; Ekesi *et al*., 2006; Rwomushana *et al*., 2008	E&W	+ in S Benin + in Tz (unpubl data) ++ in Kenya	Ornament, RHS plant finder, 2004
Musa x *paradisiaca*	Musaceae		IITA, unpublished data	W	+ in Benin	Ornament, RHS plant finder, 2004
Persea americana	Lauraceae	avocado	Vayssières *et al*., 2009; Ekesi *et al*., 2006; Mwatawala *et al*., 2006; Mwatawala *et al*., 2009	E&W	+ in S Benin +/++ in Tz	Crop, Eurostat;
Prunus persica	Rosaceae	peach	Mwatawala *et al*., 2006; Mwatawala *et al*., 2009	W&S	+ in Tz	Crop, Eurostat; Ornament, RHS plant finder, 2004
Sarcocephalus latifolius	Rubiaceae	African peach	Vayssières *et al*., 2009;	W	+ in Benin	/
Sclerocarya birrea	Anacardiaceae	marula plum	Ekesi *et al*., 2006; Rwomushana *et al*., 2008; Mwatawala *et al*., 2009; Vayssières *et al*., 2009	E&W	++ in N&S Benin ++ in Tz ++ in Kenya	PPP index
Solanum aethiopicum	Solanaceae	African eggplant	Mwatawala *et al*., 2009	E	+/++ in Tz	/
Solanum anguivi	Solanaceae	African eggplant		E	+ in Tz (unpubl data)	/
Solanum incanum	Solanaceae			E	+ in Tz (unpubl data)	PPP index
Solanum nigrum	Solanaceae	Black nightshade		E	+ in Tz (unpubl data)	PPP index
Solanum sodomeum	Solanaceae	Sodom apple		E	+ in Tz (unpubl data)	/

Sorindeia madagascariensis	Anacardiaceae	sondriry	Rwomushana *et al.*, 2008	E	+ in Kenya	/
Strychnos mellodora	Strychnaceae	monkey orange	NPPO of South Africa	S	Not sure whether actually record from S; could be based on record from Kenya	/
Syzigium cumini	Myrtaceae	jambolan	Mwatawala *et al.*, 2009	E	++ in Tz	
Syzygium jambos	Myrtaceae	rose apple		E	+ in Tz (unpubl data)	Ornament, RHS plant finder, 2004
Sizygium malaccense	Myrtaceae	Malay apple	IITA, unpublished data	W	+ in Benin	PPP index
Syzygium samarangense	Myrtaceae	Java apple	Vayssières *et al.*, 2009	W	+ in S Benin	/
Ziziphus mauritiana		Indian jujube	Vayssières pers. com. 2009		+ in N-Benin	

in North and South Benin, only hosts for which there are quantitative data and repetitions are mentioned in Vayssières *et al*., 2009.
For Kenya, data have been taken from Rwomushana *et al*., 2008

Hosts to be confirmed

Species	**Family**	**Common name**	**Reference(s)**	**Use**
Diospyros kaki	Ebenaceae	Japanese persimmon	IITA, unpublished data	Ornament, RHS plant finder, 2004
Dracaena steudneri	Dracaenaceae		IITA, unpublished data	Ornament, RHS plant finder, 2004
Ficus sycomorus	Moraceae	wild fig	IITA, unpublished data	/
Garcinia mannii	Clusiaceae	chewing stick	IITA, unpublished data	/
Landolphia sp.	Apocynaceae		IITA, unpublished data	/
Mareua duchesnei	Capparaceae		IITA, unpublished data	/

IITA, unpublished data
http://www.africamuseum.be/fruitfly/AfroAsia.htm

NPPO of South Africa
http://www.nda.agric.za/docs/NPPOZA/pest_alert_information.htm

Appendix 2

Production of hosts of *B. invadens* in the EPPO region

1. EPPO region

Total areas in hectares producing fruits and vegetables hosts of *Bactrocera invadens* in the EPPO region and neighbouring countries for 2008.

Country	Producing area in ha in the EPPO region and surrounding countries in 2008
Malus domestica (Apples)	1699828
Persea americana (Avocados)	33208
Musa spp. (Bananas)	88071
Capsicum spp. (Chillies and peppers, green)	309170
Citrus spp.	17192
Cucumis sativus (Cucumbers & gherkins)	402616
Mangifera indica, Garcinia mangostana (Mangoes, mangosteens) & *Psidium guava* (guavas)	135031
Carica papaya (Papayas)	522
Prunus persica (Peaches & nectarines)	491923
Cucurbita spp.& *Cucumis pepo* (Pumpkins, squash & gourds)	233344
Lycopersicon esculentum (Tomatoes)	1700416
Citrullus lanatus (Watermelon)	784872

Source: FAOSTAT
Note: No data for Guernsey, Jersey, Kyrgyzstan and Macedonia were available.

- Detail per country of the production area in hectares of fruits and vegetables hosts of *Bactrocera invadens* in the EPPO region (and neighbouring countries) for 2008.

Country	*Malus domestica* (Apples)	*Persea americana* (Avocados)	*Musa* spp. (Bananas)	*Capsicum* spp.(Chillies and peppers, green)	*Citrus* spp.	*Cucumis sativus* (Cucumbers & gherkins)	*Mangifera indica*, *Garcinia mangostana* (Mangoes, mangosteens) & *Psidium guava* (guavas)	*Carica papaya* (Papayas)	*Prunus persica* (Peaches & nectarines)	*Cucurbita spp.*& *Cucumis pepo* (Pumpkins, squash & gourds)	*Lycopersicon esculentum* (Tomatoes)	*Citrullus lanatus* (Watermelon)
Albania	4500			2100		2200			800	300	6500	7500
Algeria	31904		10	20663	400	4000			15000	10000	30000	43000
Armenia	8500					2339			6100		6257	5446
Austria	6029			170		365			190	367	185	13
Belarus	63840					8003					7602	
Belgium	8500			100		100					500	
Bosnia and Herzegovina	15000	300		3867		3047			1700		3810	2300
Bulgaria	5400			3751		371			6000	260	3474	4749
Croatia	8700			3365		800			1100		1250	1200
Cyprus	1115	106	258	64	42	181			764	162	330	456
Czech Republic	8754			300		1655			948		1202	
Denmark	1486					120				20	50	
Egypt	56865		56508	30000	170	67810	132078		80199	35000	571844	52000
Estonia	4331					300					200	
Finland	668			5		324				43	116	
France	52200	2		583		631			15053	4714	4122	186
Georgia	28000					4000			1600		6500	4000
Germany	31800			41		3086			105	2671	308	
Greece	12000	400	170	3900	100	2100			36900	3900	25000	14200
Hungary	43100			5200		1000			6740	500	2400	9600
Ireland	650					15					30	
Israel	3150	3000	1750	3600	650	1500	880	500	3900	250	5300	8500
Italy	54642		15	11721	1500	2065			86062	16582	115477	11091

Jordan	2291		1633	1924	0	1553			2357	3426	11752	2145
Kazakhstan	25800			4400	50	13800			300		25100	38300
Kyrgyzstan	26400			100	6	3600			1000	150	10200	5000
Latvia	5138					166				74	13	
Lebanon	10100	430	2990	280		3100			3550	1600	4060	1550
Libyan Arab Jamahiriya	480		0	1350		700			1300	2800	10000	15000
Lithuania	11655					1200				20	200	
Luxembourg	1020										1	
Malta	15				90	27			60	70	400	130
Moldova	61069			2413		3181			5641	3928	7008	8204
Montenegro	700			802					700		978	1240
Morocco	26752	1972	5683	7295	1800	1615	3	22	4900	8817	18600	16900
Netherlands	9300			1200		600				200	1500	
Norway	1676					92					36	
Occupied Palestinian Territory	260	13	270	600	190	3700	220		260	3000	2500	360
Poland	171963					19960			3176	1547	14640	
Portugal	20600	11500	1350	220		350			5900	700	13000	350
Romania	54704			20162		12986			1610	5278	51460	25930
Russian Federation	243000					73000			6500	53000	147700	133000
Serbia	36000			18827		8755			10000		20309	15976
Slovakia	3426			2067		2191			710	1744	2939	334
Slovenia	2874			183		115			513		187	
Spain	36000	15070	10073	21900	5000	7000			76966	7700	55300	16100
Sweden	1400					300					50	
Switzerland	4195			18		87			13	331	226	
Syrian Arab Republic	32320		35	2900	0	11351			6660	10500	15240	33531
Tajikistan	48000					3000			13000		13400	11570
The former Yugoslav Republic of Macedonia	15000			8199		1392			1300		5319	6211
Tunisia	28000	25		21000	7000	1700			16800	5600	26000	19600
Turkey	158400	230	4326	88000	94	59000			41446	22000	300000	139000
Turkmenistan	18000					2100			9000		14800	21000
Ukraine	113500			15100		49600			6700	26000	80800	67500
United Kingdom	15516			100		103					216	

Uzbekistan	63000			700	100	10000			8400		54000	41700
Total	**1699828**	**33208**	**88071**	**309170**	**17192**	**402616**	**135031**	**522**	**491923**	**233344**	**1700416**	**784872**

Source: FAOSTAT
No data for Guernsey, Jersey, Kyrgyzstan and Macedonia were available.

2. Summary results of the EU-27 orchard survey

Within the European Union, a recent survey on orchard provides the cultivated areas in ha for different fruits species.
Source: Ollier C, Cardoso F, Dinu M (2009) Summary results of the EU-27 orchard survey. Eurostat, European Commission. 7 p.
http://www.eds-destatis.de/de/downloads/sif/sf_09_041.pdf

Table 1: Area under the seven species of fruit trees, 2007, hectares

	Total	Table Apple	Table Pear	Peach	Apricot	Orange	Lemon	Small citrus fruit
EU-27	1,365,096	485,100	112,258	206,957	67,369	279,048	62,855	151,509
EU-15	1,028,745	200,644	95,772	189,943	52,958	277,494	62,190	149,744
NMS-12	336,351	284,456	16,487	17,015	14,410	1,554	666	1,765
Belgium	14,058	6,833	7,225	-	-	-	-	-
Bulgaria	10,518	4,121	298	3,488	2,610	-	-	-
Czech Republic	13,548	9,895	716	1,149	1,788	-	-	-
Denmark	1,886	1,486	401	-	-	-	-	-
Germany	29,469	27,888	1,581	-	-	-	-	-
Estonia	690	690	-	-	-	-	-	-
Ireland	150	150	-	-	-	-	-	-
Greece	94,771	9,337	3,127	34,127	3,929	32,440	5,180	6,632
Spain	459,524	24,822	25,976	75,118	18,700	158,824	39,859	116,225
France	76,638	40,113	6,707	14,308	13,804	29	23	1,654
Italy	279,120	55,225	32,075	63,754	15,649	73,786	16,634	21,998
Cyprus	5,937	925	146	614	268	1,554	666	1,765
Latvia	1,557	1,300	258	-	-	-	-	-
Lithuania	2,459	2,428	32	-	-	-	-	-
Luxembourg	39	30	9	-	-	-	-	-
Hungary	47,183	33,793	2,812	5,578	4,999	-	-	-
Malta	215	-	-	215	-	-	-	-
Netherlands	16,662	9,380	7,282	-	-	-	-	-
Austria	8,541	7,229	506	211	594	-	-	-
Poland	176,730	165,715	7,048	2,907	1,060	-	-	-
Portugal	39,792	11,711	9,228	2,424	283	12,416	494	3,235
Romania	70,659	60,494	4,834	1,897	3,434	-	-	-
Slovenia	3,089	2,438	196	431	23	-	-	-
Slovakia	3,765	2,656	148	734	227	-	-	-
Finland	437	437	-	-	-	-	-	-
Sweden	1,313	1,194	119	-	-	-	-	-
United Kingdom	6,346	4,810	1,536	-	-	-	-	-

Appendix 3

Imports within the EU of commodities that might be contaminated by *B. invadens* from the Africa/Carrabean/Pacific (ACP) area to the European Union- Data provided by the COLEACP from EUROSTAT

