CSL PEST RISK ANALYSIS FOR *LEUCINODES ORBONALIS*

STAGE 1: PRA INITIATION

1. What is the name of the pest?

Leucinodes orbonalis (Guenée, 1854) Lepidoptera Crambidae (Superfamily Pyraloidea). The Brinjal fruit and shoot borer

Notes on taxonomy:
Pycnarmon discerptalis (Hampson) has been suggested as a possible synonym but opinions on this vary.

BAYER CODE: LEUIOR

2. What is the reason for the PRA?

There have been many interceptions of this species in the UK. Between June 1999 and May 2006, there were 40 finds. The majority of interceptions have been on *Solanum melongena* (aubergine), but *L. orbonalis* has also been intercepted on *Solanum melongena* var. *serpentinum* (snake-shaped eggplant), *Solanum torvum* (devils-fig), *Syzygium cumini* (black olum tree) and *Vigna unguiculata* subsp. *sesquipedalis* (cow pea/black eyed pea). Most recent interceptions have been on produce imported from either India or Thailand, with the remaining interceptions from Bangladesh, Denmark, Dominican Republic, Ghana, Kenya, Nigeria, Pakistan and 4 of unknown origin (Annex 1). The number of interceptions per month is randomly dispersed[1] (X^2 =18.2, 11df) (Annex 1).

3. What is the PRA area?

This PRA considers the whole EPPO region concentrating on the European and Mediterranean area, i.e. EPPO west of the Ural mountains.

STAGE 2: PEST RISK ASSESSMENT

4. Does the pest occur in the PRA area or does it arrive regularly as a natural migrant?

L. orbonalis does not occur in the PRA area, nor does it arrive as a natural migrant. However, it is occasionally detected in consignments of produce imported into the UK (see 2).

5. Is there any other reason to suspect that the pest is already established in the PRA area?

No, there are no records indicating that *L. orbonalis* is established anywhere within the PRA area.

[1] Tested using chi-squared and an Index of Dispersion (Fowler & Cohen, 1990)

6. What is the pest's status in the Plant Health Directive (Council Directive 2000/29/EC[2]) ?

L. orbonalis is not listed in Council Directive 2000/29/EC.

7. What is the pest's status in the European and Mediterranean Plant Protection Organisation (EPPO)? (www.eppo.org)

EPPO List:	A1 regulated pest list	No	A2 regulated pest list	No	Action list	No	Alert list	No

L. orbonalis does not appear on any of the EPPO pest lists. However, it is worth noting that *L. orbonalis* is regulated by the RPPO's and countries shown in Table1.

Table 1: Pest status of *Leucinodes orbonalis* outside the EPPO/EU region

RPPO or Country	Listing
CPPC, COSAVE, OIRSA*	A1 list
Argentina, Brazil, Chile, Paraguay, Uruguay	A1 list
East Africa, Southern Africa	A2 list
USA	Quarantine pest

Source: EPPO (2005)

* Key: Caribbean Plant Protection Commission (CPPC), Comité de Sanidad Vegetal del Cono Sur (COSAVE) and Organismo Internacional Regional de Sanidad Agropecuaria (OIRSA).

8. What are the pest's host plants?

Leucinodes orbonalis hosts are listed in Table 2.

Table 2: Host list for *Leucinodes orbonalis*

Host Family	Host Genus and species	Host Common Name
Anacardiaceae	*Mangifera indica*	Mango
Chenopodiaceae	*Beta vulgaris*	Beetroot
Convolvulaceae	*Ipomoea batatas*	Sweet Potato
	Ipomoea spp.	Morning Glory
Cucurbitaceae	*Cucurbita maxima*	Pumpkin
Leguminosae	*Pisum sativum*	Pea
	Pisum sativum var. *arvense*	Austrian winter pea
Gramineae	*Pennisetum* spp.	Feather grass
Solanaceae	*Capsicum* spp.	Peppers
	Lycopersicon esculentum	Tomato
	Solanum aethiopicum	Mock tomato
	Solanum anomalum	-
	Solanum gilo	Gilo
	Solanum indicum	-
	Solanum macrocarpon	-
	Solanum melongena	Aubergine
	Solanum myriacanthum	-
	Solanum nigrum	Black nightshade
	Solanum prinophyllum	Forest nightshade
	Solanum torvum	Devil's-fig
	Solanum tuberosum	Potato

Sources: Anonymous (1984), Bradley (2000), CABI (2005), EPPO (2005), Hill (1983),

[2] http://europa.eu.int/eur-lex/en/consleg/pdf/2000/en_2000L0029_do_001.pdf

Kumar and Sadashiva (1996), Maureal, *et al*. (1982), Patnaik (2000), Robinson *et al.* (2003), Singh and Kalda (1997), Singh and Singh (2003), Website 1 and Website 2.

