Department for Environment Food & Rural Affairs

Rapid Pest Risk Analysis (PRA) for: *Scirtothrips citri*

May 2015

Stage 1: Initiation

1. What is the name of the pest?

Scirtothrips citri (Moulton). Common Name*:* Californian citrus thrips.

Phylogenetic analysis has distinguished the species from related taxa (Hoddle et al., 2008). However, there is potential for confusion in species identification and some reports are considered to be unconfirmed (see section 5). Additionally, in North America the taxonomic status of thrips related to *S. citri* is unclear, primarily because they were described before modern diagnostic characters were conceived, and this further introduces uncertainty in *S. citri* in terms of its distribution and other factors (Hoddle, 2012; EPPO, 1997; Bailey, 1964).

2. What initiated this rapid PRA?

The PRA was initiated to clarify uncertainties over its host range identified when *S. citri* was assessed for inclusion on the UK Plant Health Risk Register.

3. What is the PRA area?

The PRA area is the United Kingdom of Great Britain and Northern Ireland.

Stage 2: Risk Assessment

4. 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]?

S. citri is listed in Council Directive 2000/29/EC Annex IIAI (plants of *Citrus, Fortunella and Poncirus* and their hybrids, other than seed) and EPPO A1.

5. What is the pest's current geographical distribution?

Distribution list taken from the EPPO PQR database (EPPO, 2012), but see note in section 1 concerning possible misidentification.

Table 1 : Distribution of *Scirtothrips citri*

North America:	Mexico; USA (Arizona; California). Specimens from populations in the southern States of the USA across to Florida are very similar in structure, but the genus requires further study (Hoddle, 2012).
Central America:	Absent
South America:	Absent
Europe:	Absent
Africa:	Absent
Asia:	Unconfirmed records for China (Li et al., 2003), Iran (Akbari and Seraj, 2007) and India- absent/unreliable record (EPPO Reporting Service RS 2000/148) – see text below
Oceania:	Absent

[1] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2000L0029:20100113:EN:PDF

[2] https://www.eppo.int/QUARANTINE/quarantine.htm

Scirtothrips citri is native to North America, although its distribution is unclear as it cannot be satisfactorily distinguished from a small number of other nominate North American species (see section 1 and Hoddle, 2012). Records elsewhere are considered unconfirmed, and may be unreliable due to confusion with other species of *Scirtothrips* (Dom Collins pers comm. 2015; Bhatti et al. 2009).

6. Is the pest established or transient, or suspected to be established/transient in the UK/PRA Area?

There have been no UK outbreaks of *S. citri*. There is a single record on Europhyt referring to a UK interception in 2003 on *Festuca pratensis* originating from Thailand (Europhyt, 2003). However, this seems to be an error, and the UK has no record of such a finding. Adult females were identified as *S. citri* from sticky traps in a glasshouse at a botanical garden in southern England during surveys for *S. dorsalis* in 2008: – single individuals in "sticky trap condition" with no supporting context. Measures were being taken already for *S. dorsalis*, and there have been no findings since.

7. What are the pest's natural and experimental host plants; of these, which are of economic and/or environmental importance in the UK/PRA area?

Hosts are recorded in the CABI Crop Protection Compendium database (CABI CPC, 2015) and EPPO PQR (2014), with references added where available. Some of these listings have been assigned a cautious host status by either EPPO or CABI, for the reason that there is a lack of associated evidence to confirm that *S. citri* can use the host to complete its development and adult thrips can be associated incidentally with plants that are not hosts.

Table 2 : Hosts of *Scirtothrips citri*

Host	**Host status**	**Reference**
Citrus	Main	Arpaia and Morse, 1991; CABI CPC (2015); EPPO PQR (2014)
Citrus Limon (lemon)	Main	EPPO PQR (2014)
Citrus paradisi (grapefruit)	Main	EPPO PQR (2014)
Citrus reticulata (mandarin)	Main	CABI CPC (2015); EPPO PQR (2014)
Citrus sinensis (sweet orange)	Main	EPPO PQR (2014)