RECAPITULATIF DES IMPORTATIONS U.E. à 27 en 2008 DE FRUITS ET LEGUMES D'ORIGINES ACP, en tonnes

	Tonnes	ANANAS	AVOCATS	BANANES incl.Plantains	MANGUES GOYAVES	LITCHI TAM/F.PAS.	NOIX DE COCO	MELONS	PAPAYES	AUTRES FRUITS	ORANGES	PAMPLEMOUSSES ET POMELOS	AUTRES AGRUMES	ALLIACEES	HARICOTS VERTS	POIS MANGETOUT	TOMATES	*AUTRES LEGUMES	TOTAL Fr&L 2008
1	Côte d'Ivoire	58 902		216 583	11 250	1	10 202		3 574	1 046					4	1		923	302 486
2	Cameroun	9 924	9	279 540	225	11	3		20	92			12					1 321	291 157
3	République Dominicaine	247	3 558	170 506	4 307	13	5 850	1 284	100	158	837	1	929		736	2	127	6 572	195 227
4	Ghana	35 601	2	46 233	1 096	95	250	1	1 061	527	1 232			12	2			22 020	108 134
5	Bélize			82 149							328								82 477
6	Kenya	14	11 841	7	39	838		1	51	291				434	38 308	12 809		9 431	74 055
7	Surinam		1	65 815	9	1	6	3		14		1	7	3	87			1 421	67 368
8	Sainte Lucie		5	38 579	6	22	1		280	11								182	39 086
9	Madagascar				12	26 295	7		1	33			3	1 639	54	52		43	28 139
10	Sénégal	26			6 304	2	119	2 571		29			1	25	5 448		8 731	3 060	26 316
11	Swaziland		530								14 878	9 239	842	1				84	25 574
12	Zimbabwe		128		2	862			6	1	16 582	1 319	112	10	123	1 373		545	21 063
13	Namibie									16 308								85	16 393
14	Dominique		84	10 445	5		23		2		65	131	11					932	11 698
15	Saint Vincent			8 978								3						385	9 366
16	Mali				4 902								1					944	5 847
17	Ouganda	383	71	1 559	8	41			141	23					11			2 238	4 525
18	Burkina Faso	12		21	2 385					28					1 149			457	4 052
19	Ethiopie									98				91	3 396	17		16	3 618
20	Zambie					3									290	2 087		1 140	3 520
21	Jamaïque		6	42	240	54			100		622		306		1	1		1 890	3 264
22	Mozambique									2 146					112	19		915	3 192
23	Tanzanie	4								2 067					607	16		1	2 695
24	Togo	843			6		12			16								1 253	2 130
25	Bénin	1 851							3	91								4	1 949
26	Gambie				696					14					106			200	1 016
27	Maurice	807				183			7	9		8	7					67	888
28	Guinée	200			544					31								2	777
29	Nigeria			1					1	425					81			95	603
30	Rép.Dém. du Congo									6								469	475
31	Niger																	460	460
32	Antigua & Barbuda								1	73	351								425
33	Malawi									381									381
34	Tonga																	324	324
35	Guinée-Bissau				20					74								64	158
36	Burundi	1	9	37	3	11				1								60	122
37	République du Congo									17								66	83
38	Soudan											*			71			12	83
39	Rwanda			30		4									31			17	82
40	La Barbade			6					28									36	70
41	Grenade				6													56	62
42	Bahamas											42							42
43	Sierra Leone					2				25									27
44	Haïti				9								3					2	14
45	Gabon									9								1	10
46	Iles Marshall					7													7
47	Mauritanie				3	1													4
48	Tuvalu																	4	4
49	Trinidad &Tobago								1										1
50	Somalie			1															1
51	Rép.Centrafricaine				1														1
	TOTAL ACP	108 615	16 244	920 532	32 080	28 446	16 473	3 860	5 377	24 044	34 895	10 744	2 236	2 215	50 617	16 368	8 858	57 847	1 339 451
	Afrique du Sud	1 296	50 451	0	1 779	4 614	1	1 944	33	513 347	434 147	83 310	132 684	13 233	7	33	0	11 447	1 248 326
	Extra-UE-27	918 885	175 459	4 927 348	228 864	43 855	32 576	347 371	35 940	3 683 258	1 005 796	418 018	852 111	475 484	196 534	26 629	472 337	1 810 212	15 650 679
	Extra-UE-15	919 542	175 121	4 797 856	228 303	43 709	32 208	344 110	35 926	3 748 805	957 273	359 089	1 100 764	488 719	196 735	27 659	384 953	1 921 044	15 671 816

* Chiffres incluant la rubrique 0714 (racines et tubercules)

(Source : Eurostat - Elaboration : COLEACP / Septembre 2009)

Les "Autres fruits" comprennent : les noix (code 0802), les dattes et les figues (codes 08041 et 08042), les raisins (codes 0806), les pommes et poires (code 0808), les fruits à noyaux (0809) et d'autres fruits tels que : fraises, framboises, autres baies, kiwis, fruits de la passion (code 0810 sauf litchis 08109030).

Les "Autres légumes" comprennent : les pommes de terre primeurs, les choux, les laitues, les carottes & autres légumes racines, les concombres et autres légumes frais ou réfrigérés : c'est à dire les codes 0701 à 0709 sauf les haricots et pois (code 0708), les alliacées (codes 0703) et les tomates (code 0702).

Frequency of imports within the EU of commodities that might be contaminated by *B. invadens* from countries where the species occurs

Data on imports of ornamental plants within the European Union has been gathered from the Eurostat website (http://epp.eurostat.ec.europa.eu/portal/page/portal/external_trade/data/database).
Data is available in "External trade, detailed data", "EU trade since 1995 by CN8", all the countries where *B. invadens* is present have been selected as trading partners, and the following commodities were selected:

- FRESH BANANAS, EXCL. PLANTAINS
- FRESH SWEET ORANGES
- FRESH OR DRIED LEMONS 'CITRUS LIMON, CITRUS LIMONUM'
- FRESH OR DRIED GUAVAS, MANGOES AND MANGOSTEENS
- CUCUMBERS, FRESH OR CHILLED
- FRESH OR DRIED TANGERINES
- FRESH OR CHILLED GHERKINS
- FRESH OR DRIED AVOCADOS
- FRESH OR DRIED GRAPEFRUIT
- FRESH WATERMELONS
- FRESH PAWPAWS "PAPAYAS"
- TOMATOES, FRESH OR CHILLED
- FRESH PEACHES, INCL. NECTARINES

The values of imports for these commodities also include in some cases dried material which does not represent a risk. No imports were recorded for bananas, lemons, tangerine, gherkins, watermelons and peaches, which is contradictions with the FAOSTAT Database. The figures provided by Eurostat are therefore considered underestimated.

The tables below provides the amounts of imported commodities in 100 kg for each month in 2008:

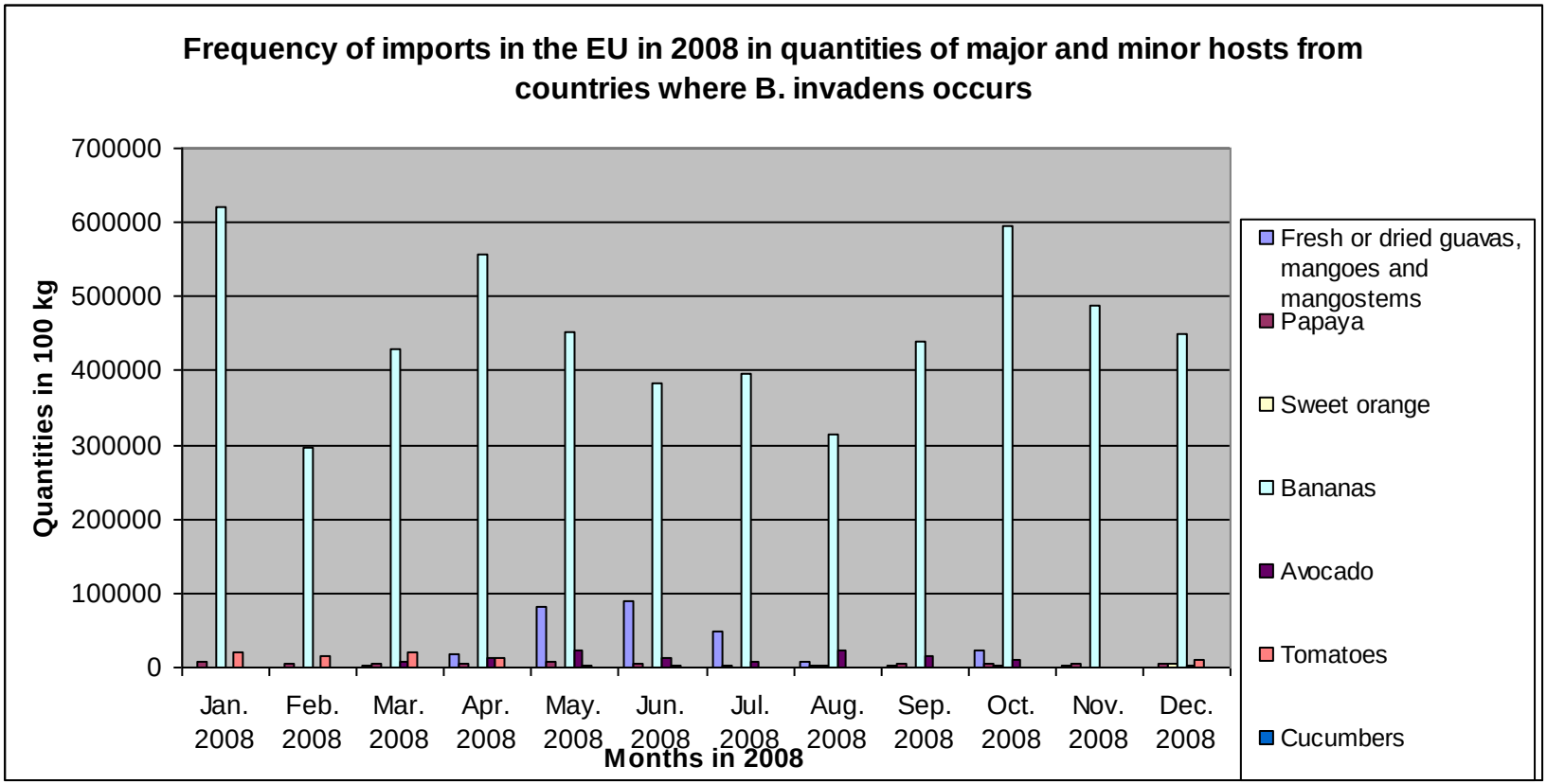
Major hosts

	Jan. 2008	**Feb. 2008**	**Mar. 2008**	**Apr. 2008**	**May. 2008**	**Jun. 2008**	**Jul. 2008**	**Aug. 2008**	**Sep. 2008**	**Oct. 2008**	**Nov. 2008**	**Dec. 2008**	**Total**
Mangifera indica, *Garcinia mangostana* (Mangoes, mangosteens) & *Psidium guava* (guavas)	644	621	1624	16897	82494	90056	47734	7925	2844	21854	1396	227	**274316**
Carica papaya (Papayas)	7792	5939	4086	5593	6751	4766	1414	1322	4151	6331	4973	5825	**58943**

Citrus sinensis (Sweet orange)	230	0	497	0	0	0	480	2640	924	1308	0	6240	**12319**

Minor hosts

	Jan. 2008	Feb. 2008	Mar. 2008	Apr. 2008	May. 2008	Jun. 2008	Jul. 2008	Aug. 2008	Sep. 2008	Oct. 2008	Nov. 2008	Dec. 2008	Total
Musa spp. (Bananas)	621956	297364	429134	558089	452370	383986	397042	313444	439596	594694	486818	450814	**5425307**
Persea americana (Avocados)	22	1000	8343	12710	23663	13763	8616	23862	15176	9696	1193	1599	**119643**
Lycopersicon esculentum (Tomatoes)	20088	15648	21173	13158	3625	3069	0	294	0	0	390	10791	**88236**
Cucumis sativus (Cucumbers)	0	0	0	0	0	85	0	2	3	2	2	2	**96**
Citrus x paradisi (Grapefruits)	0	0	0	0	2	0	0	0	0	0	0	0	**2**



