PEST RISK ANALYSIS

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INITIATION

STAGE 1: INITIATION		
The aim of the initiation stage is to identify the pest(s) and pathways, which are of phytosanitary concern and should be considered for risk analysis in relation to the identified PRA area.		
Question	**Yes / No / Score**	**Notes**
1. Give the reason for performing the PRA	Go to 2	In 2005, *Darna trima* was found at a glasshouse production site in the Netherlands on the palm species *Thrinax parviflora*. In 2006, *D. trima* was found on the same palm species at another production site. In both occasions, *D. trima* was eradicated.
2. Specify the pest or pests of concern and follow the scheme for each individual pest in turn. For intentionally introduced plants specify the intended habitats.	Go to 3	*Darna trima*
If no pest of concern has been identified, the PRA may stop at this point.		
3. Clearly define the PRA area.	*Go to 4*	The Netherlands
Earlier analysis		
4. Does a relevant earlier PRA exist ? *if yes go to 5* *if no go to 7*	No	No
5. Is the earlier PRA still entirely valid, or only partly valid (out of date, applied in different circumstances, for a similar but distinct pest, for another area with similar conditions)? *if entirely valid, End* *if partly valid proceed with the PRA, but compare as much as possible with the earlier PRA, go to 6* *if not valid go to 6*		

Stage 2: Pest Risk Assessment		
Section A: Pest categorization		
Identify the pest (or potential pest)		
6. Is the organism clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank? *if yes indicate the correct scientific name and taxonomic position go to 8* *if no go to72*		Taxonomic Tree Domain: Eukaryota Kingdom: Metazoa Phylum: Arthropoda Class: Insecta Order: Lepidoptera Family: Limacodidae Genus: *Darna* Species: *D. trima* (Anonymous, 2004a)
7. Even if the causal agent of particular symptoms has not yet been fully identified, has it been shown to produce consistent symptoms and to be transmissible? *if yes go to 8* *if no go to 17*		
Confirm pest status (actual or potential)		
8. Is the organism in its area of current distribution a known pest (or vector of a pest) of plants or plant products? *if yes, the organism is considered to be a pest, go to 10*	Yes	Yes (e.g. Siburat and Mojiun, 1998; Hoong and Hoh, 1992) Current area of distribution: Indonesia, Malaysia and possibly also Singapore (Anonymous, 2004a; see also the answer on question 1.1)

if no, go to 9		
9. Does the organism have intrinsic attributes that indicate that it could cause significant harm to plants? *if yes or uncertain, the organism may become a pest of plants in the PRA area, go to 10* *if no, go to 17*		
Presence or absence in the PRA area and regulatory status		
10. Does the pest occur in the PRA area ? *if yes go to 11* *if no go to 12*	No	Absent: pest eradicated
11. Is the pest widely distributed in the PRA area? *if not widely distributed, go to 12* *if widely distributed, go to 17*		
Potential for establishment and spread in the PRA area		
12. 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)? *if yes go to 13* *if no go to 17*	Yes	Yes, plant species belonging to the palm family (Palmae) are grown under protected conditions.
13. If a vector is the only means by which the pest can spread, is a vector present in the PRA area? (if a vector is not needed or is not the only means by	Not applicable	Not applicable

which the pest can spread go to 14) *if yes go to 14* *if no go to 17*		
14. 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 thrive (consider also protected conditions)? *if yes go to 15* *if no go to 17*	Yes	Glasshouses
Potential for economic consequences in PRA area		
15. 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? *if yes or uncertain go to 16* *if no go to 17*	Yes	
Conclusion of pest categorization		
16. **This pest could present a risk to the PRA area** (Summarize the main elements leading to the conclusion that the pest presents a risk to the PRA area)	**Go to Section B**	
17. **The pest does not qualify as a quarantine**		

pest for the PRA area and the assessment for this pest can stop (summarize the main reason for stopping the analysis).		

Section B. Assessment of the probability of introduction and spread and of potential economic consequences

1. Probability of introduction

Introduction, as defined by the FAO Glossary of Phytosanitary Terms, is the entry of pest resulting in its establishment.

