The Food & Environment Research Agency

Rapid Pest Risk Analysis for

Chrysodeixis chalcites

This document provides a rapid assessment of the risks posed by the pest to the UK in order to assist Risk Managers decide on a response to a new or revised pest threat. It does not constitute a detailed Pest Risk Analysis (PRA) but includes advice on whether it would be helpful to develop such a PRA and, if so, whether the PRA area should be the UK or the EU and whether to use the UK or the EPPO PRA scheme.

STAGE 1: INITIATION

1.What is the name of the pest?

Chrysodeixis chalcites (Esper) Lepidoptera Noctuidae: golden twin-spot moth

Synonyms in common usage: *Autographa chalcites* Esper, *Chrysodeixis chalcytes* (Esper), *Plusia chalcites* (Esper).
Other common names: garden looper, green garden looper, green looper, green semi-looper, groundnut semi-looper, tomato leafworm, tomato looper. The UK horticulture industry refers to it as Turkey moth or Turkish moth, though this name is not widely used elsewhere.

Chrysodeixis chalcites and *C. eriosoma* may be sibling species and the relationship between the two species requires clarification (Holloway *et al.,* 1987). The two species are not morphologically separable, but may be separated with pheromones, DNA or by geographic origin (Lafontaine & Schmidt, 2013), with *C. chalcites* found in the Palearctic and *C. eriosoma* occurring throughout the tropical and subtropical regions of eastern Asia and the Pacific islands as well as in Australia and New Zealand. Literature referring to *C. chalcites* in southern or eastern Asia or Oceania actually refers to *C. eriosoma* (Zhang, 1994). Notes on the deletions from the EPPO alert list state that "*C. eriosoma* is closely related to the Palaearctic species *C. chalcites* which occurs in several European countries. The relationships and status of these two species still need to be clarified."
Although there is considerable taxonomic uncertainty concerning *C. chalcites* and *C. eriosoma*, this PRA has been written on the populations found in the Africa and the Palearctic, i.e., only *C. chalcites*.

2. What is the pest's status in the EC Plant Health Directive (Council Directive 2000/29/EC[1]) and in the lists of EPPO[2]?

Pest is not listed in the EC Plant Health Directive and is not recommended for regulation as a quarantine pest by EPPO, nor is it on the EPPO Alert List.
The closely related species *C. eriosoma* was placed on the EPPO Alert List in 2000 at the UK's request, but removed in 2007 because no particular international action was requested by the EPPO member countries.

3. What is the reason for the rapid assessment?

[1] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2000L0029:20100113:EN:PDF
[2] http://archives.eppo.int/EPPOStandards/PM1_GENERAL/pm1-02(21)_A1A2_2012.pdf

Following the development of Phase I of the UK Plant Health Risk Register in the summer/autumn of 2013, this species was identified as a priority pest, with the 1996 UK PRA requiring updating. This updated assessment is required to aid in researching the potential impact of *C. chalcites* on protected crops in the UK, which will help to inform the decision on whether statutory action against future interceptions is justified.

STAGE 2: RISK ASSESSMENT

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

C. chalcites is primarily distributed between 45°N and 35°S, from southern Europe and the Mediterranean and the Middle East to southern Africa. Reports of *C. chalcites* in southern or eastern Asia or Oceania actually refer to *C. eriosoma* (Zhang, 1994).

C. chalcites immigrants from North Africa or southern Europe, borne on strong southerly winds, are sometimes recorded in central and northern Europe (Austria, Denmark, Germany, Sweden, Switzerland and the UK) in the late summer or autumn (Jor, 1973; Bretherton, 1983; Hachler et al., 1998; Karsholt and Razowski, 1996; Palmqvist, 1998, 2002; Sparks *et al.,* 2007). There are about 50 records of *C. chalcites* as a migrant to the UK between 1943 and 1990 (Bretherton, 1983); Waring & Townsend (2003) state there were more UK migrant records in the 1990s than in any previous decade, and give the total as "over 120 records".

Breeding populations occur outdoors around the Mediterranean (Spain, Portugal, southern France, Italy, Cyprus, Malta, Greece and Turkey) and also in Hungary, Bulgaria, Rumania, and the former Yugoslavia (Anon., 1977).

