



The Food & Environment Research Agency

Rapid Pest Risk Analysis for

Trialeurodes abutiloneus

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?

Trialeurodes abutiloneus (Haldeman) (Hemiptera, Aleyrodidae). Banded-winged whitefly. A common synonym used in the USA is *Trialeurodes abutilonea* (Haldeman).

2. What is the pest's status in the EC Plant Health Directive (Council Directive 2000/29/EC¹) and in the lists of EPPO²?

Trialeurodes abutiloneus is not listed in the EC Plant Health Directive and is not recommended for regulation as a quarantine pest by EPPO. It was added to the EPPO Alert List in 1998, but deleted two years later.

3. What is the reason for the rapid assessment?

Following the development of Phase I of the UK Plant Health Risk Register in the summer and autumn of 2013, this pest was considered as a priority for an updated PRA, especially with regard to the risk of virus introduction, since this whitefly is a vector of several harmful viruses. The original PRA (MacLeod 2005) was written after the first UK interception of *T. abutiloneus*, when high numbers of all life stages (eggs, larval instars and adults) were detected at Gatwick airport in a consignment of *Hibiscus* plants from USA. This document includes data from the 2005 PRA, and is updated with new information that has become available.

STAGE 2: RISK ASSESSMENT

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

Trialeurodes abutiloneus is known from much of the USA, distributed mainly in the southern and eastern states. The full list of states where it has been recorded is:

Alabama, Arizona, Arkansas, California, Colorado, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Mississippi, Missouri, Nebraska, Nevada, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Virginia, Washington and Wisconsin (Russell 1963; Hodges and Evans 2005; MacLeod 2005; Dooley *et al.* 2010). Russell (1963) reported that, in the eastern USA, the northern limits of its distribution were southern New York, Michigan and Wisconsin; she was unable to find *T. abutiloneus* in northern parts of New York state.

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](http://archives.eppo.int/EPPOStandards/PM1_GENERAL/pm1-02(21)_A1A2_2012.pdf)

This species has been found in glasshouses in states including Kentucky (White 2013), Massachusetts (Smith 2012), New York (Sanderson 2010), North Carolina (Anon [accessed 2014]) and Vermont (Frank and Skinner 2008).

Outside the USA, *T. abutiloneus* has been reported from Mexico (Martin and Mound 2007), Cuba (Vazquez *et al.* 1995), Jamaica (in MacLeod 2005), Puerto Rico and Trinidad (Russell 1963) and Colombia (Calvert *et al.* 2001). Evans (2008) additionally records it from Brazil, Costa Rica, El Salvador, Guatemala and Honduras; the reports from Iran and Hawaii are considered unproven (C. Malumphy, pers. comm., 29 April 2014).

Trialeurodes abutiloneus is not definitively known from any part of the world outside the Americas. Though virus vectoring studies with *T. abutiloneus* have been carried out in Europe (for example, Font *et al.* 2003; Verbeek *et al.* 2013), there is no suggestion that *T. abutiloneus* is present in these regions, merely that, under experimental conditions, it is capable of vectoring viruses present in Europe.

5. Is the pest established or transient, or suspected to be established/transient in the UK? (Include summary information on interceptions and outbreaks here).

There have been 5 interceptions (2 in 2005, and 3 in 2010) of this species in England, all on plants from the USA. In April 2005, there were two related interceptions on *Hibiscus* with very high numbers of whitefly present; all the plants were destroyed. In December 2010, illegal postal imports of plants were intercepted at a courier hub: three plant species (*Acacia*, *Banisteriopsis caapi* and *Brugmansia*) had this whitefly present and, again, all the plants were destroyed. Europhyt data (records retrieved 6 May 2014) records two German interceptions of "*Trialeurodes* sp.": one from Ecuador on *Hypericum* sp. in 2005, and one from the USA on *Hibiscus* sp. in 2013; but further details are lacking.

There is no definitive evidence that this species is present in any part of the world other than North, Central and South America and the Caribbean.

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

This whitefly is highly polyphagous, and is found on both crops and weed species, though Liu and Stansly (2000) state that it prefers hosts in the plant family Malvaceae (hibiscus, or mallows). There are several long lists of hosts available in the literature, for example Russell (1963), Mound and Halsey (1978) or Slosser *et al.* (2005). Liu and Stansly (2000) predict that the host range of *T. abutiloneus* will broaden with time, as it adapts to new regions where its preferred hosts are rare.