Detail for fresh or dried *Mangifera indica*, *Garcinia mangostana* (Mangoes, mangosteens) & *Psidium guava* (guavas) for months of 2008 with importing and exporting countries in 100 kg :

Exporter	Importer	Jan. 2008	Feb. 2008	Mar. 2008	Apr. 2008	May. 2008	Jun. 2008	Jul. 2008	Aug. 2008	Sep. 2008	Oct. 2008	Nov. 2008	Dec. 2008
BURUNDI	BELGIUM	3	4	10	2	1	4	2	1	1	2	2	2
CONGO	FRANCE		4										
COTE D'IVOIRE	BELGIUM				5085	14653	27454	6733	860	263	619		
COTE D'IVOIRE	CZECH REPUBLIC							1	0	2		1	
COTE D'IVOIRE	SPAIN				139	1278	1256						
COTE	FRANCE				1209	5013	2705						

D'IVOIRE													
COTE D'IVOIRE	UNITED KINGDOM				200	2142	1282						
COTE D'IVOIRE	ITALY				13	29							
COTE D'IVOIRE	NETHERLANDS				2952	30718	7888						
CAMEROON	BELGIUM (and LUXBG -> 1998)	13	38	98	355	114	66	39	3	1	10	16	12
CAMEROON	GERMANY (incl DD from 1991)		16	36	62	37	12						
CAMEROON	FRANCE	152	207	229	182	155	80			120	8	122	66
GHANA	AUSTRIA	1		1	1						0		0
GHANA	BELGIUM (and LUXBG -> 1998)	0	0	2	2	9	20	576	581	1			1
GHANA	GERMANY (incl DD from 1991)	24	20	43	35	39	6	32	14	9	3	9	17
GHANA	FRANCE					414	260	497			3		
GHANA	UNITED KINGDOM	47	43	356	599	444	387	1063	739	10	31	130	17
GHANA	ITALY			18	15	8		571				5	
GHANA	LUXEMBOURG						124	269	89				
GHANA	NETHERLANDS	233	198	186	125	517	423	854	285	269	128	100	74
GAMBIA	BELGIUM (and LUXBG -> 1998)						28						
GAMBIA	UNITED KINGDOM					911	3497	2380	140				
GUINEA	BELGIUM (and LUXBG -> 1998)						202						
GUINEA	SPAIN				438	656	422						
GUINEA	UNITED KINGDOM					1450	2271						
GUINEA-BISSAU	PORTUGAL					6	8	184					
INDIA	AUSTRIA			4	16	44	29	3					
INDIA	BELGIUM (and LUXBG -> 1998)	2	2	11	364	594	167	6	2	2	4	4	2
INDIA	GERMANY (incl DD from 1991)			42	139	481	277	25	1		5		
INDIA	DENMARK	0	0	0	9	23	4	0					
INDIA	FINLAND					1	0						
INDIA	FRANCE			6	63	632	695	122	67				7
INDIA	UNITED		10	134	1838	9172	8377	1188	402	213	70		8

	KINGDOM												
INDIA	IRELAND	0		0	5	1	1	0	1	2	1	17	2
INDIA	ITALY					16	99	32		12			
INDIA	NETHERLANDS			0	1	62	47						
INDIA	PORTUGAL			3	13	14	16	6					
INDIA	ROMANIA						1						
INDIA	SWEDEN			7	1	12	18	72	26	5	0	4	5
KENYA	AUSTRIA					0	1	0	1	0		0	0
KENYA	GERMANY (incl DD from 1991)				5	11	23	13					
KENYA	FRANCE			3									
KENYA	UNITED KINGDOM	46	43	46	27	23	56	20	25	15	8	19	3
KENYA	NETHERLANDS						1					1	0
KENYA	SWEDEN						1						
SRI LANKA (ex CEYLAN)	GERMANY (incl DD from 1991)	66	27		11	12	14	11	9	16	8	8	11
SRI LANKA (ex CEYLAN)	FRANCE	24			9	41							
SRI LANKA (ex CEYLAN)	UNITED KINGDOM					13							
SRI LANKA (ex CEYLAN)	NETHERLANDS											3	
SRI LANKA (ex CEYLAN)	SWEDEN							6					
MALI	BELGIUM (and LUXBG -> 1998)				356	2288	5252	2410	1089		865		
MALI	FRANCE		9	320	1784	2904	1483	261					
MALI	NETHERLANDS			53	831	7510	12343	8609	653				
MAURITANIA (incl.Sp SAH.from 1977)	FRANCE					25							
SENEGAL	AUSTRIA						10						
SENEGAL	BELGIUM (and LUXBG -> 1998)			7		8	1987	7904	946	1190	19629	950	
SENEGAL	SPAIN							202	17				
SENEGAL	FRANCE			9			4144	6794	182	703			
SENEGAL	UNITED KINGDOM						4224	5477	422				
SENEGAL	ITALY							87					
SENEGAL	NETHERLANDS						2390	1285	1358		410		

TOGO	BELGIUM (and LUXBG -> 1998)										50		
TOGO	FRANCE				5								
TANZANIA, UNITED REPUBLIC OF	NETHERLANDS				3								
UGANDA	BELGIUM (and LUXBG -> 1998)	1		0	3	0					0		0
UGANDA	GERMANY (incl DD from 1991)						1						
UGANDA	DENMARK					1	0						
UGANDA	UNITED KINGDOM	12				12			12	10		5	
UGANDA	IRELAND	20											
	Total	**644**	**621**	**1624**	**16897**	**82494**	**90056**	**47734**	**7925**	**2844**	**21854**	**1396**	**227**

Detail for *Musa* spp. (bananas) for months of 2008 with importing and exporting countries in 100 kg :

PARTNER	**REPORTER/PERIOD**	**Jan. 2008**	**Feb. 2008**	**Mar. 2008**	**Apr. 2008**	**May. 2008**	**Jun. 2008**	**Jul. 2008**	**Aug. 2008**	**Sep. 2008**	**Oct. 2008**	**Nov. 2008**	**Dec. 2008**	**Jan.-Dec. 2008**
BURUNDI	BELGIUM (and LUXBG -> 1998)	17	21	34	9	25	29	24	19	70	60	18	3	329
COTE D'IVOIRE	BELGIUM (and LUXBG -> 1998)	101600	17092	50410	107276	93432	80598	86778	55384	113262	124206	91324	77513	998875
COTE D'IVOIRE	SPAIN	794	198	594	2368	3014	196	396			410	820	2223	11013
COTE D'IVOIRE	FRANCE	130979	54473	68898	69979	75856	45291	41781	39172	59922	93360	75519	64849	820079
COTE D'IVOIRE	UNITED KINGDOM	12581	24921	30496	39304	27561	30194	32569	27775	31243	27307	26488	27722	338161
COTE D'IVOIRE	ITALY							205				1199		1404
CAMEROON	BELGIUM (and LUXBG -> 1998)	137223	30768	94050	92243	67327	59218	95051	61750	66122	142594	101675	107796	1055817
CAMEROON	GERMANY (incl DD from 1991)					3								3
CAMEROON	SPAIN		4767	6418	16310	19853	6213							53561
CAMEROON	FRANCE	92883	69609	85304	95602	53633	60514	49732	39409	73375	102987	93296	65601	881945
CAMEROON	UNITED KINGDOM	90791	75507	60990	78918	60751	61451	49426	56039	67303	66152	65715	70934	803977
GHANA	BELGIUM (and LUXBG -> 1998)	19092			2833	714	356	346		176	386		356	24259
GHANA	FRANCE	34610	19216	31861	51929	49778	39320	36617	29806	23833	33116	27784	30310	408180
GHANA	UNITED KINGDOM	1330	744		1260	360	552	4072	4054	4239	4074	2932	3457	27074
INDIA	AUSTRIA						1	0						1

INDIA	IRELAND	4	1	2	2			1	2	2	2	2	1	19
KENYA	NETHERLANDS			3	1	1	1							6
SRI LANKA (ex CEYLAN)	BELGIUM (and LUXBG -> 1998)	4			7									11
SRI LANKA (ex CEYLAN)	GERMANY (incl DD from 1991)	5	6	7	7	5	5	5	3	3	5	4	5	60
UGANDA	BELGIUM (and LUXBG -> 1998)	4	4	6	6	5	5	4	4	6	5	3	4	56
UGANDA	GERMANY (incl DD from 1991)	30	34	50	30	37	42	27	22	40	30	36	40	418
UGANDA	FRANCE	7	3	11	5	15		7	5			3		56
UGANDA	NETHERLANDS	2												2
UGANDA	SWEDEN							1						1
	Total	**621956**	**297364**	**429134**	**558089**	**452370**	**383986**	**397042**	**313444**	**439596**	**594694**	**486818**	**450814**	**5425307**

Detail for *Persea americana* (avocados) for months of 2008 with importing and exporting countries in 100 kg :

Exporter	Importer	Jan. 2008	Feb. 2008	Mar. 2008	Apr. 2008	May. 2008	Jun. 2008	Jul. 2008	Aug. 2008	Sep. 2008	Oct. 2008	Nov. 2008	Dec. 2008
BURUNDI	BELGIUM	4	6	10	5	7	12	7	6	14	9	8	4
CONGO, DEMOCRATIC REPUBLIC OF	BELGIUM			1								0	0
CAMEROON	BELGIUM		2	2	9	18	20	8	10	5	3	3	10
GHANA	BELGIUM	0	0	2	3	8	2	1	2	2	4	0	0
KENYA	BELGIUM			440	301	1831	197				202		
KENYA	GERMANY							411					
KENYA	SPAIN		230	1353	2043	5016	3163	1778	661	566			
KENYA	FRANCE		419	2628	5697	9957	3974	1305	12807	4196	4624	1104	1104
KENYA	UNITED KINGDOM			221	390		211	1690	4647	1901	422		
KENYA	NETHERLANDS	1	239	3613	4193	6784	6092	3351	5686	8432	4361		442
SRI LANKA (ex CEYLAN)	GERMANY		2		1		2	2	2	1	5		
SRI LANKA (ex CEYLAN)	ITALY							10		6	7		
SRI LANKA (ex CEYLAN)	SWEDEN							3					

UGANDA	BELGIUM	17	18	31	30	42	36	32	30	35	53	24	33
UGANDA	FRANCE		9										
UGANDA	UNITED KINGDOM		74	42	38		54	18	10	18	6	54	5
UGANDA	NETHERLANDS		1		0				1	0			1
	Total	**22**	**1000**	**8343**	**12710**	**23663**	**13763**	**8616**	**23862**	**15176**	**9696**	**1193**	**1599**

Detail for *Lycopersicon esculentum* (tomatoes) for months of 2008 with importing and exporting countries in 100 kg :

Exporter	Importer	Jan. 2008	Feb. 2008	Mar. 2008	Apr. 2008	May. 2008	Jun. 2008	Jul. 2008	Aug. 2008	Sep. 2008	Oct. 2008	Nov. 2008	Dec. 2008
SENEGAL	BELGIUM	5674	1013	5415	4237	2241	3069		294				2178
SENEGAL	SPAIN				6								
SENEGAL	FRANCE	6166	4880	5076	2416	233						250	3735
SENEGAL	UNITED KINGDOM	2493	3394	2376	2581	686						140	1813
SENEGAL	NETHERLANDS	5755	6361	8306	3918	465							3065
	Total	**20088**	**15648**	**21173**	**13158**	**3625**	**3069**	**0**	**294**	**0**	**0**	**390**	**10791**

Detail for *Carica papaya* (papaya) for months of 2008 with importing and exporting countries in 100 kg :