Most reported cases of economic damage occur on aubergine. Although *L. orbonalis* is able to develop on both potatoes and tomatoes, it is not reported as a pest of these crops. Maureal *et al.*, (1982) reported that "even when tomato was planted in the immediate vicinity of eggplant [in the field], the borer was never observed to infest tomato fruits unless when subjected to hunger stress".

9. What hosts are of economic and/or environmental importance in the PRA area?

Significant hosts of economic importance in the PRA area are shown in Table 3.

Table 3: Production statistics for *L. orbonalis* hosts in the EU and UK

	EU (Mean 2004-2005)		UK (Mean 2000-2005)	
Host	Production (Mt)	Area harvested (Ha)	Production (Mt)	Area harvested (Ha)
beetroot	128,631,700	2,203,600	8,748,000	160,500
potatoes	63,384,200	2,140,300	6,464,000	154,000
tomatoes	17,714,000	299,000	92,500	355
peas	1,454,600	35,600	377,500	35,500
pumpkin	839,565	27,520	0	0
aubergine	563,600	17,800	No data available	No data available
sweet potato	57,350	5,365	See note below	See note below
peppers	No data available	No data available	12,300*	53*

Source: Anonymous (2005) and FAO (2005)

***** = 2000-2004

Notes:

Prior to December 2005, a 5 acre crop of glasshouse grown aubergine (the biggest in the UK) was grown in North Yorkshire, UK. Aubergine production has now been abandoned at this site due to escalating gas prices (PHSI, 2006, *pers. com.*)

I. batatas (cv. Red Skin) was first trialled in the UK in 2000 by Horticultural Research International (HRI). HRI found that yields of roughly 10kg per plant could be achieved provided young plants were given early protection (Website 3). Since then small scale commercial production of sweet potato has taken place in the UK and the first commercial crop was produced by Barfoots of Botley (Website 4) in May 2000 from cuttings imported from the USA. However, Barfoots of Botley have now ceased UK production (Lynne Matthews, CSL, 2006, *pers. com*.).

10. If the pest needs a vector, is it present in the PRA area?

No vector is required. This is a free living organism.

11. What is the pest's present geographical distribution?

The distribution of *L. orbonalis* is shown in Table 4.

Table 4: **Distribution of *Leucinodes orbonalis***	
North America:	USA
Central America:	Absent - No records
South America:	Absent - No records
Europe:	Intercepted only (e.g. in UK on aubergines).
Africa:	Burundi, Cameroon, Democratic Republic of the Congo, Ethiopia, Ghana, Kenya, Lesotho, Malawi, Mozambique, Nigeria, Rwanda, Sao Tome & Principe, Sierra Leone, Somalia, South Africa, Tanzania, Uganda, Zaire, Zambia, Zimbabwe
Asia:	Andaman and Nicobar Islands, Bangladesh, Brunei Darussalam, Burma, Cambodia, China, Hong Kong, India, Indonesia, Japan, Laos, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, Vietnam
Oceania:	Absent - No records

Sources: Bradley (2000), CABI (2005), EPPO (2005), Hill (1983), Singh and Singh (2003) and Zhang (1994)

12. How likely is the pest to enter the PRA area[3]?

Very unlikely		Unlikely	✓	Likely		Very likely	

L. orbonalis has been intercepted 36 times in the UK in the past 7 years. Hosts are widely grown both outdoors and in protection.

Caterpillars could be introduced to the UK on plants for planting (they are known to bore into stems), however as Solanaceae from countries other than those in the Euro-Mediterranean area are prohibited entry to the PRA area the risk of this is considered minimal.

13. How likely is the pest to establish outdoors in the PRA area?

Very unlikely	✓	unlikely		Likely		Very likely	

This is a tropical pest that is very unlikely to be able to establish out of doors in the PRA area. Various studies have been conducted on the life-history of *L. orbonalis*, all of which have come to similar conclusions. For example Katiyar and Mukharji (1974) report that in the laboratory egg development was severely delayed at 15°C, (with only one egg batch out of 15 hatching), whereas development was fastest between 20°C-25°C. Pupae held at 10°C did not develop, but when transferred to 27 +/- 2°C adults emerged within 24 hours and adult life span was longer at 27 +/- 2°C than at room temperature. Singh and Singh (2003) found that the highest levels of fecundity occurred when the average maximum temperature was more than 27°C, the average minimum temperature was more than 17°C and the average relative humidity was more than 85%. They also found that the average lowest fecundity occurred when the average maximum and minimum temperatures were 21.95°C and 11.90°C

[3] Pest entry includes an assessment of the likelihood of transfer to a suitable host (ISPM No. 11, FAO, Rome)

respectively. Mall *et al.* (1992) report that 30°C and 70-90% RH were the most favourable conditions for 'multiplication' of *L. orbonalis* in the field.