Probability of entry

1.1 Consider all relevant pathways and list them. *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* Go to 1.2		All plants, which are imported from regions where the pest occurs (Indonesia, Malaysia and possibly also Singapore) and which may act as a host plant. <u>Host plants of *Darna trima*</u> Various host plants are mentioned in literature of which coconut and especially oil palm are mentioned most frequently. According to the CABI Crop Protection Compendium (2004a), *Darna trima* has the following host plant species: • Major hosts: *Camellia sinensis* (tea), *Cocos nucifera* (coconut), *Elaeis guineensis* (African oil palm), *Metroxylon sagu* (sago palm), *Theobroma cacoa* (cocoa) • Minor host: *Canna*, *Citrus*, *Coffea* (Coffee), *Eugeni*, *Mangifera indica* (Mango), *Musa* (banana)., In literature, no experimental or observational data could be found for most plant species that are indicated as hosts, other than coconut and oil palm. *D. trima* is, however, considered as a species with a very wide host range (Anonymous, 2004a). Siburat and Mojiun (1998) refer to an unpublished paper (Lim, 1998) in which 15 species of wild shrubs and two species of ferns are described as possible host plants to limaconid pests in an oil palm plantation in Malaysia. No records could be found on *Thrinax parviflora* as a host plant although the pest was found on this plant species at a commercial glasshouse production site in the Netherlands. Therefore, all plant species mentioned in literature (see lists above) and all plant species belonging to the palm family (Palmae or Arecaceae) are considered in this PRA as host plants. It was investigated which palm species were imported from the region of

origin using a list of 18 economically most important palm genera in the Netherlands to assess the possibility of entry (Anonymous, 2004b). This list certainly does not show all palm genera imported into the Netherlands (e.g. *Thrinax spp.* are not on this list). However, the top 4 of these genera represents about 90% of all palm plants sold via Dutch auctions (Anonymous, 2004b). All records of imported plants from April 2004 to March 2005 were investigated for *Thrinax* spp and the 18 economically most important palm genera and for other plant species recorded as hosts of *D. trima* (see the lists of major and minor hosts above).

Plants of palm species imported from Indonesia (may not be complete):

- *Thrinax parviflora*
- *Cocos*
- *Licuala*
- *Phoenix*
- *Raphis*

Host plants other than palm species imported from Indonesia:

- Musa (banana)

Palm species imported from Malaysia (may not be complete):

- *Areca*
- *Caryota*
- *Chrysalidocarpus*
- *Licuala*
- *Phoenix*
- *Ravenae*
- *Raphis*

		Host plants other than palm species imported from Malaysia: • *Citrus spp.* No import records of palm species or other possible host plants from Singapore were found for the period April 2004 – March 2005. The cocoons of *D. trima* resemble seeds of the Kentia palm (*Howea*, *Areca* and *Chamaedora* spp.) and might be present among imported seeds (W. den Hartog, Dutch Plant Protection Service, pers. comm. to D.J. van der Gaag, March 2006). The probability that cocoons will be present among seeds is considered very low since the mature larva pupates near the base of the leaflets of the base of the palm (Holloway *et al*, 1987) and not in the inflorescence. Moreover, no import records of seeds from Indonesia, Malaysia or Singapore were found from period April 2004 to March 2005. Therefore, this pathway will not be analysed in this PRA. In this PRA, only plants from genera belonging to the *Palmae* family have been analysed as a pathway since the other host plants which are imported from countries where *D. trima* is present, *Citrus* sp. and *Musa* sp., are minor host plants and imported and grown on a much smaller scale than palm plants in the Netherlands. **Note on distribution of *D. trima*** • *D. trima* is present in Indonesia and Malaysia (e.g. Kamarudin and Wahid, 1992; Pardede, 1992) and possibly also in Singapore (Anonymous, 2004a). *D. trima* was recorded in a Chinese article in a tea plantation in China (Yang *et al*, 1994; English abstract was read only). However, records of occurrence in Thailand and China probably refer to other *Darna* species according to Holloway *et al* (in Anonymous, 2004a). Plants imported from Thailand and China are, therefore, not considered as

		potential pathways in the present PRA. One article was found (in Cab abstracts 1972 – 2005/02) in which an outbreak of *D. trima* was recorded in the Philippines (Crawford, 1984). No other records have, however, been found on *D. trima* in the Philippines and it is uncertain if *D. trima* is present in the Philippines.
1.2 Estimate the number of relevant pathways, of different commodities, from different origins, to different end uses. Go to 1.3	Few	See also the answer on question 1.1. Plants of palm species imported from Indonesia, Malaysia and Singapore are combined and considered as one pathway in this PRA.
1.3. Select from the relevant pathways, using expert judgement, those which appear most important. If these pathways involve different origins and end uses, it is sufficient to consider only the realistic worst-case pathways. The following group of questions on pathways is then considered for each relevant pathway in turn, as appropriate, starting with the most important. Go to 1.4		Plants of palm species imported from Indonesia, Malaysia and Singapore.
Probability of the pest being associated with the individual pathway at origin.		
1.4 Is the prevalence of the pest on the pathway at origin likely to be high, taking into account factors like the prevalence of the pest at origin, the life stages of the pest, the period of the year? Go to 1.5	Moderately likely	*D. trima* is a common pest in oil palm and coconut in Indonesia and Malaysia but it does usually not occur at high densities (Ginting, 1989; Hoong and Hoh, 1992; Siburat and Mojiun, 1998).