Exporter	Importer	Jan. 2008	Feb. 2008	Mar. 2008	Apr. 2008	May. 2008	Jun. 2008	Jul. 2008	Aug. 2008	Sep. 2008	Oct. 2008	Nov. 2008	Dec. 2008
BURUNDI	BELGIUM		1	0	0	0							
BENIN	FRANCE											28	
COTE D'IVOIRE	BELGIUM	2479		1451	1848	681	1029	517	86	1487	2929	1179	2622
COTE D'IVOIRE	FRANCE	3037	4642	965	727	1040	395			853	873	905	580
COTE D'IVOIRE	UNITED KINGDOM		25	118	443	295	131	11	154	314	103	370	568
COTE D'IVOIRE	NETHERLANDS	58		358	119	442			189	271	855	491	100
CAMEROON	BELGIUM	8	11	18	8	5	3	1	2	7	6	6	24
CAMEROON	GERMANY			20	25								
CAMEROON	FRANCE											27	27
GHANA	BELGIUM	175	0	28	122	192	191	12	71	355	291	257	353
GHANA	GERMANY	67	26	58	40	44	4	18	67	46	160	37	25
GHANA	FRANCE	65							23	38	85	52	78
GHANA	UNITED KINGDOM	116	53	55	36		7	39	20	105	29	118	37
GHANA	ITALY			13							8		
GHANA	LUXEMBOURG	826	700	510	389	195		21	278	256	744	1170	1048
GHANA	NETHERLANDS	163	160	138	86	103	57	25	14	19	40	20	22
INDIA	AUSTRIA		0	0		2	0	1					
INDIA	GERMANY	32	18	20	4		5	27	30	20	25	69	56

INDIA	UNITED KINGDOM	311	64	243	1640	3532	2736	469	183	78	75	147	137
KENYA	UNITED KINGDOM	139	27	25	8	20	37	60	43	36	21	34	62
KENYA	NETHERLANDS											1	
SRI LANKA	GERMANY	14	14	16	17	13	10	10	10	7	10	37	39
SRI LANKA	FRANCE	18	47	39	34	36	6	28	24	21	21		
SRI LANKA	UNITED KINGDOM	7				22					7	11	
SRI LANKA	ITALY										3		
NIGERIA	UNITED KINGDOM									12			
SENEGAL	BELGIUM			1								0	
UGANDA	BELGIUM	1	1	2	1	1	1	0	0	0	0	0	1
UGANDA	GERMANY										1		
UGANDA	DENMARK					2							0
UGANDA	UNITED KINGDOM	276	150	8	46	126	154	175	128	226	45	14	46
	Total	**7792**	**5939**	**4086**	**5593**	**6751**	**4766**	**1414**	**1322**	**4151**	**6331**	**4973**	**5825**

Detail for *Citrus sinensis* (sweet orange) for months of 2008 with importing and exporting countries in 100 kg :

Experter	Importer	Jan. 2008	Feb. 2008	Mar. 2008	Apr. 2008	May. 2008	Jun. 2008	Jul. 2008	Aug. 2008	Sep. 2008	Oct. 2008	Nov. 2008	Dec. 2008
GHANA	UNITED KINGDOM	230		497				480	2640	924			6240
GHANA	NETHERLANDS										1308		
	Total	**230**	**0**	**497**	**0**	**0**	**0**	**480**	**2640**	**924**	**1308**	**0**	**6240**

Detail for *Cucumis sativus* (cucumbers) for months of 2008 with importing and exporting countries in 100 kg :

Exporter	**Importer**	**Jan. 2008**	**Feb. 2008**	**Mar. 2008**	**Apr. 2008**	**May. 2008**	**Jun. 2008**	**Jul. 2008**	**Aug. 2008**	**Sep. 2008**	**Oct. 2008**	**Nov. 2008**	**Dec. 2008**
INDIA	IRELAND	0		0	0	0	0	0	2	3	2	2	2
KENYA	NETHERLANDS					0	6						
SENEGAL	FRANCE						79						
	Total	**0**	**0**	**0**	**0**	**0**	**85**	**0**	**2**	**3**	**2**	**2**	**2**

Detail for *Citrus x paradisi* (grapefruit) for months of 2008 with importing and exporting countries in 100 kg :

Exporter	**Importer**	**Jan. 2008**	**Feb. 2008**	**Mar. 2008**	**Apr. 2008**	**May. 2008**	**Jun. 2008**	**Jul. 2008**	**Aug. 2008**	**Sep. 2008**	**Oct. 2008**	**Nov. 2008**	**Dec. 2008**
SRI LANKA	GERMANY					2							
	Total	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Appendix 4

Data on trade of ornamental plants imported within the European Union from countries where *B. invadens* is present

Data on imports of plants for planting including seeds, tissue cultures, cuttings etc

Data on imports of plants for planting including seeds, tissue cultures, cuttings etc has been gathered from the Dutch NPPO for the years 2006, 2007 and 2008 in number peaces by origins. Colored rows indicate exporting countries where the species occurs.

		2006	2007	2008
Genus	**Origin**			
ANNONA	**THAILAND**	12	3	-
AVERRHOA	**CHINA**	-	1650	3000
	THAILAND	28	21	1
CARICA	**ISRAEL**	10460	30383	44577
	ISRAEL	1705	-	-
	INDONESIE	-	2	-
	ISRAEL	4188	-	-
CHRYSOPHYLLUM	**AUSTRALIE**	-	10	-
	AUSTRALIE	-	-	20
	CHINA	-	57	-
	THAILAND	-	5	-
COFFEA	**COSTA RICA**	-	1080	8327
	BURUNDI	3	-	-
	COSTA RICA	1264	2488	6620
	GUATEMALA	-	42	-
	COSTA RICA	2149	-	3551
CUCUMIS SATIVUS	**ISRAEL**	-	296	-
CUCURBITA	**ZUID-AFRIKA**	-	1500	-
	ZUID-AFRIKA	500	-	-
DIOSPYROS	**THAILAND**	-	-	1
DIOSPYROS KAKI	**CHINA**	200	-	-
	CHINA	-	5800	-
	NOORD-KOREA	-	-	350
	ZUID-KOREA	-	-	1
DRACAENA	**CHINA**	-	113040	-
	CHINA	-	-	2000
	BURUNDI	22244	-	-
	CHINA	27802537	21143405	19939364
	COSTA RICA	4054950	3423734	3216543
	ECUADOR	-	12380	-
	GHANA	3200	-	-
	GUATEMALA	7299	2000	20955

HONDURAS	5000	-	-
HONG-KONG	-	76	75965
INDONESIE	4	40	-
MALEISIE	7320	-	40520
PANAMA	-	-	72815
SINGAPORE	268	-	-
SRI LANKA	975879	539261	558772
TAIWAN	-	-	60000
THAILAND	259200	-	-
COSTA RICA	-	1300	-
CHINA	8	-	-
BURUNDI	71986	77794	85167
CHILI	129	-	-
CHINA	1017206	620767	41395
COLOMBIA	-	69005	-
COSTA RICA	20005996	30363800	32082455
DOMINICAANSE REPUBLIEK	10	20	-
EGYPTE	3	-	-
ETHIOPIE	-	3377	-
GUATEMALA	124087	150	6500
HONDURAS	90160	61971	60025
HONG-KONG	-	-	1000
MALEISIE	120959	183859	132502
NEDERLAND	4400	2400	-
NIEUW-ZEELAND	21000	-	-
PANAMA	-	-	30333
SRI LANKA	237156	561905	549046
TAIWAN	-	968	10090
THAILAND	17195	12829	437
BRAZILIE	-	310	-
BURUNDI	11903	6767	-
CHINA	497298	812518	1186828
COSTA RICA	1534383	1278288	1679491
DOMINICA	-	-	4
DOMINICAANSE REPUBLIEK	-	50	-
GUATEMALA	44	-	18950
HONDURAS	12	-	60
INDONESIE	16	-	-
MALEISIE	1055	1780	-
SPANJE	450	-	72
SRI LANKA	41919	6000	-
THAILAND	-	10	5
BURUNDI	-	26451	16623
COSTA RICA	-	-	6523

	SINGAPORE	-	-	7500
	SRI LANKA	9875	-	-
	COSTA RICA	-	100	-
	SRI LANKA	-	19720	-
ERIOBOTRYA	**CHINA**	-	-	6000
	ISRAEL	-	165	336
	SPANJE	3348	-	-
FICUS	**CHINA**	-	5	43200
	COSTA RICA	43276	45339	1843
	GUATEMALA	1	1	28000
	OEGANDA	-	42000	1674222
	SRI LANKA	163248	74424	115295
	TANZANIA	325270	98325	33100
	CHINA	1986	-	-
	CHINA	-	4836	-
	OEGANDA	-	2400	-
	CHILI	-	1625	5000
	CHINA	260033	661391	597994
	COSTA RICA	151303	125909	144456
	DOMINICAANSE REPUBLIEK	5806	2650	-
	EGYPTE	32	-	-
	EL SALVADOR	-	1703	-
	GUATEMALA	-	10347	15210
	INDIA	-	50	-
	ISRAEL	12618	76	1690
	MALEISIE	-	1	197
	OEGANDA	-	-	484475
	SINGAPORE	-	1	-
	SRI LANKA	35873	307732	295568
	TAIWAN	810	1814	-
	TANZANIA	76000	255450	354458
	THAILAND	1209	1232	520
	VERENIGDE STATEN VAN AMERIKA	-	210	707
	ZUID-KOREA	20	-	-
	CHINA	1761475	2268942	2031503
	COSTA RICA	6320	5132	3603
	DOMINICAANSE REPUBLIEK	6099	-	-
	INDONESIE	119	185	266
	ISRAEL	1672	-	6220
	MALEISIE	6695	357	-
	SINGAPORE	80	-	-
	SRI LANKA	472782	102671	9000
	TAIWAN	70	4	3000

	THAILAND	144737	3699	1190
	VERENIGDE STATEN VAN AMERIKA	1245	557	2661
	CHINA	-	91020	86411
	EGYPTE	-	4620	21378
	SRI LANKA	-	11474	9533
	INDIA	6	-	-
GARCINIA	**MALEISIE**	-	18	-
MANGIFERA	**THAILAND**	6	-	-
MANGIFERA INDICA	**THAILAND**	6	1	-
MUSA	**INDIA**	-	20	45
	COSTA RICA	1500	-	-
	INDIA	7500	20150	4200
	TURKIJE	-	600	-
	TURKIJE	89985	23475	21502
	BRAZILIE	-	84	420
	CHINA	372617	477520	711188
	GHANA	-	73	-
	GUATEMALA	-	14	-
	INDIA	252005	282560	271475
	INDONESIE	-	-	100
	ISRAEL	5	2638	2556
	THAILAND	-	-	1040
	TURKIJE	-	6975	-
	VERENIGDE STATEN VAN AMERIKA	-	72	2700
	ZUID-AFRIKA	962903	858818	781259
	BURUNDI	280	-	-
	THAILAND	-	-	4
PERSEA AMERICANUM	**ISRAEL**	195	-	-
PRUNUS	**VERENIGDE STATEN VAN AMERIKA**	1	-	-
PSIDIUM GUAJAVA	**COSTA RICA**	1	-	-
	THAILAND	10	-	-
SYZYGIUM	**CHILI**	-	-	17835
	ISRAEL	4866	4022	18339
	ISRAEL	810	-	-
	CHINA	58	28	44
	INDONESIE	62	213	139
	ISRAEL	640	-	-
	THAILAND	1	-	-
TERMINALIA	**KENIA**	-	266000	71810
	KENIA	-	15400	3310
	INDIA	-	-	170

	INDONESIE	-	-	27530
	THAILAND	-	3	-

Data on imports of ornamental plants within the European Union

Data on imports of ornamental plants within the European Union has been gathered on the Eurostat website (http://epp.eurostat.ec.europa.eu/portal/page/portal/external_trade/data/database), as this information is not available in FAOSTAT.