14. How likely is the pest to establish in protected environments in the PRA area?

Very unlikely	Unlikely	Likely	Very likely
✓			

No records of *L. orbonalis* in heated glasshouses have been found (van der Gaag & Stiger, 2005) and there is no obvious pathway from infested imported produce to protected environments in the UK. However, should there be an introduction to a protected crop, it is possible that a population could develop. Temperatures in glasshouses in the Netherlands for the production of aubergine are usually between 20 and 25ºC and may exceed 30ºC during warm periods (van der Gaag & Stiger, 2005). These temperatures, which are expected to be similar in the UK, exceed the minimum required for egg development, i.e. 15ºC (Anon, 1984). At 20ºC, development time (egg to adult) is about 55 days (van der Gaag & Stiger, 2005). The high temperatures and humidities of many topical botanic gardens are also conducive to the build-up of large populations, but survival of the pest would depend upon a suitable host being present.

15. How quickly could the pest spread within the PRA area?

Very slowly	Slowly	Quickly	Very quickly
✓			

Information on the ability of *L. orbonalis* to spread within an area is limited. Natural spread is unlikely in northern Europe, where climatic conditions make it very unlikely that the pest will establish outdoors. Spread could occur between glasshouses on planting material.

16. What is the pest's potential to cause economic and/or environmental damage in the PRA area?

Very Small	Small	Medium	Large	very Large
✓				

Estimates of loss or damage caused by *L. orbonalis* vary considerably and taking *S. melongena* as an example: Patnaik (2000) reports that damage to fruit in the field ranges from 47.6% to 85.8%, Mehto *et al.* (1983) report a reduction in yield ranging from 50-60% and Mall *et al.* (1992) report average losses in the field of 13%.

From just these three examples it is clear that this pest is capable of causing significant levels of damage in areas where it has become established. However, the likelihood of establishment in the PRA area has been assessed to be between very unlikely to unlikely. Consequently although damage can be significant where it is established, the overall potential for economic impact has been assessed as small.

17. What is the pest's potential as a vector of plant pathogens?

There are no records of this pest acting as a vector of plant pathogens.

STAGE 3: PEST RISK MANAGEMENT

18. What are the prospects for continuing to exclude the pest from the PRA area?

a) Outdoors:	Very good	✓	Good		Poor		Very Poor	
b) In protection:	Very good	✓	Good		Poor		Very Poor	

To date, all UK interceptions of *L. orbonalis* have been in association with produce, from which there is no obvious pathway to susceptible hosts growing under glass.

19. How likely are outbreaks to be eradicated?

Very likely	✓	Likely		Unlikely		Very unlikely	

L. orbonalis is a tropical pest, which is very unlikely to establish outdoors in the PRA area. Outbreaks on protected crops would probably be controlled with insecticides during cropping and eradicated during the crop break. However the move to all-year–round production of glasshouse salads in the UK, plus the cryptic nature of the pest, may make eradication difficult in some cases. Eradication from a tropical botanic garden would be especially challenging due to continuous presence of a wide range of hosts. However, there have been no reports of *L. orbonalis* from glasshouses to date.

20. What management options are available for containment and control?

Destruction of infested crops, plus weed hosts, would be the most effective method of ensuring eradication of the pest. Alternatively, insecticide treatments could be used. General purpose contact-acting insecticides suitable for the control of caterpillars include deltamethrin (e.g. 'Decis') and nicotine ('XL All Insecticide'), both of which are approved for use on protected aubergines and tomatoes in the UK. However, contact-acting products will be less effective in infestations where the pest bores into plant tissue. Puranik *et al.* (2002) found that five sprays of the stomach-acting bacterium *Bacillus thuringiensis* ('Dipel 8L') at 0.2% at 10 day intervals was the most effective treatment against *L. orbonalis* and resulted in minimal shoot and fruit infestation and maximum yield of marketable fruits. *B. thuringiensis* ('Dipel DF') is approved for use on protected UK tomatoes and can therefore be used on protected aubergines under the 'Long-Term Arrangements for the Extension of Use'[4]. As with contact-acting insecticides, *B. thuringiensis* based products may not be effective against caterpillars boring within plant tissue as it must be consumed by the pest.

[4] The 'Long-Term Arrangements for the Extension of Use' on edible crops are currently being phased out in favour of individual Specific Off-Label Approvals for each crop/product combination. No minor uses should be lost as a result of this transition, which is due to be completed by mid-2006.