1.5 Is the prevalence of the pest on the pathway at origin likely to be high, taking into account factors like cultivation practices, treatment of consignments? Go to 1.6	Moderately likely (probably)	*D. trima* has been found in 2005 and 2006 at two different glasshouse productions sites in the Netherlands belonging to the same grower. The pest was eradicated in both occasions (information from the Dutch Plant Protection service). In both occasions, the pest had probably been introduced with palm plants imported from the same location in Indonesia.
1.6 How large is movement along the pathway? Go to 1.7	moderate	From April 2004 – March 2005 the following import records are known: Number of palm plants imported from Indonesia: Palm species: • *Cocos* 50 • *Licuala* 7 • *Phoenix* 3022 • *Raphis* 51785 Number of palm plants imported from Malaysia: Palm species: • *Areca* 115 • *Caryota* 1000 • *Chrysalidocarpus* 100 • *Licuala* 337 • *Phoenix* 10 • *Ravenae* 1000 • *Raphis* 33668 No records of palm plants imported from Singapore were present for the period April 2004 – March 2005.
1.7 How frequent is the movement along the pathway?	very often	Palm species are imported from Indonesia or Malaysia into the Netherlands in sea containers without climate control during the whole year.

Go to 1.8		
Probability of survival during transport or storage		
1.8 How likely is the pest to survive during transport / storage? Go to 1.9	likely	The conditions in sea containers without climate control are appropriate for the transport of living plants from tropical regions. These conditions are likely to allow for survival of *D. trima*.
1.9 How likely is the pest to multiply / increase in prevalence during transport / storage? Go to 1.10	unlikely	If eggs are present they may hatch during transport (duration of egg development is 2-7 days (Halloway et al. 1987; CAB international 2004) and may start feeding. Eclosion of pupae that are present is likely. The conditions during transport in sea containers without climate controle are not believed to be favourable for reproduction (mating, developing of eggs and egg deposition).
Probability of the pest surviving existing pest management procedures		
1.10 How likely is the pest to survive or remain undetected during existing phytosanitary procedures? Go to 1.11	likely	The eggs are very small and are dispersed over the whole plant. Detection of eggs is very difficult. Older stages of caterpillars are up to 16 mm long (Chong *et al*., 1991) and are likely to be detected. Early stage caterpillars are small (+/- 2 mm) (Holloway *et al*., 1987) and difficult to spot. When cocoons would be present in seed lots, they will be difficult to detect among seeds of Kentia, Areca and Chamaedorea plants since the cocoons are similar in appearance.
Probability of transfer to a suitable host or habitat		
1.11 In the case of a commodity pathway, how widely is the commodity to be distributed throughout the PRA area? Go to 1.12	moderately widely	Palm species are grown on about 20 – 30 ha in glasshouses in the Netherlands. Most of these glasshouses are located in glasshouse areas the western part of the Netherlands (regions: Aalsmeer and Westland). Some of the glasshouse productions sites are located in the southern and eastern part of the Netherlands (G. van Leeuwen, Applied Plant Research, the Netherlands, pers. communication to D.J. van der Gaag, May 2005).
1.12 In the case of a commodity pathway, do consignments arrive at a suitable time of year for pest establishment? If yes, go to 1.13	Yes	Consignments arrive throughout the year. The temperature in glasshouses is suitable for pest establishment during the whole year.

If no, go to 1.3 (and start with other pathway, if relevant)		
1.13 How likely is the pest to be able to transfer from the pathway to a suitable host or habitat? Go to 1.14	very likely	The pest is introduced on palm plants and is likely to transfer to other host plants (usually other palm species) in the same glasshouse. It might also move to host plants in other nearby glasshouses (uncertainty).
1.14 In the case of a commodity pathway, 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? Go to 1.15	very likely	*D. trima* present on imported plants can easily infest other host plants in the same glasshouse. It might also move to host plants in other nearby glasshouses (uncertainty).
Consideration of further pathways In principle, all the relevant pathways selected at point 1.3 may in turn be considered. However, the replies given for the pathway(s) so far considered may indicate that it is not necessary to consider any more.		
1.15 Do other pathways need to be considered? If yes, go back to 1.3 If no, go to conclusion on the probability of entry	No	
Conclusion on the probability of entry		
Describe the overall probability of entry and identify the risks presented by different pathways Go to 1.16		The probability of entry is moderately high. *D. trima* can enter the Netherlands mainly with plants from genera belonging to the *Palmae* family originating from Indonesia and Malaysia. Imported plants are grown in glasshouse production sites, a suitable habitat for *D. trima*. The pest has been found twice on different locations in the Netherlands, in 2005 and 2006.