Lempke (1982) and Vos and Rutten (1995) noted that *C. chalcites* is present all year round in glasshouses in the Netherlands and according to M. van der Straten (pers. comm. 6 March 2014), this species is still one of the most common pests in protected cultivation in the Netherlands. Veire (1993) reported populations established in glasshouses in Belgium, J-M Ramel (pers. comm. 17 March 2014) reports that adults in France are attracted to the light and heat in the glasshouse environment and high numbers of the moth can consequently develop, though so far (in Corsica), populations have easily been controlled. There are no reports of outbreaks in protected cultivation in Germany (P. Baufeld, pers. comm., 14 March 2014). It is present in UK glasshouses, mostly in eastern England and usually on tomato crops (Rob Jacobson, pers. comm. 8 May 2014). However, there is no evidence that *C. chalcites* can overwinter outdoors in the Netherlands (Lempke, 1982) or elsewhere in northern Europe.

5. Is the pest established or transient, or suspected to be established/transient in the UK?

C. chalcites is not established outdoors in the UK. A few immigrants are found along the southern coasts of the UK every year (UK Moths website, Norfolk Moths website) however this species is unable to overwinter outdoors in the UK (CABI CPC, 2012). The species is, however, present in UK protected cultivation, and has been reported from at least 9 sites, mostly in eastern England, feeding on tomato and cucumber, as well as on aubergines, peppers and ornamentals (Rob Jacobson, pers. comm. 8 May 2014).

Larvae have previously been imported into the UK on *Chrysanthemum morifolium* and intercepted at nurseries (Seymour & Kirby, 1978). When *C. chalcites* larvae are imported on *Chrysanthemum*, they are often accompanied by larvae of *Autographa gamma* (Carter, 1984).

Between 1996 and 2012 *C. chalcites* was intercepted on entry to the UK on 47 occasions. Complete information is not available for all of these interceptions. Where information is available the following can be ascertained:

- All of the interceptions were larvae on plant leaves or cuttings.

- 19 interceptions were on plant material from Israel: *Ajuga* sp., *Astericus* sp., *Bupleurum* sp*., Geranium* sp*., Impatiens* sp*., Ocimum basilicum, Ocimum* sp*., Pelargonium* sp*., Plectranthus* sp*.,Thymus* sp*., Trachelium* sp*.*
- Six interceptions were on plant material from the Netherlands: *Musa* sp*., Coffea* sp*.,* Dendranthema sp., *Gardenia* sp*., Zelkova* sp*.*
- Four interceptions were on plant material from Spain (Canary Islands): Dendranthema sp., *Ocimum basilicum, Ocimum* sp*.*
- Three interceptions were on plant material from Kenya: *Ocimum basilicum, Pelargonium* sp*.*
- Two interceptions were on plant material from Nigeria: *Chorchorus* sp*.*
- One interception on plant material from each of the following countries: Democratic Republic of Congo, Portugal (*Lavandula* sp.)*,* Sierra Leone, Zimbabwe (*Solidago* sp.).

6. What are the pest's natural and experimental host plants; of these, which are of economic and/or environmental importance in the UK?
C. chalcites is extremely polyphagous. It feeds on many fruit, vegetable and ornamental crops and weeds in many plant families including Acanthaceae, Asteraceae, Bignoniaceae, Boraginaceae, Brassicaceae, Convolvulaceae, Crassulaceae, Lamiaceae, Fabaceae, Malvaceae, Orchidaceae, Rosaceae, Scrophulariaceae, Solanaceae, Verbenaceae and Violaceae (CABI CPC).

Major hosts: *Glycine max* (soybean), *Gossypium herbaceum* (short staple cotton), *Nicotiana tabacum* (tobacco), *Phaseolus* spp. (beans), *Phaseolus vulgaris* (common bean), *Solanum lycopersicum* (tomato), and *Solanum tuberosum* (potato) (CABI CPC).

Minor hosts: *Anethum graveolens* (dill), *Arachis hypogaea* (peanut), *Aster* spp., *Brassica oleracea* var. *botrytis* (cauliflower), *Brassica oleracea* var. *capitata* (cabbage), *Brassica* spp., *Capsicum annuum* (bell pepper), *Chrysanthemum indicum* (chrysanthemum), *Citrus* spp., *Coffea arabica* (coffee), *Cucumis sativus* (cucumber), *Cucurbita pepo* (zucchini), *Cynara cardunculus* subsp. *cardunculus* (=C. scolymus) (artichoke), *Dahlia* spp., *Dianthus* spp. (carnation), *Ficus carica* (fig), *Fragaria* spp. (strawberry), *Helianthus tuberosus* (Jerusalem artichoke), *Hippeastrum hybrids* (amaryllis), *Lactuca sativa* (lettuce), *Medicago sativa* (alfalfa), *Musa* spp. (banana), *Pelargonium* spp. (geranium), *Salvia officinalis* (common sage), *Stachytarpheta jamaicensis* (Jamaica vervain), *Trifolium repens* (white clover), *Triticum aestivum* (wheat), and *Zea mays* (corn) (CABI CPC).