Data is available in "External trade, detailed data", "EU trade since 1995 by CN8", the selected codes were 06029045, 06029049, 06029050, 06029051, , 06029059, 06029070, 06029099 corresponding to categories of plants for planting into which hosts of *B. invadens* with soil attached could fall:

- OUTDOOR ROOTED CUTTINGS AND YOUNG PLANTS OF TREES, SHRUBS AND BUSHES (EXCL. FRUIT, NUT AND FOREST TREES)
- OUTDOOR TREES, SHRUBS AND BUSHES, INCL. THEIR ROOTS (EXCL. CUTTINGS, SLIPS AND YOUNG PLANTS, AND FRUIT, NUT AND FOREST TREES)
- LIVE OUTDOOR PLANTS, INCL. THEIR ROOTS (EXCL. BULBS, TUBERS, TUBEROUS ROOTS, CORMS, CROWNS AND RHIZOMES, INCL. CHICORY PLANTS AND ROOTS, UNROOTED CUTTINGS, SLIPS, RHODODENDRONS, AZALEAS, ROSES, MUSHROOM SPAWN, PINEAPPLE PLANTS, VEGETABLE AND STRAWBERRY PLANTS, TREES, SHRUBS AND BUSHES)
- PERENNIAL OUTDOOR PLANTS
- LIVE OUTDOOR PLANTS, INCL. THEIR ROOTS (EXCL. BULBS, TUBERS, TUBEROUS ROOTS, CORMS, CROWNS AND RHIZOMES, INCL. CHICORY PLANTS AND ROOTS, UNROOTED CUTTINGS, SLIPS, RHODODENDRONS, AZALEAS, ROSES, MUSHROOM SPAWN, PINEAPPLE PLANTS, VEGETABLE AND STRAWBERRY PLANTS, TREES, SHRUBS AND BUSHES)
- INDOOR ROOTED CUTTINGS AND YOUNG PLANTS (EXCL. CACTI)
- INDOOR FLOWERING PLANTS WITH BUDS OR FLOWERS (EXCL. CACTI)
- LIVE INDOOR PLANTS AND CACTI (EXCL. ROOTED CUTTINGS, YOUNG PLANTS AND FLOWERING PLANTS WITH BUDS OR FLOWERS)

These figures correspond to import from countries where *B. invadens* is present.

Quantities of plants for planting with growing media imported into the European Union in 2007 and 2008 in quantities (by 100 kg), countries are ordered by importance of volumes for 2008:

Exporter	**Total 2007**	**Total 2008**
NETHERLANDS	20552	22142
BELGIUM	2142	3269
GERMANY	3420	2827
FRANCE	962	335
ITALY	1029	192
SWEDEN	16	68
UNITED KINGDOM	41	60
SPAIN	43	56
PORTUGAL	3	14
CYPRUS	1	8
GREECE	20	8
DENMARK	0	7
POLAND	33	6
BULGARIA	0	3
CZECH REPUBLIC	2	3

HUNGARY	2	2
AUSTRIA	4	0
ROMANIA	1	0
Total	**28271**	**29000**

Detail of quantities of plants for planting with growing media by origins imported into the European Union in 2007 and 2008 in quantities (by 100 kg), countries are ordered by importance of volumes for 2008:

Exporter	Importer	TOTAL 2007	TOTAL 2008
NETHERLANDS	BURUNDI	365	324
	COTE D'IVOIRE	75	38
	CAMEROON	0	2
	ETHIOPIA	243	341
	GHANA	44	55
	GAMBIA	0	7
	GUINEA	2	3
	INDIA	235	203
	KENYA	1136	2013
	SRI LANKA	17729	18654
	TOGO	0	1
	TANZANIA, UNITED REPUBLIC OF	720	426
	UGANDA	2	75
	ZIMBABWE	1	0
BELGIUM	BURUNDI	354	410
	COTE D'IVOIRE	1784	2765
	CAMEROON	0	2
	GUINEA	0	1
	INDIA	0	1
	SRI LANKA	1	2
	SENEGAL	3	79
	TOGO	0	9
GERMANY	BURUNDI	3	0
	CAMEROON	3	6
	ETHIOPIA	576	9
	GUINEA	14	6
	INDIA	82	67
	KENYA	1950	1842
	SRI LANKA	765	794
	SENEGAL	2	3
	TOGO	0	9
	TANZANIA, UNITED REPUBLIC OF	25	35
	UGANDA	0	56
FRANCE	COTE D'IVOIRE	208	0
	ETHIOPIA	68	125
	GUINEA	1	0

	KENYA	674	208
	SRI LANKA	0	1
	SENEGAL	3	1
	UGANDA	8	0
ITALY	COTE D'IVOIRE	0	2
	CAMEROON	1	0
	INDIA	920	92
	KENYA	99	80
	COMOROS	0	0
	SRI LANKA	8	18
	MOZAMBIQUE	1	0
SWEDEN	SRI LANKA	16	68
UNITED KINGDOM	ETHIOPIA	24	33
	INDIA	12	0
	KENYA	5	26
	SRI LANKA	0	1
SPAIN	GUINEA	1	0
	EQUATORIAL GUINEA	2	0
	INDIA	3	5
	KENYA	27	44
	SRI LANKA	5	0
	TOGO	0	6
	TANZANIA, UNITED REPUBLIC OF	5	0
	UGANDA	0	1
PORTUGAL	ETHIOPIA	0	1
	INDIA	0	1
	KENYA	1	4
	COMOROS	0	0
	SRI LANKA	2	8
CYPRUS	INDIA	0	1
	SRI LANKA	1	7
GREECE	SRI LANKA	20	8
DENMARK	SRI LANKA	0	7
POLAND	KENYA	33	6
BULGARIA	SRI LANKA	0	3
CZECH REPUBLIC	ETHIOPIA	1	0
	GUINEA	1	2
	KENYA	0	1
HUNGARY	GUINEA	2	2
AUSTRIA	KENYA	4	0
ROMANIA	KENYA	1	0
	Total	**28271**	**29000**

- Frequency of imports in 2008 in 100 kg of plants for planting with soil with growing media from countries where *B. invadens* occurs :

	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08
European Union	2612	3048	2418	2126	2060	2108	2744	2195	2280	2396	2263	2750

Appendix 5

Climatic prediction for *Bactrocera invadens* with CLIMEX

Document prepared by the EPPO Secretariat and Darren Kriticos

The CLIMEX model is a computer programme aiming at predicting the potential geographical distribution of an organism considering its climatic requirements. It is based on the hypothesis that climate is an essential factor for the establishment of a species in a country.
CLIMEX provides tools for predicting and mapping the potential distribution of an organism based on:

(a) climatic similarities between areas where the organism occurs and the areas under investigation (Match Index),

(b) a combination of the climate in the area where the organism occurs and the organism's climatic responses, obtained either by practical experimentation and research or through iterative use of CLIMEX (Ecoclimatic Index).

For *Bactrocera invadens*, a compare location analysis has been undertaken.

1. Geographical distribution of the species

B. invadens is native to Asia. It is not clearwhether Buthan should be considered as part of the native area (de Meyer *et al*., 2009). The native range is likely larger than currently assumed, since specimens may be misidentified as other representatives of the complex (de Meyer *et al*., 2009).

Asia: Bhutan, India, Sri Lanka.

Note: In India, the species is exotic and been found for the first time in 2005 in Tamil Nadu in mango orchards, and it was particularly dominant in Chennai (Sithanantham *et al*., 2006).

Africa: Angola, Benin (first found 2004-06), Burkina Faso (2005-05), Burundi (2008-11), Cameroon (2004-08), Central African Republic (2008-08), Chad, Congo (2005-11), Comoros (2005-08), Côte d'Ivoire (2005-05), Democratic Republic of Congo, Equatorial Guinea, Ethiopia (2004-07), Gabon, Gambia (2005-06), Ghana (2004-11), Guinea (2005-05), Guinea-Bissau (2005-07), Kenya (2003-02), Liberia (2005-07), Mali (2005-06), Mauritania (2007-08), Mayotte (France) (2007-03), Mozambique (2007-07), Namibia (2008-10), Niger (2005-08), Nigeria (2003-11), Senegal (2004-06), Sierra Leone (2005-07), Sudan (2004-05), Tanzania (2003-07), Togo (2004-10), Uganda (2004-07), Zambia (2008).

Note: Its first place of discovery (i.e. Kenya) should not be assumed to be its point of entry into Africa, as it may have been overlooked in some areas.

Data from de Meyer *et al*. (2009) has been taken, as well as new observations from de Meyer for 2008 and 2009. After removing the duplicate records, the file is composed of 167 locations.

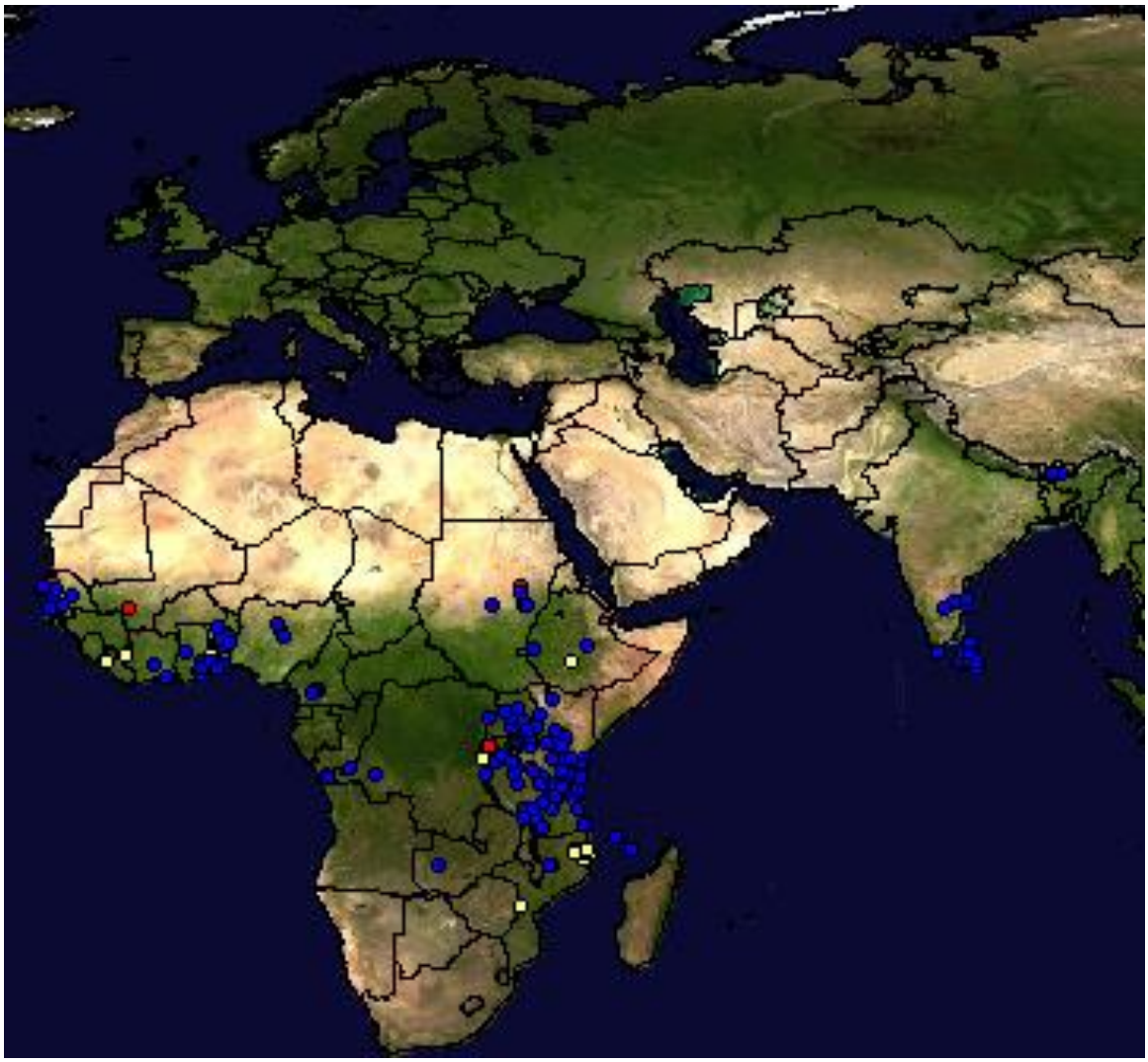


Figure 1: Worldwide distribution of *Bactrocera invadens* from aggregated sources
Legend and origin of data:
Blue points: from De Meyer 2009 and GBIF
Yellow points: de Meyer pers. com., 2008
Red points: de Meyer pers. com., 2009

Climatic requirements

In Tanzania, *B. invadens* populations increase from the onset of the short rains period onwards (October – December), in order to reach a maximum at the short rains period. The relationship between the start of the rainy season, with the increase of *B. invadens* and heavy mango losses was also observed in Benin (Vayssières *et al*., 2005). The period of short rain is followed by a shorter period of drier conditions (but with high relative humidity). The average temperature remains high but gradually decreases during the long rains period, which is the main fruiting season for mango and guava. Populations of *B. invadens* remain high during this period but seem to infest mainly guava, as well as other non commercial fruits available such as tropical almonds. When temperature and rainfall decrease during the dry season, the population of *B. invadens* also decreases dramatically, but viable populations can be maintained in non commercial hosts (eg. loquat, jew plum) till the next short rains period (Mwatawala *et al.*, 2009).