Probability of establishment		
Availability of suitable hosts or suitable habitats, alternate hosts and vectors in the PRA area		
1.16 Specify the host plant species (for pests directly affecting plants) or suitable habitats (for non parasitic plants) present in the PRA area. Go to 1.17		Palm plant species of more than 20 genera are commercially grown in glasshouse production sites in the Netherlands of which the 4 most important ones are: • *Chamaedorea* • *Chrysalidocarpus* • *Phoenix* • *Howea* These 4 genera constituted 90% of the total number op palm plants sold via auctions in the PRA area in 2003 (Anonymous, 2004b).
1.17 How widespread are the host plants or suitable habitats in the PRA area? (specify) Go to 1.18	moderately widely	Palm species are grown on about 20 – 30 ha protected cultivation (this is a rough estimate, no detailed figures are known). Most glasshouse production sites that grow palm species are located in two glasshouse areas: Westland and Aalsmeer. Some glasshouse production sites are located in the southern and eastern part of the Netherlands (pers. comm. G. van Leeuwen, Applied Plant Research – Glasshouse horticulture, the Netherlands). Palm plants are grown outdoors in gardens or on pavements on a very limited scale. *Darna trima* is, however, a tropical species and not believed to be able to survive outdoors in the Netherlands.
1.18 If an alternate host is needed to complete the life cycle, how widespread are alternate host plants in the PRA area? (not relevant for plants) Go to 1.19	Not applicable	
1.19 If the pest requires another species for critical stages in its life cycle such as transmission, (e.g. vectors), growth (e.g. root symbionts), reproduction (e.g. pollinators) or	Not applicable	

spread (e.g. seed dispersers) how likely is the pest to become associated with such species? Go to 1.20		
Suitability of the environment		
1.20 How similar are the climatic conditions that would affect pest establishment, in the PRA area and in the area of current distribution? Go to 1.21	not similar for outdoor circumstances moderately similar for protected cultivation	Not similar for outdoor circumstances Moderately similar for protected cultivation
1.21 How similar are other abiotic factors that would affect pest establishment, in the PRA area and in the area of current distribution? Go to 1.22	Not relevant	*D. trima* is present in Indonesia, Malaysia and possibly also Singapore. The pest is not restricted to mountain areas and it has no soil phase in its life cycle. Abiotic factors other than climate conditions are probably of minor importance for establishment
1.22 (Answer this question only if protected cultivation is important in the PRA area.) How often has the pest been recorded on crops in protected cultivation elsewhere? Go to 1.23	Rarely	The pest has been observed in two glasshouses in the Netherlands. No pest records are known in protected cultivation elsewhere.
1.23 How likely is establishment to be prevented by competition from existing species in the PRA area? Go to 1.24	very unlikely	*D. trima* might face some competition from caterpillars of other species. However, it is very unlikely that the level of competition will play a significant role in the establishment of *D. trima*.

1.24 How likely is establishment to be prevented by natural enemies already present in the PRA area? Go to 1.25	very unlikely	In the area of origin several natural enemies are present, among which viruses, predators and parasitoids (Cock *et al*., 1987). Due to regular use of chemical insecticides in glasshouses that import palms, the presence of natural enemies is negligibly low or absent. This means that prevention of establishment through natural enemies is very unlikely.
Cultural practices and control measures		
1.25 To what extent is the managed environment in the PRA area favourable for establishment? Go to 1.26	highly favourable,	Host plants are grown in heated glasshouses where the temperature is favourable for the pest throughout the year. Host plants are usually present in the glasshouse during the whole year, which favours establishment of the pest.
1.26 How likely are existing control or husbandry measures to prevent establishment of the pest? Go to 1.27	unlikely	In the Netherlands, the crop is incidentally treated with insecticides to control caterpillars. In these cases, such control measures may prevent establishment of *D. trima*. In most cases, establishment will not be prevented since pesticides that are effective against caterpillars are not routinely applied. **Note** D. *trima* has been found in *Thrinax parviflora* where it probably has been present since the plants were imported about 1.5 years ago. The *Thrinax* plants were relatively large (2.5 – 4 m high) and control may be easier in smaller plants.
1.27 How likely is it that the pest could be eradicated from the PRA area ? Go to 1.28	likely	*D. trima* is a tropical species that probably cannot establish outdoors in the Netherlands. It has been found in plants of *Thrinax parviflora* in two glasshouse production sites from the same grower and successfully eradicated in 2005 and 2006, respectively. These plants had probably been imported about 1.5 years ago. No other records are known in the Netherlands and *D. trima* has probably not spread to other glasshouses. These data indicate that the pest can be eradicated.
Other characteristics of the pest affecting the probability of establishment		
1.28 How likely is the reproductive strategy	unlikely	The total life cycle takes about 2 months (Cock *et al*., 1987), which is relatively long. Adult