Wild hosts: *Echium vulgare* (viper's-bugloss), *Marrubium* spp. (horehound), *Teucrium scorodonia* (wood germander), and *Urtica dioica* (stinging nettle) (CABI CPC).

The economically important crops grown in the UK are almost any plant grown in protected cultivation, due to the highly polyphagous nature of this pest. Crops at risk include tomato and cucumber, as well as many protected ornamentals.

7. If the pest needs a vector, is it present in the UK?
No vector is required.

8. What are the pathways on which the pest is likely to move and how likely is the pest to enter the UK? (*By pathway*):
Plants for planting (including cuttings): *C. chalcites* larvae have been carried with *Pelargonium* from Germany to Hungary (Meszaros & Tusnadi, 1994). Given the high number of UK interceptions on herbs and cuttings of ornamental plants, particularly from Israel, the Netherlands, the Canary Islands and African countries, it is very likely that *C. chalcites* will enter the UK by this pathway. As the plants considered in this pathway are likely to be grown on, even low infestations of this pest could establish as plants are more likely to be kept together in large quantities, and grown in protected cultivation. Many countries have reported outbreaks in protected cultivation (details are provided in the answer to question 9). Therefore, this pathway is rated as very likely.

Produce (including cut herbs for immediate consumption and flowers): *C. chalcites* has been intercepted in Italy on bananas from the Canary Isles. Larvae fed mainly on the banana peel, but some burrowed into the unripe pulp. Superficial damage, consequent blackening and the general unpleasant appearance of the fruit rendered the bananas unsaleable (Jannone, 1966). The species is a major pest in protected crops of tomatoes and peppers in countries from which we import these commodities. *C. chalcites* is also a major pest of field fruit and vegetables in Israel and Egypt (CABI CPC). Some of the Fera interception records, e.g., *Ocimum* spp., are likely to be cut herbs, though it is not always clear from old records which commodities are produce and which are cuttings for growing on. While larvae are imported on produce reasonably frequently, produce is often rapidly dispersed as it is eaten or processed. Even if the infestation is detected and the produce discarded as waste, the larvae need to complete development, possibly locating a new host in order to do so, and then find suitable protected cultivation in sufficient numbers to establish. However, some UK packhouses do process imported produce at their UK sites during the time when their own growing crops, including protected crops, are out of season. These packhouses are often located near the UK growing sites, so while this may only be applicable to a small number of imports, the risk of the pest transferring to a growing crop is much higher. Overall, this pathway is rated as moderately unlikely due to the difficulties of transfer to protected cultivation and the fact most infested consignments only contain very low numbers of larvae.

Natural migrants: *Chrysodeixis chalcites* is a known migrant species, and specimens have been regularly found in the UK (Waring & Townsend, 2003). This pathway is rated as likely. Though migrants are few in number, and either a gravid female or several individuals would need to find protected cultivation to form a breeding population and successfully overwinter, there appears to be at least one instance of adult(s) successfully forming a breeding population in a glasshouse (Jacobson, 2007).

	Very unlikely	Unlikely	Moderately likely	Likely	Very likely
Imported plants for planting:	☐	☐	☐	☐	☑
Imported produce	☐	☐	☑	☐	☐
Natural migrants	☐	☐	☐	☑	☐

9. How likely is the pest to establish outdoors or under protection in the UK?

The climate in the UK prevents overwintering without protection. The greatest risk is therefore to almost anything which is grown under protection in the UK including food (tomatoes, cucumbers, peppers) and ornamental plants.

Eggs are laid singly or in small groups on the underside of host leaves (Watt, 1915). Females can lay up to 640 eggs at an optimal temperature of 25^{o}C. At this temperature, eggs take about 3 days to hatch, but may take up to 29 days at lower temperatures (Watt, 1915). Details of developmental rates at different temperatures are shown in Tables 1 and 2 that follow.