Citrofortunella microcarpa (panama orange)	Minor	EPPO PQR (2014)
Citroncircus	Minor	EPPO PQR (2014)
Fortunella	Minor	EPPO PQR (2014)
Ponicrus trifoliate (trifoliate orange)	Minor	EPPO PQR (2014)
Citrus aurantiifolia (lime)	Other	CABI CPC (2015)
Vaccinium corymbosum	Other	CABI CPC, 2015; An established pest of 'southern' high bush blueberry (Haviland et al., 2009), which is a cross between *V. corymbosum* (northern high bush blueberry) and other *Vaccinium* species to produce warm climate-tolerant hybrids.
Ligustrum (privet)	Habitat/association	CABI CPC, 2015; Collections in the museum of the University of California- see below
Mangifera indica (mango)	Habitat/association	CABI CPC, 2015; Collections in the museum of the University of California - see below, also referred to as damaging to mango by Zahn and Morse (2013).
Pistacia vera (pistachio)	Habitat/association	CABI CPC, 2015; Collections in the museum of the University of California - see below
Vitis vinifera (grapevine)	Habitat/association	CABI CPC, 2015; Collections in the museum of the University of California - see below
Carya illoinensis (pecan)	Incidental	EPPO PQR (2014)
Gossypium hirsutum (cotton)	Incidental	EPPO PQR (2014)
Magnolia	Incidental	EPPO PQR (2014)
Medicago sativa (lucerne)	Incidental	EPPO PQR (2014)
Phoenix dactylifera (dates)	Incidental	EPPO PQR (2014)
Rosa	Incidental	EPPO PQR (2014)
Quercus	Wild / weed	EPPO PQR (2014)
Rhus laurina	Wild / weed	EPPO PQR (2014)

CABI CPC (CABI CPC, 2015) provides the following information on *S. citri* hosts:"Citrus is an introduced crop in California (USA), there being no native plants of the family Rutaceae in that area. In contrast, *Scirtothrips citri* is native to California and adjoining states, and

therefore must have changed its host-plant relationships in the areas of citrus cultivation. The primary natural host-plant of this thrips species appears to be *Rhus laurina* (Anacardiaceae) (Morse, 1995), and the host-shift by the insect is thus particularly remarkable. Adults of the thrips have been collected from a wide range of plants, including native and introduced trees, shrubs and herbs, but definitive studies on the larval host plants are still required. Collections in the museum of the University of California, Riverside, include larvae of *S. citri* from the following plants: *Ligustrum* sp., *Mangifera indica*, *Pistacia vera*, *Quercus grisea*, *Rhus* sp., *Simmondsia chinensis* and *Vitis vinifera*. Despite this, it is generally assumed that most of the total population of *S. citri* in California lives on citrus, with only limited immigration into the crop from other plants and surrounding areas".

The EPPO datasheet (EPPO, 1997) refers to hosts of *S. citri* as "Primarily a pest of *Citrus* in California (USA), this species has been taken from 53 different plant species; not all of these are likely to be breeding host plants and many, like *Citrus*, are not native Californian plants (Morse, 1995). Other crops on which it has been found include cotton (*Gossypium hirsutum*), dates (*Phoenix dactylifera*), grapevine (*Vitis vinifera*) lucerne (*Medicago sativa*) and pecans (*Carya illinoensis*), and also ornamentals such as *Magnolia* and *Rosa*. The native host plant is possibly one or more species of *Quercus* (Bailey, 1964), or more likely *Rhus laurina* (Morse, 1995)".

In summary, the finding of larvae of *S. citri* in a wide range of hosts where *S. citri* is endemic in southern USA demonstrates a potentially extensive host range, though populations damaging crop species are limited and restricted mainly to *Citrus* and *Vaccinium,* of which *Vaccinium* is the most important UK host. There have been no reports of damaging populations of *S. citri* on *Quercus* or *Vitis* (also important UK species), and these hosts are likely to be occasional or incidental hosts.

In its endemic range in southern USA *S. citri* has undergone a major host shift from its (major) natural host to infest *Citrus* and *Vaccinium* production where populations have been sufficient to cause significant damage to these introduced hosts.

8. What pathways provide opportunities for the pest to enter and transfer to a suitable host and what is the likelihood of entering the UK/PRA area?

All life stages of *S. citri* (adults, eggs, larvae, nymphs and pupae) can occur on leaves, fruits, flowers and calyx (CABI Crop Protection Compendium data sheet; CABI, 2015).

Pathway 1: Fruit.

Citrus and *Vaccinium* fruits are the principal confirmed crop hosts on which *S. citri* has been found in high numbers and infested fruits could provide a means for entry if imported to the UK.