Manrakhan *et al*. (undated) report that generation time is largely dependant on temperature, and at 15°C, the mean total developmental time for immature stages was 75 days. The lower development threshold of *B. invadens* was found to be 8.8°C, 9.4°C and 8.7°C for the egg, larva and pupa.

Other predictions performed

HARDINESS ZONES

USDA (2008) considered that the distribution of *B. invadens* corresponds to USDA Plant Hardiness Zone 10-13. Based on its distribution, it was estimated that *B. invadens* could survive in at least zone 10 in the continental USA. However, because the species has not yet fully realized its potential distribution, it is likely that it can survive in other Hardiness Zones, and *B. invadens* might be able to establish in zone 9.

NAPPFAST

A climatic prediction analysis has been performed with the software NAPPFAST, which concludes that entire Africa poses has a high potential for the establishment of *B. invadens*. The model estimated lowest number of generations per year in Southern and Northern parts of Africa (having a Mediterranean type climate); however, *B. invadens* may have as many as 6 generations per year in those areas. For continental US, 0 to 5 generations were predicted (Hurt & Takeuchi, 2006).

Comparison with the behaviour of other Tephritidae in the Mediterranean

Bactrocera dorsalis is native from Asia (South of India and Sri Lanka, Himalaya, Thailand, Viet Nam, Cambodia, etc.), and is invasive in tropical islands such as Reunion, Guam, Nauru, as well as in Japan. It is absent from the Mediterranean Basin, so no comparison is possible (Stephens *et al*., 2007).

Bactrocera zonata originates in South and South-East Asia. In the Mediterranean, in recent years, *B. zonata* has become a widespread pest in Egypt, and in addition it has been intercepted in Israel. In Egypt, the species is present in the Sinaï and is the object of eradications at the border with Israël with intensive phytosanitary treatments and Male Annihilation Technique (with méthyl-eugénol) (D. Nestel, com. pers., 2010). At present, it is considered that *B. zonata* is present and widespread in Egypt, and the situation is as follows: *Mainland*: whole Nile Delta region, Nile Valley, and Kharga and Dakla oases. In Israel, all detected outbreaks have been eradicated to date
(see EPPO website at http://www.eppo.org/QUARANTINE/bactrocera_zonata/bactrocera.htm).

Ceratitis capitata originates in tropical Africa, from where it has spread to the Mediterranean area and to parts of Central and South America. In Mediterranean countries, it is particularly damaging on citrus and peaches. It also transmits fruit-rotting fungi (See EPPO Datasheet at http://www.eppo.org/QUARANTINE/insects/Ceratitis_capitata/CERTCA_ds.pdf).

2. Influence of climatic factors on distribution

The parameters used for *Bactrocera doraslis* available into the CLIMEX software were taken as a basis.

The parameters used in the CLIMEX model for *B. invadens* are summarized in Table 1, the ones for B. dorsalis are summarized in Table 2. The role and meaning of these parameters are fully described in Sutherst *et al*. (2004), and their values are discussed below. It should be noted that the meteorological data used in this model represent long-term monthly averages, not daily values. This means that it is not possible to compare directly values derived using the model with instantaneous values derived through direct observations. This applies mostly to parameters relating to maximum and minimum temperatures.

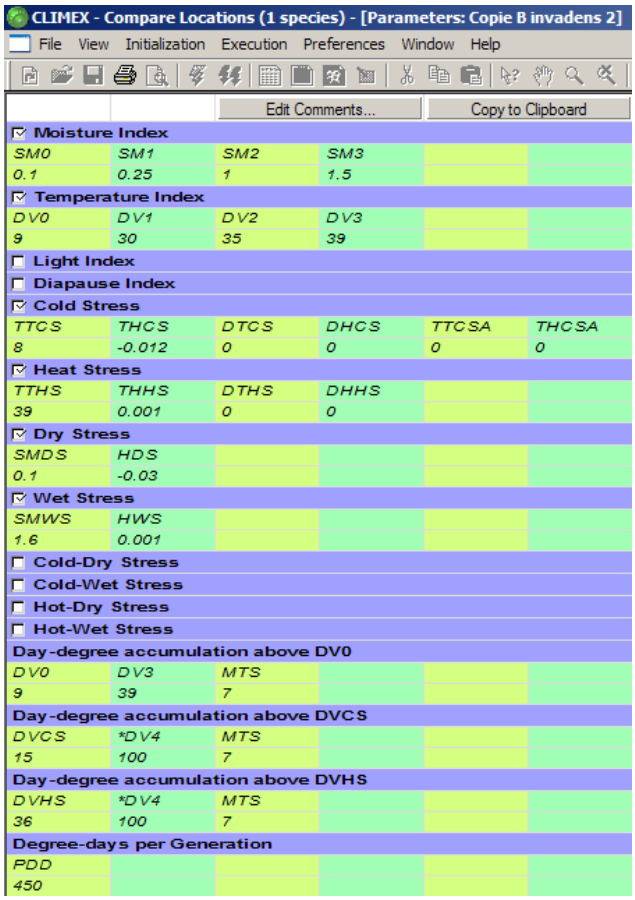


Table 1: parameters used for *Bactrocera invadens*

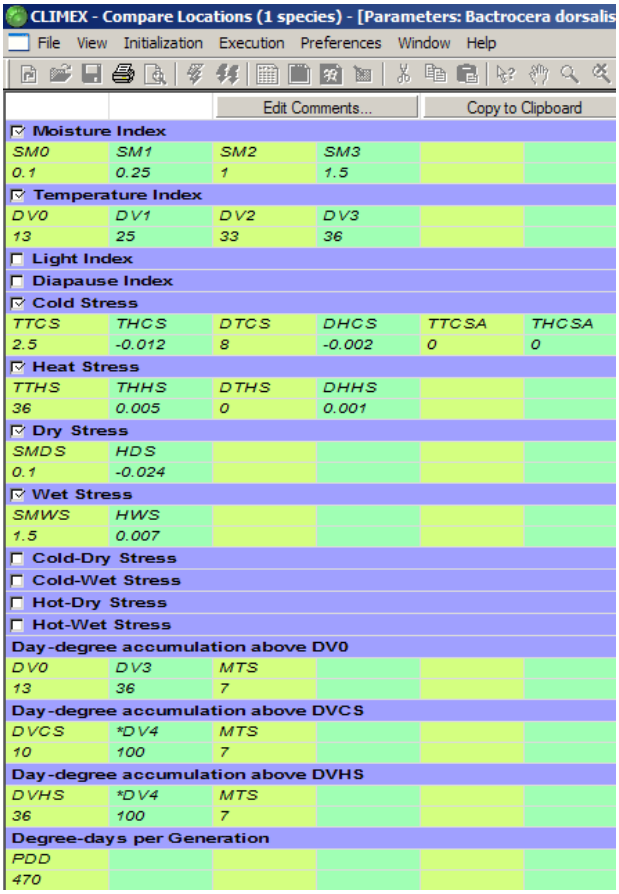


Table 2: parameters used for *Bactrocera dorsalis* from Stephens *et al*., 2007

Moisture index
The moisture index for B. invadens was kept as the same as for B. dorsalis.

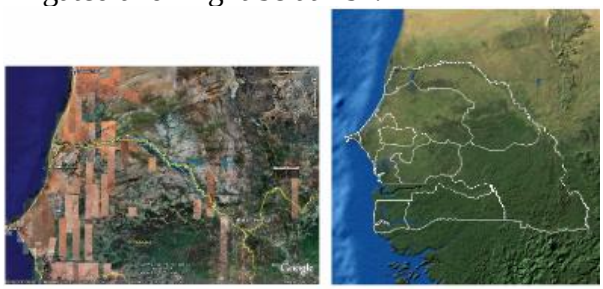
Temperature index
DV0 was set to 9, DV1 to 30, DV2 to 35 and DV3 to 39.

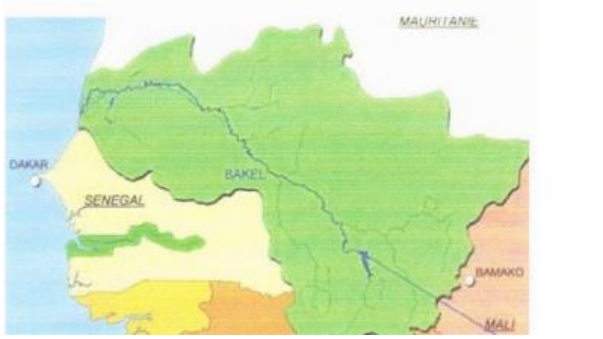
Cold stress
TTCS was set to 6 and THHS to 0.001. DTCS and DHCS are kep as for *B. dorsalis*. The cold stress is the most uncertain parameter as the current distribution might not be representative of the full potential distribution of the species. This area would deserve experiments.

Hot stess
In Sudan, the species has been found in Sennar in September-October 2009 by de Meyer (pers. com., 2009) while the parameters entered for *B. dorsalis* made this location is too hot for the species. The parameters are set accordingly.
DV3 is set to 39 and THHS to 0.001, instead of DV3 at 36 and THHS at 0.005.

Wet stress
In Bhutan (southern border), the parameters entered for *B. dorsalis* did not predict the species to thrive because of a wet stress. *B. invadens* does not seem to be overtly limited by wet stress as it grows well after rains in Tanzania. SM3 is set to 1.6, and HWS to 0.001 instead of SM3 at 1.5 and HWS at 0.007.

Dry stress
Bactrocera species, although of the same genus, may have different tolerances to dry stress. While B. dorsalis is not dry stress tolerant, it was stressed that *B. zonata* is present even in very dry areas, where few host plants are present, and event on isolated trees.
The Dakar area in Senegal and Al Jazirah in Sudan does not appear suitable with the parameters entered for *B. dorsalis* because of a dry stress. After investigation, it appears that the data given in Senegal as “Sandiara” was a mistake, and should be “Sinndia”, which is a location more south, and less dry, where *B. invadens* has been found the second half of September in different orchards (*Citrus* spp., mangoes, guayavas, etc.) which were irrigated for some of them. In Dakar, the captures of *B. invadens* have occurred the second half of September or the beginning of October in urban areas (de Meyer, pers. com., 2009). The GBIF for this area data are not documented and cannot be verified and cannot be taken into account to set the parameters for the analysis. It appears that the Senegal Valley is irrigated and might be at risk.





Map of the Senegal Valley taken from http://www.memoireonline.com/06/08/1177/m_formation-agricole-rurale-vallee-fleuve-senegal-cadre-pilotage-regional5.html

In Sudan, the material has been collected in September-October 2009 (de Meyer, pers. com., 2009). The traps are situated near extensive irrigation schemes along the blue Nile. It is considered that the species can only maintain populations due to artificial irrigated conditions. Nevertheless, the flies are abundant there (several hundreds of specimens found) (de Meyer, pers. com., 2009). These trapping are new and it is not known whether the species was only found because September and October consist in rainy seasons, or whether the species will be able to maintain populations all year round.

Map of Sudan and its rivers taken from http://www.goodnewsmedia.com/sudan/

SMDS is set at 0.1 and HDS at 0.03.

Degree days per generation

The degree days per generation were set at 450.