of the pest and the duration of its life cycle to aid establishment? Go to 1.29		moths live about one week. Life cycle duration or reproductive strategy do not specifically aid establishment.
1.29 How likely are relatively small populations or populations of low genetic diversity to become established? Go to 1.30	likely	Small populations of immature moths may escape detection. Adult moths that originate from a small larval population may spread in the glasshouse and deposit eggs, which will increase the pest population. Climatological conditions in glasshouses are favourable for reproduction.
1.30 How adaptable is the pest? Go to 1.31	Adaptability is: moderate	Regarding host plants: the species is polyphagous, and may switch between host plants. In that sense the species is rather adaptable. Regarding climate: although no data are available on this topic, it is believed that the species will not be able to adapt to the Dutch climate and will not be able to survive outdoors in the Netherlands.
1.31 How often has the pest been introduced into new areas outside its original area of distribution? (specify the instances , if possible) Go to 1.32	rarely	*Darna trima* has probably been introduced on Dutch glasshouse production sites with imported plants: it was found in 2005 and 2006 at two different locations and subsequently eradicated. No other cases of introduction into new areas are known. Introduction of *Darna trima* in China, Thailand and/or Philippines is uncertain (see also the Note on distribution in the answer of question 1.1).
1.32 Even if permanent establishment of the pest is unlikely, 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) ? (Transience = presence of a pest that is not expected to lead to establishment) Go to 1.33	unlikely	Transient populations are very unlikely to occur through natural migration since *D. trima* is currently only present in countries with a tropical climate and which are far from the Netherlands. *Darna trima* may enter the Netherlands with imported plants that are placed in glasshouses. Permanent establishment in glasshouses is likely to occur but outdoor establishment is not because of the unfavourable climate most time of the year. It is also unlikely that transient populations of the tropical species will occur outdoors during summer time since very few host plants are present outdoors and the life cycle of *D. trima* is relatively long (2 months; Anonymous, 2004a).

Probability of spread		
1.33 How likely is the pest to spread rapidly in the PRA area by natural means? Go to 1.34	very unlikely	Evidence from the rate of spread of outbreak populations indicates a low dispersal ability (Godfray *et al*., 1987). No detailed figures are known on the dispersal velocity of *Darna trima*. *Monema flavescens*, a closely related species, moves about 1 mile (1600 m) per year (Clausen, 1978). Outdoors, very few host plants are present in the Netherlands and they are commercially grown on about 30 ha under protected conditions (rough estimate). This limited occurrence of host plants in the PRA area will also not favour a rapid spread of the pest. Moreover, the outdoor climate will be unfavourable for *D. trima* most time of the year.
1.34 How likely is the pest to spread rapidly in the PRA area by human assistance? Go to 1.35	unlikely	As far as known, Dutch growers only sell imported plants directly to traders or consumers and not to other growers in the PRA area (information obtained from Dutch growers). It is, therefore, assumed to be unlikely that *D. trima* will spread among glasshouses by human assistance.
1.35 How likely is it that the spread of the pest could be contained within the PRA area? *Go to Conclusion on the probability of introduction and spread*	likely	*D. trima* is a tropical species that will probably not be able to establish outdoor in the PRA area nor in neighbouring countries. The risk on spread of the organism from glasshouse production sites in the Netherlands to glasshouse production sites in neighbouring countries is, therefore, expected to be low. Plants imported into the PRA area from regions where the pest occurs are not resold to commercial nurseries in other countries as far as known (pers. comm. P. Mocking, Dutch Plant Protection Service).
Conclusion on the probability of introduction (= entry + establishment) and spread		
Describe the overall probability of introduction and spread. The probability of introduction and spread may be expressed by comparison with PRAs on other pests. *Go to 1.36*		The probability of introduction is moderately high. *Darna trima* can be introduced with import of plants (mainly palm species) from Indonesia, Malaysia and possibly also Singapore. It has been found twice (2005 and 2006) on palms that had been imported from the same location in Indonesia. The probability of spread is low. *Darna trima* is a tropical species and the outdoor climate will be unfavourable most time of the year. Moreover, *D. trima* does probably not fly over distances much longer than 1 km and host plants are present on a very limited scale