In the UK during the summer months, adult *S. citri* entering the UK could, through the disposal of fruit or peelings, transfer to several potential hosts of outdoor-grown plants including *Vaccinium, Vitis, Ligustrum, Quercus* and *Rhus* (see section 7). Transfer to suitable hosts under protection could be more limited because hosts are mostly not grown under protection. Whilst basic biosecurity measures used by commercial growers limit transfer risks from *S. citri* on initially entering the UK, in some circumstances potential for transfer to *Vaccinium* is higher. These include premises where hosts are grown and which are open to the public (eg. 'pick your own' enterprises). However, opportunities for transfer from the fruit pathway are likely to be limited to locations where imported infested fruit are repackaged close to premises where the host is also grown. However, most imports will go directly to the retail market where transfer is much more unlikely.

There have been no interceptions in the UK or the rest of the EU on fruit.

Citrus fruit import from 'third countries' is regulated under Annex IV in the Council Directive 2000/29/EC and requires that leaves and other plant parts associated with the fruit are removed, which reduces entry risks from this source. Data from a group of UK Citrus fruit suppliers that account for approximately 40% of UK imports found 77% of imports originated from Europe and Africa and trade from the USA accounted for 0.7% of imports of which, grapefruit was a significant import (Defra, 2012). Trade on *Citrus* from countries where *S. citri* is known to be present is thus relatively low.

The international trade section of the Eurostat database (Eurostat, 2015) records import data for *V. corymbosum* (highbush blueberry) fresh fruit combined with data from *V. macrocorpum* (cranberry). In 2014 a total of 389700 kg of fruit from both species was imported into the UK from the USA which suggests a substantial import of blueberry though no information is available for imports specifically from southern US states, where *S. citri* is present.

The lack of UK interceptions of *S. citri* and the difficulties of transfer is consistent with a low entry risk in imported fruit and this pathway is rated as unlikely. A high confidence score is given due to the clear difficulties in transfer even though some infestations may remain undetected and there is a lack of information on imports of blueberry fruit from southern USA, where the pest is present.,

Pathway 1	Very unlikely	☐	Unlikely	☑	Moderately likely	☐	Likely ☐	Very likely ☐
Confidence	High Confidence	☑	Medium Confidence	☐	Low Confidence	☐		

Pathway 2: Plants for planting

Larvae of *S. citri* feed on soft tissues of developing leaves or fruit of *Citrus* and post-feeding stage larvae move from their feeding sites to find optimal environments to complete their development to adults. Up to 50% of larvae move to the soil at the base of

plants and stems though twigs can also be used as refuges for moulting to adult and eggs can be laid and over-winter in crevices in bark as well as in soil (Kerns et al. 2004; Schweizer and Morse, 1989). The CABI Crop Protection Compendium datasheet (CABI, 2015) indicates that in *Citrus*, all life cycle stages of *S. citri* can be found on leaves but have not been associated with growing medium, shoots or bark.

Import of plants for planting of *Citrus* (and *Vitis*) from third countries are prohibited by Annex IIIA of Council Directive 2000/29/EC, which reduces entry risks from this potential pathway for these hosts. As a deciduous shrub, *Vaccinium* imported with leaves or fruitsattached is prohibited under Annex IVAI of the Council Directive, and this reduces *S. citri* entry risks from this host as well as other deciduous shrubs.

In the UK the only finding of *S. citri* was from a botanic garden in the south of England and may have originated from the import of specialist host species that may not be widely traded. Considering that there has only been this single instance of *S. citri* in the UK (see section 6), entry risks from this pathway appear to be largely controlled by existing regulations and this entry pathway is rated as unlikely. The large potential host range and difficulties in identifying infested plants contributes to the uncertainty in assessing the entry rating and the confidence rating is scored as medium.

Pathway 2	Very unlikely	☐	Unlikely	☑	Moderately likely	☐	Likely	☐	Very likely	☐
Confidence	High Confidence	☐	Medium Confidence	☑	Low Confidence	☐				

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

Establishment outdoors is rated as very unlikely because the distribution of *S. citri* in the USA is restricted to southern regions that have hotter summer and warmer winter temperatures than the UK. Climatic unsuitability in the UK is supported by a study of the effect of temperature on development and survival of *S. citri* on *Citrus* foliage that found that the thermal threshold for egg development was 18.3° C (Tanigoshi et al., 1980). The lower temperature limit for development has been reported as 14° C (EPPO/CABI 2015; data sheet). The optimum feeding rate of larvae occurs at 29-30° C (Wiesenborne and Morse, 1986). Although it is possible that *S. citri* could complete its development in the summer months in warmer parts of the UK, it is very unlikely to successfully overwinter and establish in hosts that are not grown under protection in the UK.