Table 1: Summary of *C. chalcites* development details (Gasim & Younis, 1989)

Temp (^{o}C)	Eggs incubation period (days)	Eggs (% hatch)	No. larval instars	Days before females oviposit	No. of days females lay eggs for	Mean no. eggs laid
20	4.5	95 %	6	1.8	4.6	386
25	3.0	96 %	6	1.5	5.4	640
30	2.0	91 %	6	3.3	4.1	408

Table 2: Summary of *C. chalcites* development details

Temp (^{o}C)	Egg incubation period (days)	No. larval instars	Larval period (days)	Pupal period (days)	Reference
20	5 to 26	5	44 to 50	15 to 26	Gaumont & Moreau (1961)
-	up to 29	-	21 to 28	10 to 20 or up to 85	Watt (1915)

The following outbreaks have been reported in protected cultivation in other countries including:

- USA, Ohio on Pelargonium (Passoa, 1995)
- Western Switzerland on tomatoes (Hächler *et al.,*1998)
- Poland on tomatoes (Napiórkowska-Kowalik and Gawłowska, 2007)
- Turkey on tomatoes (Uygun and Ozgur, 1980)
- Bulgaria on tomatoes, cucumbers, peppers (*Capsicum annuum*), peas and dill (Lecheva & Loginova, 1988)
- Belgium on sweet peppers (Veire, 1993)
- Netherlands on tomatoes, peppers and other crops; a continual pest in glasshouses (Lempke, 1982; Vos and Rutten; 1995). High numbers recorded outside glasshouses in 1992 probably originating from populations inside glasshouses (Vos and Rutten, 1995)
- Israel on tomatoes (Broza and Sneh, 1994)
- Canada on tomatoes and green beans (Murillo *et al.,* 2013)
- Turkmenistan on tomatoes (Daricheva *et al.,* 1983)
- UK on tomatoes, cucumbers, aubergines, peppers and protected ornamentals (Rob Jacobson, pers. comm. 8 May 2014).

	Very unlikely	Unlikely	Moderately likely	Likely	Very likely
Outdoors:	✓				
Under protection:					✓

10. How quickly could the pest spread in the UK?

C. chalcites would spread slowly by natural means. This is a known migrant species, and would not be limited by host availability as it's so polyphagous. In the summer, it could move long distances outdoors. However, because it needs to find a new site of protected cultivation to overwinter, and to form a breeding population there, natural spread is rated as slow. However, it could spread very rapidly in trade with the main routes likely to be from a plant importer to glasshouses and in fruit and vegetable waste, Although the larvae are

usually found on the outside of the host plant, they can be difficult to find because they dangle on a silk thread if disturbed (Goodey, 1991). They have also been observed burrowing into tomatoes (Daricheva *et al.,* 1983; Napiórkowska-Kowalik, and Gawłowska, 2006).

	Very slowly	Slowly	Moderate pace	Quickly	Very quickly
Natural spread:		✓			
In trade:					✓

11. What is the area endangered by the pest?
Protected crops or ornamentals in any region of the UK.

12. What is the pest's economic, environmental or social impact within its existing distribution?
According to Daricheva *et al.* (1983), the reduction in yield of tomatoes in glasshouses in Turkmenistan was 10-15%. It is regarded as a serious pest of tomatoes, cucumbers and peppers in Bulgaria (Loginova,1992) and Turkey (Uygun and Ozgur, 1980). This species can reach high levels of infestation and is considered to be one of the most serious lepidopteran pests in many countries. In protected cultivation in the Netherlands and Bulgaria, *C. chalcites* can occur at any time of the year on vegetables and decorative plants under glass and plastic-foil glasshouses. The crops affected are tomato, cucumber, pepper, pea, dill, carnation and Amaryllis (Lecheva & Loginova, 1988; Linden, 1996). However, there is very little information available on economic damage (CABI CPC).

Very small	Small	Medium	Large	Very large
			✓	

13. What is the pest's potential to cause economic, environmental or social impacts in the UK?
C. chalcites has the potential to have a serious economic impact in protected crops in the UK due to the high levels of infestation which can be reached and failure to eradicate it from glasshouses in other countries. However, while damage to fruit and foliage has occurred in the UK, this moth seems to be easily controlled within IPM programmes (including *Macrolophus* predation) (Rob Jacobson, pers. comm. 8 May 2014). Overall, impacts in the UK are rated as medium.