		outdoors. Host plants are grown in commercial glasshouse production sites on about 30 ha (rough estimate; no exact figures are known). The probability of spread by human activities is also considered low: as far as known, glasshouse growers do not sell imported plants to other growers.
Conclusion regarding endangered areas		
1.36 Based on the answers to questions 1.16 to 1.35 identify the part of the PRA where presence of host plants or suitable habitats and ecological factors favour the establishment and spread of the pest to define the endangered area. Go to 2 Assessment of potential economic consequences		Glasshouse production sites that import palm plants from Indonesia, Malaysia, and possibly also Singapore are the most endangered area. Glasshouse production sites that grow palm plants (but do not import plants from Indonesia, Malaysia, and possibly also Singapore) are the less endangered area.

2. Assessment of potential economic consequences		
Pest effects		
2.1 How important is the effect of the pest on crop yield and/or quality to cultivated plants or on control costs caused by the pest within its area of current distribution? Go to 2.2	moderate	Larvae of *Darna trima* eat leaves of palms, which can have a major effect on yield (CAB International, 2004). Reductions of up to 60% of the leaf area of palms by *D. trima* have been reported in one outbreak (Young, 1971 in Anonymous, 2004a). *D. trima* and Limacodids in general were no serious pests on oil palm agencies in Malaysia during 1981 – 1990 (Kamarudin and Wahid, 1992). According to Siburat and Mojiun (1998), D. trima is one of the three most encountered pests in Sapi plantations in Malaysia. Largest populations are usually present during periods with low rainfall (around April). During these periods costs for control of leaf pests are relatively high. At other times of the year the pest occurs normally in relative small number. About 236,000 ha oil palm plantation was present in Sabah (Malaysia) in '80's (Hoong and Hoh, 1992). About 31,000 ha were infested by nettle caterpillars (*D. trima* is one of the three common nettle caterpillar species) from 1980 to 1985 with an estimated control cost of 900,000 US dollar during this period excluding loss in production and management time. No recent data have been found on yield losses or data on costs of control of the pest in literature.
2.2 How great a negative effect is the pest likely to have on crop yield and/or quality in the PRA area? Go to 2.3	minor	In the PRA area, palms are grown as ornamentals in glasshouses. Leaves damaged by larvae of *D. trima* may have to be removed by hand. Damage caused by *D. trima* on the palm species *Thrinax parviflora* in a Dutch nursery did, however, not lead to unmarketable plants (pers. comm. P. Mocking, Dutch Plant Protection Service). Uncertainty: *D. trima* may cause higher yield reductions in other palm species.
2.3 How great an increase in production costs (including control costs) is likely to be caused by the pest in the PRA area? Go to 2.4	minimal - minor	The pest appeared to be relatively easy to control. A few sprays with insecticides in a nursery where the palm *Thrinax parviflora* was infested, were sufficient to eradicate or to minimize the *D. trima* population in a glasshouse nursery in the Netherlands (pers. comm. A.C. Meijer, Dutch Plant Protection Service). Apparently, the pest can be easily controlled and the increase

		in production costs by the use of insecticides will be minor. Costs for pesticides constitutes about 0,5% of the total costs on pot plant production sites (Source: Bedrijven-Informatienet LEI, www.lei.wur.nl) and total costs for crop protection including labour and depreciation of spraying equipment may be a few percent of the total production costs. The costs to remove damaged leaves were low: it concerned a limited number of about 135 plants each 2.5 – 4 m high. Costs for removal of damaged leaves will be relatively higher in case of smaller, less valuable, plants. Therefore, the relative increase in production costs will be minimal - minor.
2.4 How great a reduction is the pest likely to cause on consumer demand in the PRA area? Go to 2.5	minimal	The pest can probably be controlled easily (see answer on question 2.3) and the effect of the pest on consumer demand is expected to be minimal.
2.5 How important is environmental damage caused by the pest within its area of current distribution? Go to 2.6	minimal	Although *Darna trima* is polyphagous, it is a pest almost exclusively of oil palm plantations in a restricted area of South east Asia. Literature on this particular species does not mention exceptional damage to palms other than plantations (Godfray et al, 1987; Wood and Nesbit, 1969).
2.6 How important is the environmental damage likely to be in the PRA area? Go to 2.7	minimal	*Darna trima* can most likely not establish itself in the PRA area in the outside environment and it is therefore very unlikely to cause environmental damage.
2.7 How important is social damage caused by the pest within its area of current distribution? Go to 2.8	minor	Recent data on damage caused by *D. trima* are not available in literature. *D. trima* was not considered a serious pest of oil palm in Malaysia during 1981 – 1990 (Kamarudin and Wahid, 1992). Besides its impact on trees, *D. trima* is a nuisance to humans, as the stinging spines of the larvae, when touched, cause skin irritation comparable to touching a stinging nettle plant (*Urtica dioica*) or to a wasp sting, depending on a persons sensitivity to the poison (M.J. van Straten, Dutch Plant Protection Service, pers. communication).
2.8 How important is the social damage likely to be in the PRA area? Go to 2.9	minimal	*D. trima* is a nuisance to humans, as the stinging spines of the larvae, when touched, cause skin irritation comparable to touching a stinging nettle plant (*Urtica dioica*) or to a wasp sting, depending on a persons sensitivity to the poison (M.J. van Straten, Dutch Plant