Outdoors	Very unlikely	☑	Unlikely	☐	Moderately likely	☐	Likely	☐	Very likely	☐
Confidence	High Confidence	☑	Medium Confidence	☐	Low Confidence	☐				

Vaccinium species grow in the wild and are mostly produced as an outdoor crop in the UK though some plants may be grown under protection. V*itis* is produced as a field crop though conservatory-grown plants are widely grown in the UK. Establishment of *S. citri* could occur in these hosts in protected environments by completing their lifecycle during the summer and then over-wintering as eggs when the host is dormant (Kerns et al., 2004). In California, a population study of *S. citri* in blueberry maintained in hoop houses found had 2-3 times greater numbers in the early season compared to numbers recorded in bluberry grown outdoors (Haviland et al., 2009), which confirms that *S. citri* is able to efficiently reproduce under protection. *Citrus* are only grown under protection by specialist growers and in small quantities. The detection of *S. citri* on sticky traps at a botanic garden in southern England suggests that the pest may be capable of establishing under protection though only two individuals were ever reported. Establishment is rated as likely for hosts grown under protection.

Under Protection	Very unlikely	☐	Unlikely	☐	Moderately likely	☐	Likely	☑	Very likely ☐
Confidence	High Confidence	☐	Medium Confidence	☐	Low Confidence	☑			

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

Not applicable.

11. How quickly could the pest spread in the UK/PRA area?

Thrips are not strong flyers, which limits their speed of spread. Although thrips can be borne in wind currents the low probability of *S. citri* encountering a suitable host grown under protection reduces the significance of wind dispersal and the speed of natural spread is rated as slowly. Dissemination of *S. citri* could occur more rapidly by human activity through trade, which is rated as quickly.

Natural Spread	Very slowly	☐	Slowly	☑	Moderate pace	☐	Quickly	☐	Very quickly ☐
Confidence	High Confidence	☐	Medium Confidence	☑	Low Confidence	☐			
With trade	Very slowly	☐	Slowly	☐	Moderate pace	☐	Quickly	☑	Very quickly ☐
Confidence	High Confidence	☑	Medium Confidence	☐	Low Confidence	☐			

12. What is the pest's economic, environmental and social impact within its existing distribution?

When *S. citri* eggs are laid at an early stage in *Citrus* fruit the subsequent feeding larvae produce a ring of damage in the rind that reduces fruit marketability. Damage to developing leaves can lead to partial defoliation of branches that can contribute to losses in *Citrus* fruit yield and expenses are associated with costs of insect control including insecticide use. In southern USA significant economic damage has been recorded (Rhodes and Morse, 1989).

In *Vaccinium* leaf damage is the primary damaging symptom and causes a reduction in fruit yield (Haviland et al., 2009). This study reported that in southern USA, card traps placed in *Vaccinium corymbosum* production areas recorded more than 700 thrips per trap over an approximately 3 week period. These high population levels were associated with damage to stems and leaf symptoms including curling and twisting of new foliage. Economic damage is rated as medium to reflect damage to *Citrus* and blueberry.

Though there is some evidence that *Quercus* or *Vitis* (and a wide range of other species) may be able to serve as hosts for *S. citri*, there have been no reports of significant populations that have caused damage to these hosts.

Impacts	Very small	☐	Small	☐	Medium	☑	Large	☐	Very large ☐
Confidence	High Confidence	☑	Medium Confidence	☐	Low Confidence	☐			

13. What is the pest's potential to cause economic, environmental and social impacts in the UK/PRA area?

In the UK, *Citrus* is produced as a minor ornamental by specialist growers and damage to fruit (which is not sold) would not have significant impacts. *Vaccinium* and conservatory-grown *Vitis* could be at risk from *S. citri* infestations, and damage to leaf development could occur in blueberry grown under protection. Although there is some potential for localised infestations to cause impacts to individual growers, overall economic impacts are rated as small. There is some uncertainty relating to *S. citri* population sizes that could be attained in *Vaccinium* cultivation under UK conditions, which will determine the level of damage produced, and the confidence in the rating is scored as medium to reflect this. Wild populations of *Vaccinium* in the PRA area are not at threat from *S. citri* because they are not grown under protection and environmental impacts are rated as very small.