The map of the potential distribution of *Bactrocera invadens* in the world is as follows:

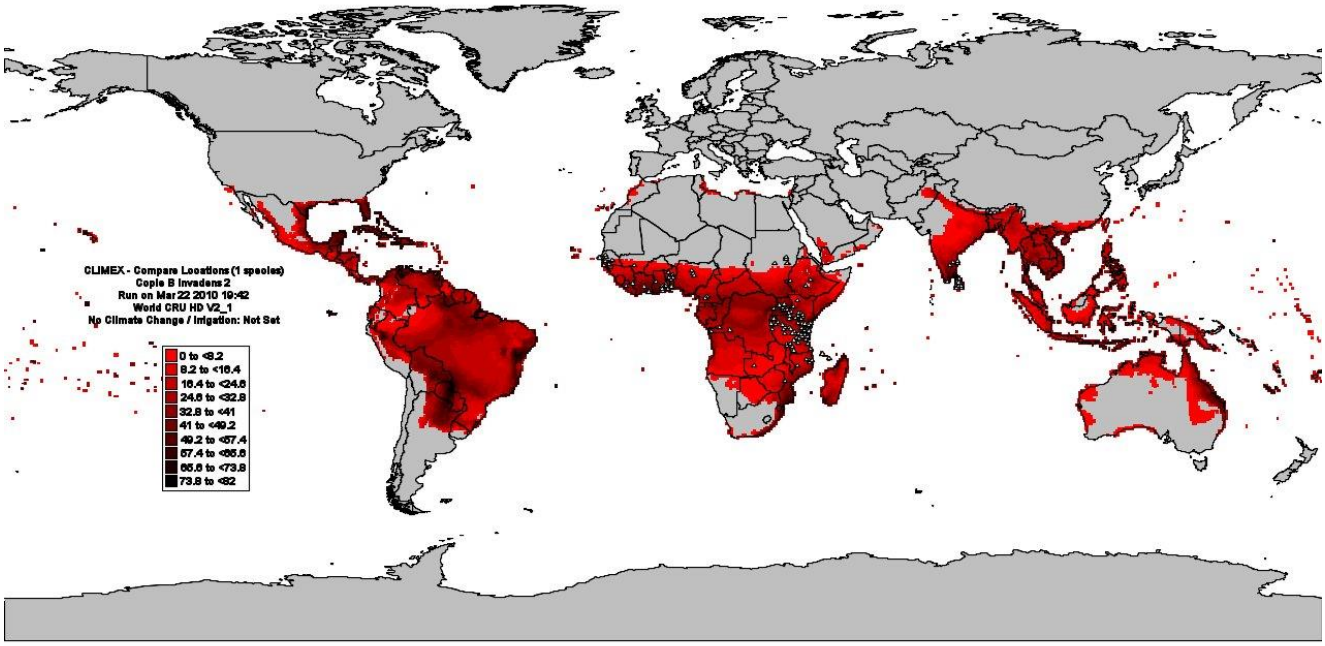


Figure 2: Potential distribution of *B. invadens* in the world (Ecoclimatic index)

This distribution is consistant with the recorded distribution of the species in Niger, Chad and Sudan. The species had been recorded in Somalia, probably it is present there but the war did not allow communicating the presence of the pest.

Zoom on the Mediterranean area:

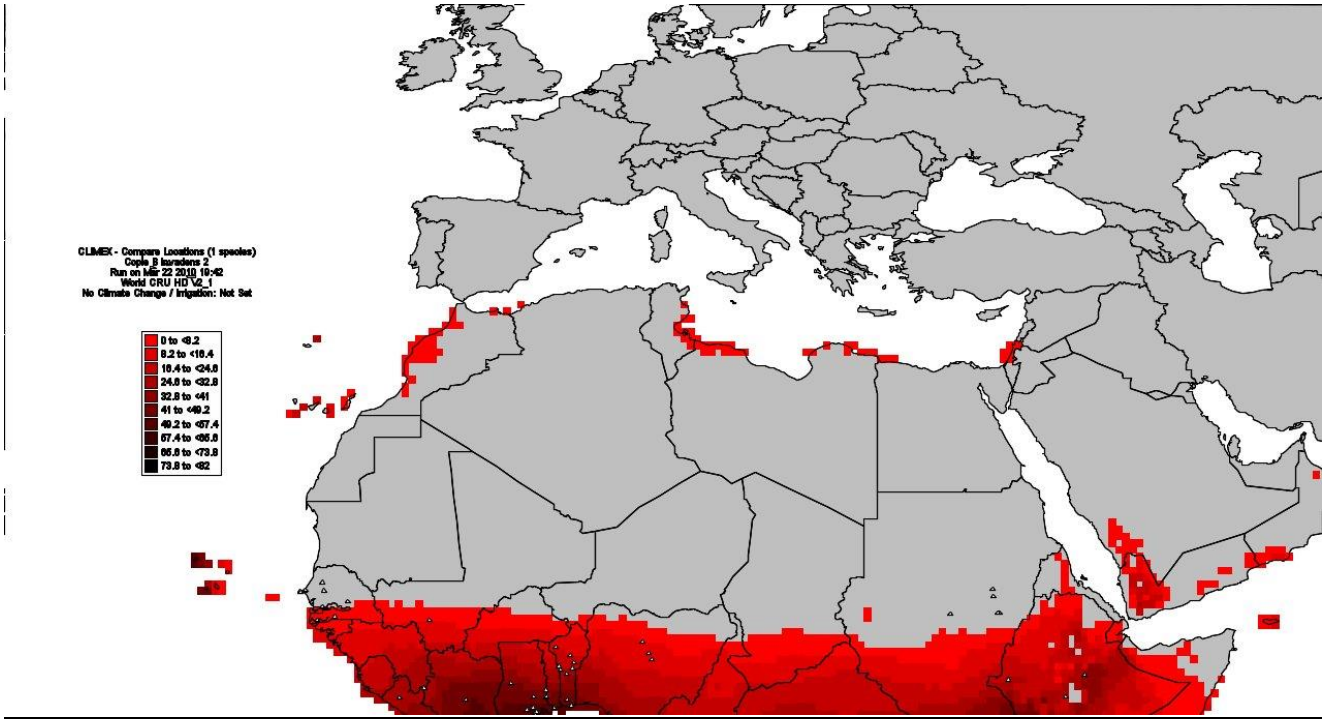


Figure 3: Potential distribution of *B. invadens* in the Mediterranean Basin (Ecoclimatic index)

Irrigation scenario

The species has been trapped in Sudan in September or October 2009 in irrigated crops in Sudan. Without irrigation, central part of Sudan would be too dry for *B. invadens*. The irrigation scenario is set at 7 mm per day in summer with topup irrigation, and provides the following maps:

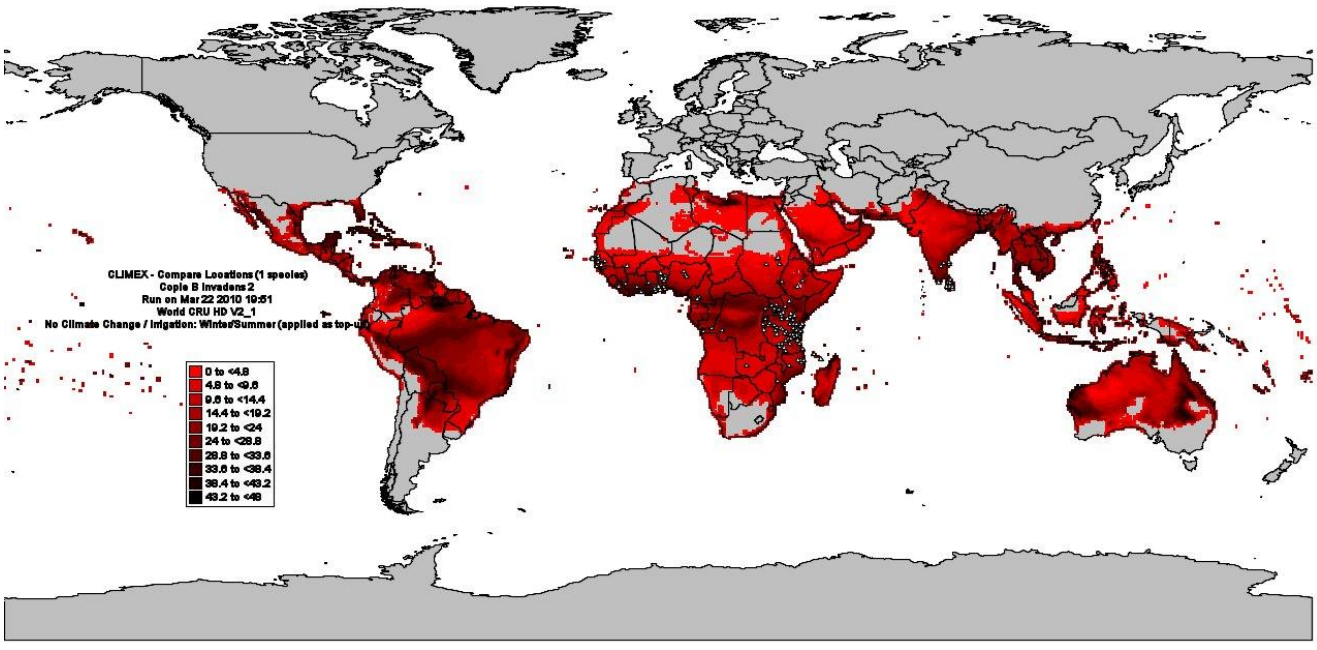


Figure 3: Potential distribution of *B. invadens* in the world with irrigation scenario (Ecoclimatic index)

Zoom on the Mediterranean area:

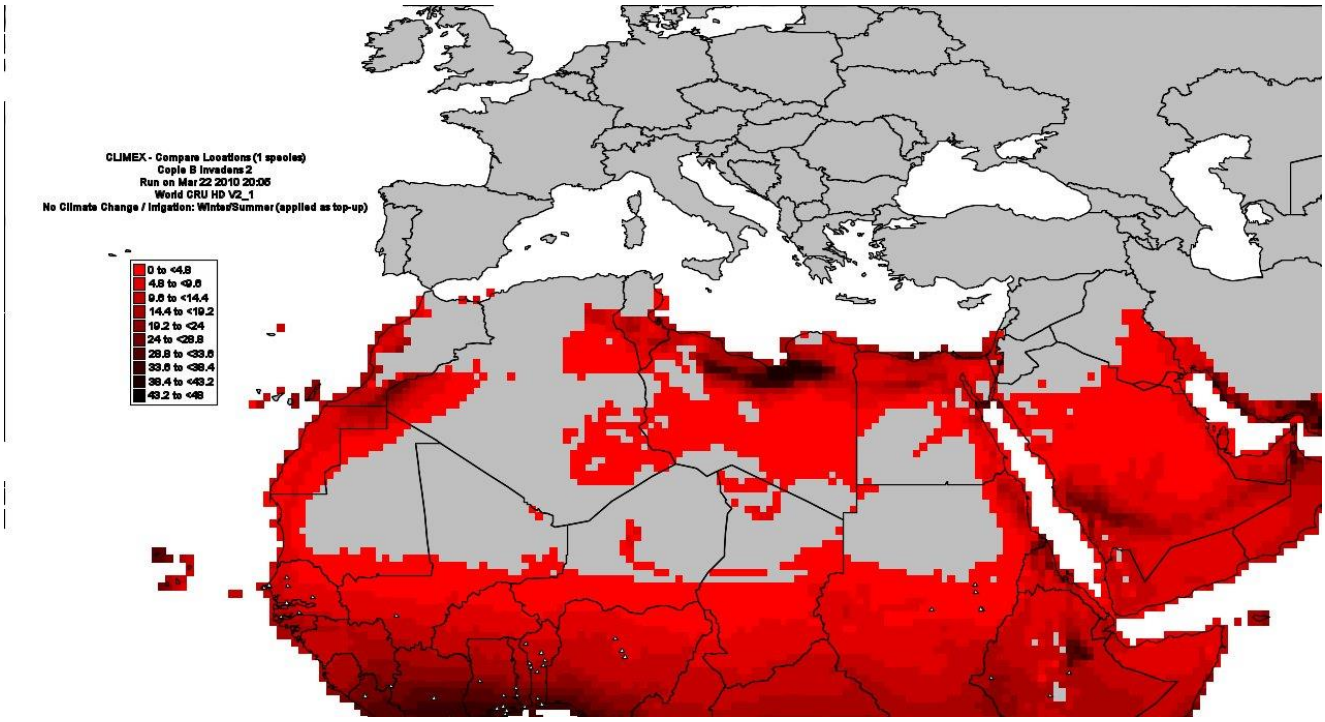


Figure 4: Potential distribution of *B. invadens* in the Mediterranean Basin with irrigation scenario (Ecoclimatic index)

The irrigation scenario only increases the potential distribution of the species in desertic areas of the Southern part of the Mediterranean area, as the limiting factor in EU Mediterranean countries are cold temperatures.
The distribution points in Sebegal and Sudan appear to be fiting the model with the irrigation scenario.
What is important to note is the potential ability of the species to spread naturally from central Africa to the Mediterranean through the Moroccan coasts. This would only be possible if irrigated crops would be present there, keeping in mind that the pest could fly 40 km and make stops to vegetation through this coast. While looking at this area from google earth, it seems very unlikely that irrigated crops exist. The desert should therefore be a limited factor for the species to spread naturally.
The species could develop sustainable populations in Algeria, Egypt, Jordan, Israel, Lybia, Morocco, and Tunisia, and these populations appear to have a high Ecoclimatic index, and therefore top be well suited for such countries.