		Protection Service, pers. communication). However, the number of larvae will be lower in the Netherlands compared to the pest's current area of distribution.
The evaluation of the following questions may not be necessary if any of the responses to questions 2.2, 2.3, 2.4, 2.6, or 2.8 is "major or massive" or "likely or very likely". You may go directly to point 2.16 unless a detailed study of impacts is required.		
2.9 How easily can the pest be controlled in the PRA area? Go to 2.10	easily	*Darna trima* had probably been present during about 1.5 years before it was found at a glasshouse production site in 2005. During that 1.5-years period, damage was minimal although the pest was not intensively controlled by the grower. In 2005, an eradication program was performed and a few sprays with methomyl and LVM application of deltamethrin was sufficient to minimize or even eradicate the *D. trima* population (pers. comm. A.C. Meijer, Dutch Plant Protection Service). *Darna trima* was eradicated after a 56-days control program during which insecticides were applied weekly. A shorter period may have been sufficient for eradication. On 16 February 2006, larvae of *Darna trima* were found at another location. The grower applied an insecticide the same day after which no more larvae or adults were found (pers. comm. S.P.G.G. Mocking, Dutch Plant Protection Service). Apparently, the pest can be easily controlled. Uncertainty: control may be more difficult in other host plants, for example plants that provide places where the caterpillars are difficult to hit by insecticide sprays.
2.10 How probable is it that natural enemies, already present in the PRA area, will suppress populations of the pest if introduced? Go to 2.11	unlikely	In glasshouses in the PRA area, caterpillars from other species than *D. trima* are not (sufficiently) suppressed by natural enemies, but are controlled by insecticides instead (including those based on *Bacillus thuringiensis*). It is, therefore, unlikely that natural enemies already present in the PRA area will suppress *D. trima* populations.
2.11 How likely are control measures to disrupt existing biological or integrated systems for control of other pests or to have negative effects on the environment?	very unlikely	The use of natural enemies for the control of pests in pot plants is limited at this moment. In case predatory mites are being used against for example thrips, the insecticide teflubenzuron can be used which has no or little harmful effect on these mites. *Bacillus thuringiensis* based products are selective and can be used in an integrated control system. However, their

Go to 2.12		efficacy may not be sufficient (Basri *et al*, 1994)
2.12 How likely is the presence of the pest in the PRA area to affect export markets? Go to 2.13	unlikely	Palms are sold as final product to consumers in the Netherlands and are exported to various European countries including Russia and Southern Europe (information from an exporting company). Young plants are also exported to growers in southern Europe where they are further raised (pers. comm. G. van Leeuwen, Applied Plant Research – Glasshouse horticulture, the Netherlands). In the Netherlands, the total turnover of palm species via auctions was about 42 million euro in 2003 (Anonymous 2004b). Export figures are not known but most plants are probably exported (information obtained from a company which exports plants). *D. trima* can probably easily be controlled using insecticides and plants that are visually damaged by *D. trima* will not be marketed or only when damaged leaves have been removed. However, some plants may be sold with larvae or pupae of *D. trima* and this may negatively affect the image of palm plants from Dutch glasshouse production sites.
2.13 How important would other costs resulting from introduction be? Go to 2.14	minor	Costs for pest control may increase to some extent. Costs for the control of one isolated outbreak of *D. trima* in *Thrinax parviflora* were minor in the Netherlands. Uncertainty: control may be more difficult (and control costs higher) on host plants where the organism can hide at places where they are difficult to hit by insecticide sprays.
2.14 How likely is it that genetic traits can be carried to other species, modifying their genetic nature and making them more serious plant pests? Go to 2.15	very unlikely	No other *Darna* species occur in the Netherlands.
2.15 How likely is the pest to act as a vector or host for other pests? Go to 2.16	very unlikely,	No records exist of *Darna trima* being a vector.
Conclusion of Assessment of potential economic consequences		