Economic Impacts	Very small	☐	Small	☑	Medium	☐	Large	☐	Very large ☐
Confidence	High Confidence	☐	Medium Confidence	☑	Low Confidence	☐			

Environ - mental Impacts	Very small	☑	Small	☐	Medium	☐	Large	☐	Very large ☐
Confidence	High Confidence	☑	Medium Confidence	☐	Low Confidence	☐			

Social Impacts	Very small	☑	Small	☐	Medium	☐	Large	☐	Very large ☐
Confidence	High Confidence	☑	Medium Confidence	☐	Low Confidence	☐			

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

No pathogens have been reported to be vectored by *S. citri*. Other species in the genus have been reported to vector viruses so there is some potential for *S. citri* to transmit viruses (Yeh and Chu, 1999).

15. What is the area endangered by the pest?

All regions of the UK where hosts (*Vaccinium, Vitis* and *Citrus*) are grown under protection are at risk from *S. citri* infestation.

Stage 3: Pest Risk Management

16. What are the risk management options for the UK/PRA area?

Insecticides can be used for control of *S. citri* and their use as part of an integrated pest management strategy in *Citrus* has been reviewed recently (Grafton-Cardwell, 2015). The fungal biocontrol agent *Beauveria bassinia* has been found to significantly reduce *S. citri* populations infesting blueberry when applied to irrigation water (Zahn et al., 2013 a and b).

Regulation of *S. citri* under Directive 2000/29/EC is restricted to infestation on *Citrus, Fortunella and Poncirus*. Should *S. citri* be encountered in the PRA area, other than on these hosts, and considered a threat, then action against it could be taken under existing EU regulations for newly introduced, but non-regulated pests under Article 16 (2) of the above directive.

17. Summary and conclusions of the rapid PRA

This rapid PRA shows:

Climatic conditions limit potential UK impacts from *S. citri* to plants grown under protection. Damaging populations in countries were *S. citri* is present are restricted to *Citrus* and *Vaccinium.* Considering the small quantities of these hosts grown under protection in the UK, economic impacts are rated as small.

Risk of entry

Two entry pathways were considered, namely the imports of infested fruit and plants for planting, both of which were rated as unlikely. The low scores reflected the difficulty of transfer from the fruit pathway, the lack of interceptions on fruit and the fact there has been only one UK finding which may have been associated with plants for planting, which provides evidence for the effectiveness of current regulation in controlling entry risks. Whilst the low natural spread of *S. citri* and limited extent of hosts grown under protection in the PRA area make transfer unlikely, in some circumstances transfer risks could be increased e.g. where members of the public bring in food for consumption to premises or packaging of imported fruits occurs where the host is grown.

Risk of establishment

Climatic limitations preclude establishment of *S. citri* in hosts that are not grown under protection in the PRA area. There is some potential for establishment of *S. citri* in *Vaccinium, Vitis* or *Citrus* that are grown in limited amounts under protection in the UK. Establishment risks are scored as very unlikely for hosts not grown under protection and likely for hosts grown under protection.

Economic, environmental and social impact

Potential economic damage from *S. citri* is limited because susceptible hosts are not grown extensively under protection in the UK. Economic, impacts are rated as small and both environmental and social impacts are scored as very small.

Endangered area

Where hosts are grown under protection within the PRA area.

Risk management options

Statutory action could be taken against UK findings on the legal basis it is a newly introduced harmful pest. Chemical control options are also available.

Key uncertainties and topics that would benefit from further investigation

S. citri has utilised new hosts grown for commercial production in its natural distribution range and there is potential for the thrips to increase its host range to new crop hosts in the future. There is some taxononomic uncertainty associated with *S. citri*, which could be addressed by future molecular phylogenetic analysis. There are several reports of *S. citri* where identification requires further confirmation.

18. Is there a need for a detailed PRA or for a more detailed analysis of particular sections of the PRA? If yes, select the PRA area (UK or EU) and the PRA scheme (UK or EPPO) to be used.

(For completion by the Plant Health Risk Group) ✓ *(put a tick in the box)*

No	✓				
Yes		PRA area: UK or EU		PRA scheme: UK or EPPO	

19. Images of the pest

Adult S. citri

Photo courtesy of Joseph Morse (Bugwood Images)

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

[*For completion by the Plant Health Risk Group*] *(put a tick in the box)*

Yes Statutory action	✓	No Statutory action	

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