Very small	Small	Medium	Large	Very large
		✓		

14. What is the pest's potential as a vector of plant pathogens?
C. chalcites is not a known vector of any plant disease.

STAGE 3: PEST RISK MANAGEMENT

15. What are the risk management options for the UK?
There are several options for control if necessary. The following is summarised from the CABI CPC.

Pyrethroids can give control of *C. chalcites* and Bassi *et al.* (2000) reported effective control of *C. chalcites* using indoxacarb on vegetable crops in open fields and plastic houses in Italy. The insect growth regulator cyromazine, gave good control of second- and fourth-instar larvae of *C. chalcites* in glasshouses on tomatoes, lettuce and ornamentals when applied as a foliar spray (Veire and Degheele, 1994).

Different strains of *Bacillus thuringiensis* gave full control (100% efficacy) of *C. chalcites* when sprayed on tomatoes grown under net protection or in non-heated greenhouses in Sicily, Italy (Vacante *et al.,* 2001). *B. thuringiensis* var. *kurstaki* is used to control *C. chalcites* in Israel (Broza and Sneh, 1994).

Biocontrol using entomopathogenic fungi and endoparasitoids has been shown to be only partially successful so is not a practical option for eradication.

Linden (2000) found that *Alcippe brunnea*, a bird found in dense forest undergrowth in India, successfully controlled *C. chalcites* on sweet peppers grown in glasshouses in the Netherlands.

Rob Jacobson (pers. comm. 8 May 2014) reports that *C. chalcites* is “easily controlled within IPM programmes” in the UK, and also reports that Dipel is very effective.

16. Summary and conclusion of rapid assessment.
This rapid assessment shows:

Risk of entry
This has been assessed as very high on plants for planting. *Chrysodeixis chalcites* is a known glasshouse pest, with introductions into protected cultivation in many countries. It is known to be present in Dutch glasshouses, from where the UK imports a lot of propagating material.

Risk of establishment
If able to enter protected cultivation, *C. chalcites* has established under cover in the UK. It will not be able to establish in the wider environment, as all available information indicates it cannot overwinter outdoors, though transient summer populations may be capable of developing.

Economic impact
The economic impact is uncertain. While this can be a major pest in some areas, including under protected cultivation, data on impacts are lacking. The experience of some countries, such as the Netherlands, indicates that *C. chalcites* may be difficult to eradicate from protected cultivation once established, but again data are lacking on specifics of eradicating or controlling this pest. The ease of control would affect the impact on UK crops.

Endangered area
Any protected cultivation in the UK is potentially at risk.

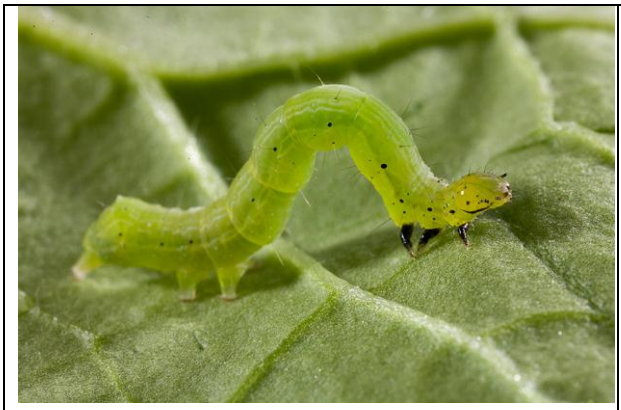
Risk management
Control options would seem to be similar to those against other Lepidoptera, and existing IPM programmes appear to control the populations of this species in UK protected cultivation. However, the experience of other countries shows that at least some outbreaks in protected cultivation are difficult or impossible to eradicate.

17. Is there a need for a detailed PRA? If yes, select the PRA area (UK or EU) and the PRA scheme (UK or EPPO) to be used.

No	✓

Yes		PRA area: UK or EU		PRA scheme: UK or EPPO	

18. IMAGES OF PEST

	
Chrysodeixis chalcites caterpillar © Crown copyright, Fera	*Chrysodeixis chalcites* pinned adult moth © Crown copyright, Fera

19. Given the information assembled within the time scale required, is statutory action considered appropriate / justified?

Yes Statutory action		No Statutory action	✓

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Author (s): Larissa Collins; Anastasia Korycinska, Richard Baker