Adult moths could be controlled using a smoke treatment, e.g. 'Nicotine 40% Shreds', or pheromone traps. The major component of the female sex pheromone of *L. orbonalis* has been isolated (Cork *et al.,* 2001) and used in integrated pest management trials (Cork *et al.,* 2003). Delta and wing traps baited with a synthetic version of the pheromone were found to catch and retain ten times more moths than other designs. Wingtraps placed at crop height caught significantly more moths than traps placed 0.5m above or below the crop canopy (Cork *et al.,* 2003). The adults are not attracted to light traps (Cork *et al.,* 2001). Larvae of *L. orbonalis* are parasitized by an ichneumonid wasp, *Trathala flavoorbitalis*. Third to fifth instar larvae are preferred over first and second instars (Sandanayake and Edirisinghe, 1992). However, this species is not commercially available for UK release.

21. FURTHER WORK THAT WOULD REDUCE UNCERTAINTIES		
Section of PRA	**Uncertainties**	**Further work that would reduce uncertainties**
Taxonomy	None	
Pathway	Presence of a pathway from imported produce to suitable protected environments, such as botanical gardens.	Monitor all suitable protected environments which are near points of entry of infested produce. Check reports of finds by other EU MS
Distribution	None	
Hosts	None	
Establishment	Establishment potential under glass in the PRA area.	Continue to monitor the literature for reports of establishment in protected environments.
Spread	Rate of potential spread in areas at risk within the PRA area	Continue to monitor the literature for reports on ability to spread.
Impact	Potential to cause damage in protected environments	Continue to monitor the literature for reports on damage caused in protected environments
Management	None	

22. Summary

L. *orbonalis* is a major pest of *S*. *melongena* (aubergine) and is mainly found in Africa and Asia. There are records of it feeding on other solanaceous crops, such as tomato and potato, but it is not considered to be an economic pest on these species. It is intercepted infrequently in the UK and is always associated with imported produce. There is little chance of *L*. *orbonalis* surviving outdoors in the UK, but protected environments where suitable host plants are grown may be at risk. However, there is no obvious pathway between infested imported produced and suitable protected environments. If this pest were to become established in a protected environment, eradication would be achievable but could be difficult. The life history of *L*. *orbonalis*, suggests that EPPO member states with a warmer climate than the UK, e.g. Spain, Portugal & Israel, are more at risk.

23. Conclusions

L. *orbonalis* represents little threat to the UK or northern EPPO region, although monitoring of suitable protected environments that are near points of entry of infested produced may be advisable. Member states with more suitable climates should be informed of the findings of this PRA.

24. REFERENCES

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ANNEX 1

Leucinodes orbonalis: Statistics concerning detections in consignments

Figure 1: The number of interceptions of *L*. *orbonalis* by country of origin between June 1999 and May 2006

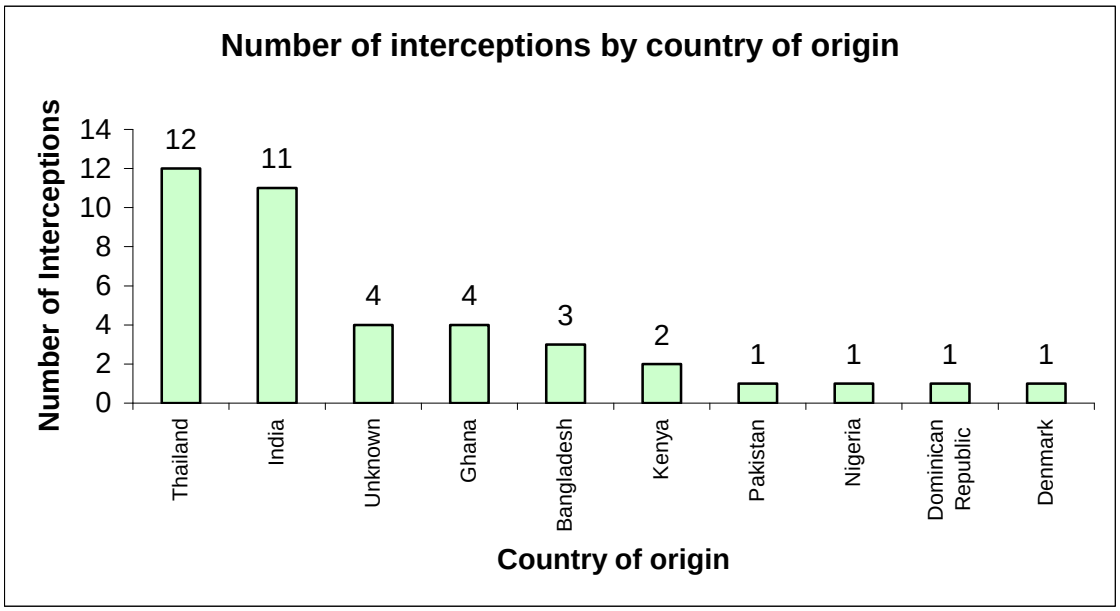

Figure 2: The number of interceptions of *L*. *orbonalis* by month between June 1999 and May 2006