Growth index
Although the Southern side of the Mediterranean seems to be suitable for *B. invadens* to maintain sustainable populations, it appears that transient populations occuring in the northern side of the Mediterranean could develop through the summer months and maintain several generations, as shown on the map below:

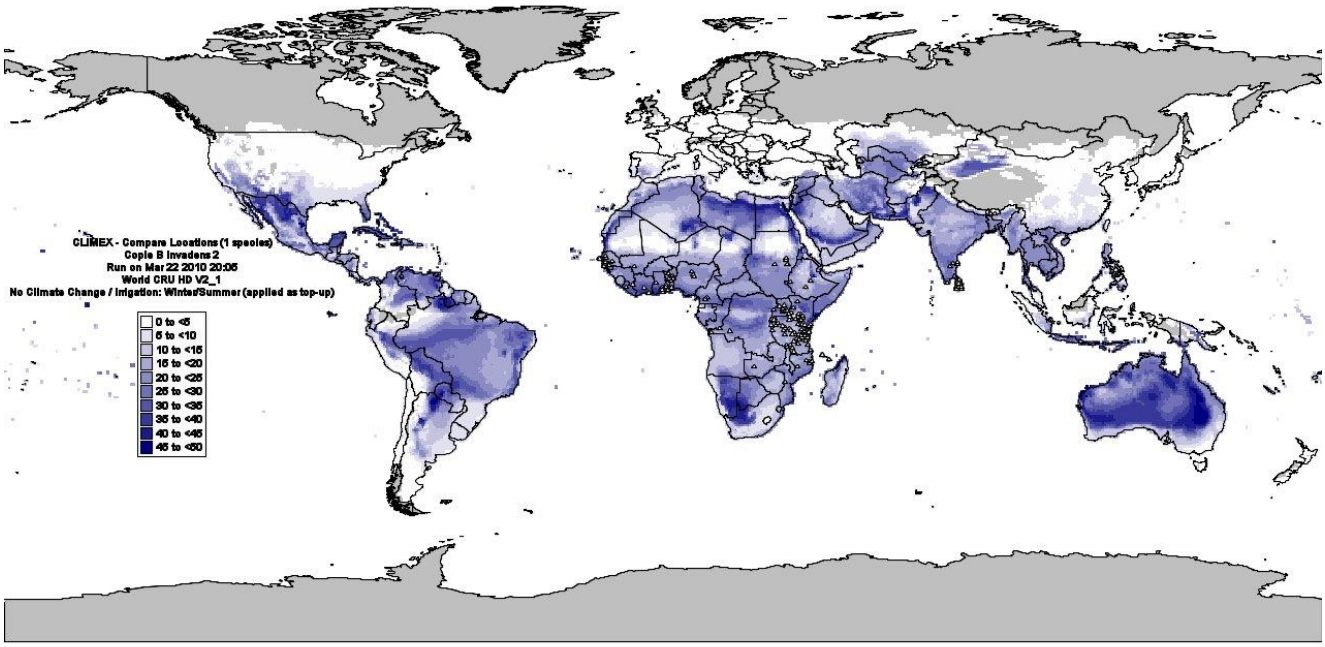


Figure 5: Growth index of *B. invadens* in the world with irrigation scenario

Zoom on the Mediterranean basin:

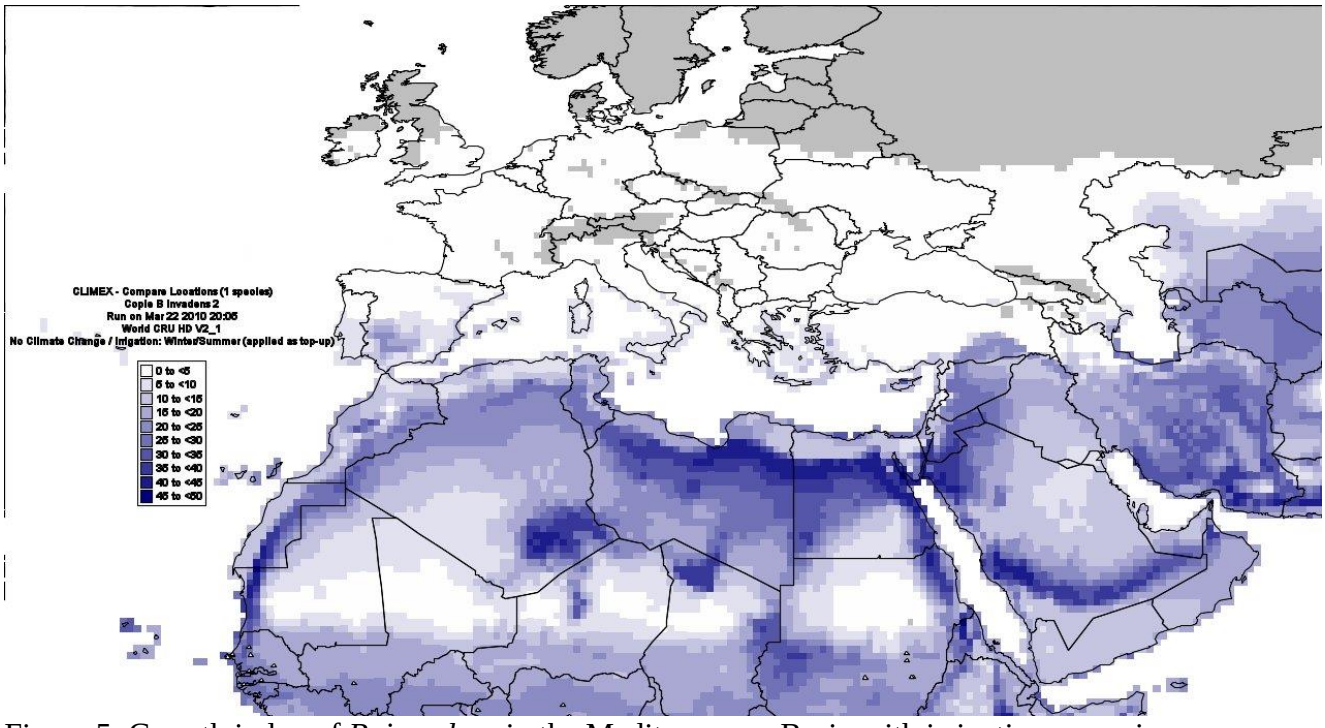


Figure 5: Growth index of *B. invadens* in the Mediterranean Basin with irrigation scenario

Southern Spain is particularly at risk, even more bearing in mind that from established populations in Morocco, the species could easily fly the 20 km of the Gilbratar straight and set transient populations every year. Up to 6 generations of *B. invadens* could be produced in Southern Spain in spring and at the end of the summer.

The countries were at least 5 generations of *B. invadens* can threive are shown on the map below, irrigation scenario has been integrated:

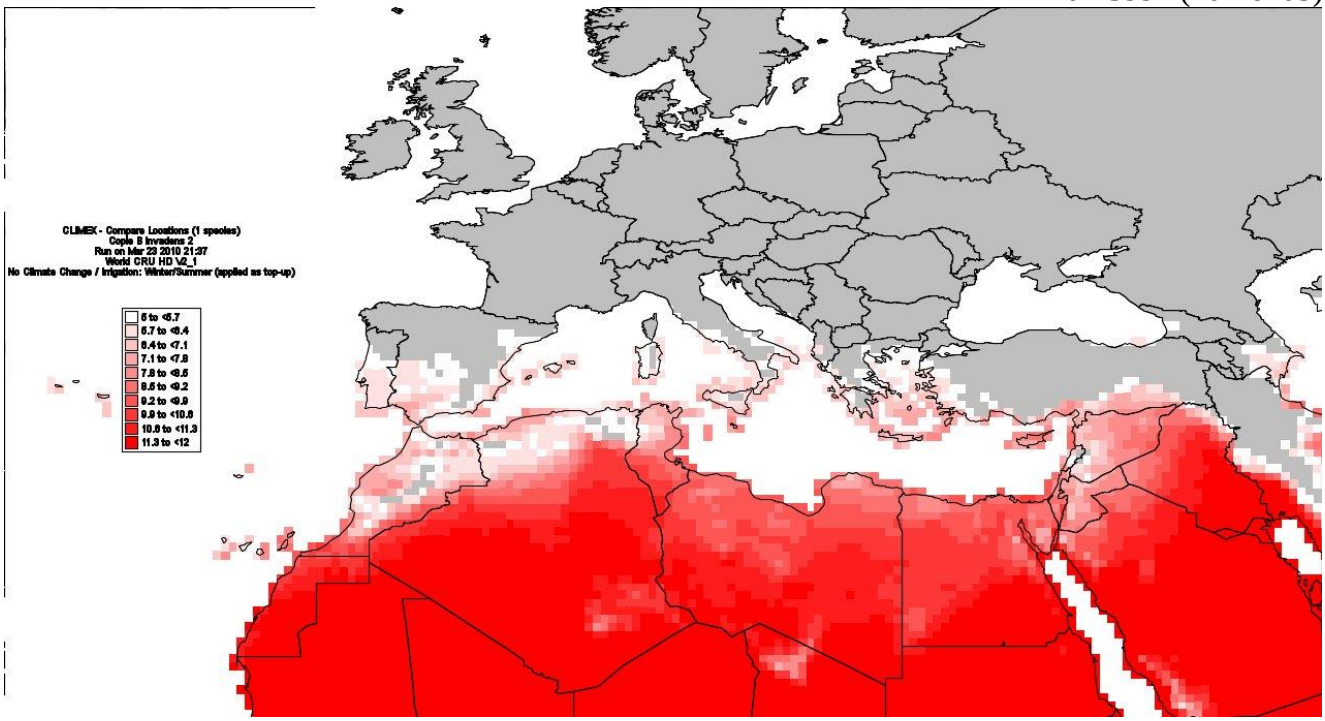


Figure 6: Number of generations of *B. invadens* superior to 5 in the Mediterranean Basin, with irrigation scenario

Other countries at risk of contamination from transient populations introduced as contaminants of commodities such as fruits include (the indicative number of at least 5 generations has been taken): Albania, Corsica, Crete, Croatia, Greece, Italy (Sardinia, Sicily), Lebanon, Portugal, Syria, Turkey.

Nevertheless, B. invadens could thrive for 1 generation in almost all temperate EPPO countries.

Climate change scenario

No climate change scenario has been implemented, but it would most probably increase the range of the species in southern Europe.

Conclusions

The countries of the Mediterranean basin that are considered to be particularly at risk (including non EPPO countries) as *B. invadens* could establish: Algeria, Egypt, Jordan, Israel, Lybia, Morocco, and Tunisia.

In other Mediterranean countries, establishment is not expected. *B. invadens* could be regularly intrudced as a contaminant of fruit and have detrimental impacts through transient populations. Indeed, the species could develop 5 generations in Albania, France (Corsica), Cyprus, Croatia, Greece (Crete), Italy (Sardinia, Sicily), Lebanon, Portugal, Spain, Syria, Turkey. This is expected to be localized excursions, as the building up of population would be low. Spain is particularly at risk as the species could spread naturally if it was established in Morocco.

The tolerances of the species to cold temperatures, as well as to dry conditions remain the 2 major uncertainties. The species could adapt to new conditions in the Mediterranean and have a wider distribution than the one descibed above.

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