2.16 Referring back to the conclusion on endangered area (1.36), identify the parts of the PRA area where the pest can establish and which are economically most at risk. Go to Degree of Uncertainty	Glasshouse production sites that import palm plants from Indonesia, Malaysia, and possibly also Singapore are economically most at risk, although the economic impact is considered to be minor.
Degree of uncertainty	

Document the areas of uncertainty and the degree of uncertainty in the assessment, and indicate where expert judgment has been used. This is necessary for transparency and may also be useful for identifying and prioritizing research needs. Go to Conclusion of the Risk Assessment	Host plants: oil palm and coconut are mentioned in several research articles as host plants; sago palm is mentioned in one research article (CAB Abstracts 1972 – 2005/02). Several other plant species are listed as host plant in the Cabi Crop Protection compendium (Anonymous, 2004a), but no records of these host plants have been found in literature. *Thrinax parviflora* was not listed although *D. trima* has been found at a glasshouse production site in the Netherlands. It is, therefore uncertain which plant species are hosts of *D. trima*. In the present PRA, all plant species belonging to the palm family and plant species listed in the Cabi Crop Protection compendium (Anonymous, 2004a) have been assumed to be hosts. *D. trima* may affect several palm species grown in glasshouses in the PRA area. Practical information is available from two outbreaks on the same palm species (*Thrinax parviflora*). However, the degree of damage and difficulty to control in different palm species may differ but no information is available on damage and control in other plant species in the PRA area. Based on experiences with pests with a comparable life cycle and already present in the PRA area, it is expected that the degree of damage and difficulty to control will not vary largely among different palm species (expert judgement). It is believed that the probability that *Darna trima* will spread from one glasshouse production site to another is low in the PRA area unless the glasshouse sites are located close to each other (e.g. less than 100 m). However, no information is available on spread of *Darna trima* from one glasshouse production site to another. Expert judgement has been used to assess the probability of spread and limited information available from literature about the spreads of the pest in its current area of distribution. Uncertainty: most palm plants grown in the Netherlands are probably exported to other European countries but no export figures are known.

3. Conclusion of the Risk Assessement

Entry

Darna trima can enter commercial glasshouses with imported plants (mainly palm species) from its current area of distribution (Indonesia, Malaysia and possibly also Singapore). It has been found twice (2005 and 2006) on palms in two different glasshouse productions sites of the same grower who had imported these palms from Indonesia.

ENTRY RISK: MODERATELY HIGH

Establishment

In 2005, *D. trima* was found on palm plants that had been imported about 1.5 year before. Thus, *D. trima* had probably already been present for about 1.5 years in that glasshouse which indicates that it can establish in glasshouses. *D. trima,* a tropical species, can probably not establish outdoor since the climate in the Netherlands is not favourable most time of the year. Glasshouse production sites that grow host plants (mainly palm species) present the greatest risk of establishment (estimated area: 20 – 30 ha). The probability that *D. trima* will spread from one glasshouse productions site to another is estimated to be low: *D. trima* will probably not fly over long distances (e.g. distances much longer than 1 km), few host plants are present outdoors and the outdoor climate is unfavourable for development of the pest most time of the year.

ESTABLISHMENT RISK IN GLASSHOUSES: HIGH

Spread

Darna trima is a tropical species and the outdoor climate in the Netherlands will be unfavourable for development of this species most time of the year. Moreover, *D. trima* is probably not able to fly over distances much longer than 1 km and host plants are scarce outdoors. The probability of spread by human activities is also considered low: as far as known, glasshouse growers do not sell imported plants to other growers.

SPREAD RISK: LOW

Economic importance

D. trima has been found twice on commercial glasshouse production sites in the Netherlands. In one occasion, the pest had probably been introduced with imported plans 1.5 year before. During that 1.5 year, *D. trima* had caused minor losses. The pest could be eradicated relatively easily with insecticides.

ECONOMIC IMPACT: MINOR

Overall conclusion

D. trima does not qualify as an quarantine organism. The probability that *D. trima* will enter the PRA area and establish in some greenhouses which grow palm species is moderately high but:

- The pest does not spread very easily among glasshouse production sites

- It can be relatively easily controlled with pesticides
- The economic losses are estimated to be minor

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