Selected hosts (all from the references listed above), of economic importance to the UK include:

Field crops: beans (*Phaseolus* spp.), potato (*Solanum tuberosum*), *Brassica* spp. and maize (*Zea mays*).

Protected cultivation (edible plants): cucumber (*Cucumis sativus*), lettuce (*Lactuca sativa*) and tomato (*Solanum lycopersicum*).

Protected cultivation (ornamentals): *Petunia*, *Geranium*, *Hibiscus*, poinsettia and other species of *Euphorbia*, and many other species.

Courgettes (*Cucurbita pepo*), sunflowers (*Helianthus annuus*) and *Wisteria* are among the hosts widely grown by gardeners in the UK; *Taraxacum* sp. (dandelion) and blackberries (*Rubus* spp.) are commonly distributed in the wider environment.

7. If the pest needs a vector, is it present in the UK?

This is a free-living organism and does not require a vector.

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: this whitefly may be found on almost any plant as it is highly polyphagous. Detection at import may be problematic. While the Plant Health and Seeds Inspectorate in England and Wales routinely find whitefly during the course of their inspections, eggs and early-instar larvae are tiny and can be overlooked during an inspection. Additionally, the puparia are very similar to the cosmopolitan species *Trialeurodes vaporariorum* (glasshouse whitefly) (Malumphy *et al.* 2010), the two species

requiring slide-mounting and high-power microscopy for certain separation. Hence, *T. abutiloneus* puparia may be misidentified (under field conditions) as *T. vaporariorum*. *Trialeurodes vaporariorum* is found widely in UK protected cultivation, is not a quarantine pest for the UK, and thus no action is taken on imports due to the presence of this whitefly. Using unpublished Fera data, there were 69 interceptions of whitefly (Aleyrodidae) on plants from the USA between 1996 and 2013 (although the distinction between produce and growing plants is not always clear in these historical data). Of these interceptions, 19 were *T. vaporariorum*, a species originating from the New World but now found much more widely, including protected cultivation in the UK; and 31 interceptions were of *Bemisia tabaci*, a whitefly species of quarantine significance to the UK. No other species of whitefly was found more than twice in this time period from the USA. Some plants from the first interception of *T. abutiloneus*, in 2005, reached a commercial nursery before the plants were destroyed due to the presence of high numbers of this whitefly. However, it is unclear why this species is apparently only rarely detected moving in trade. Overall, this pathway is considered to be moderately likely.

Produce (including cut flowers): again, due to the polyphagous nature of the species, it could be present on a wide range of produce, with similar detection problems as described under plants for planting. However, this pathway is rated as unlikely as plant products have a short shelf life and are likely to be rapidly dispersed, the immature stages are sessile (except for a very brief period immediately after hatching), and the adults are unlikely to fly long distances. All of these factors mean that those whiteflies which arrive on produce are judged unlikely to be capable of transfer to a host, though as the species is highly polyphagous, suitable hosts are likely to be present in most areas.

Plants for planting:	Very unlikely	<input type="checkbox"/>	Unlikely	<input type="checkbox"/>	Moderately likely	<input checked="" type="checkbox"/>	Likely	<input type="checkbox"/>	Very likely	<input type="checkbox"/>
Produce and cut flowers:	Very unlikely	<input type="checkbox"/>	Unlikely	<input checked="" type="checkbox"/>	Moderately likely	<input type="checkbox"/>	Likely	<input type="checkbox"/>	Very likely	<input type="checkbox"/>

Trialeurodes abutiloneus is a vector of 8 plant pathogenic viruses, many of economic importance (Tzanetakis *et al.* 2013; Verbeek *et al.* 2013), none of which are present in the UK (pers. comm., A. Fox 28 April 2014), and 5 of which are absent from Europe. While it is a semi-persistent vector for all 8 viruses, meaning the infectious period of the whitefly is limited, there is nonetheless a risk of non-native viruses being introduced to the UK by this whitefly, if infected individuals are able to locate a suitable host plant while still infective.

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

Trialeurodes abutiloneus is widely distributed in the USA extending from Washington (temperate oceanic) and California (Mediterranean) in the west, through Arizona and Colorado (arid desert and steppe) to Florida (subtropical rain) and southern New York state (temperate continental) in the east. It is therefore able to survive in several climatic zones, though it is not always clear whether it is present outdoors or under protection. Smith (2012) suggests that, in Massachusetts (north-eastern USA), *T. abutiloneus* enters protected cultivation in the autumn; White (2013) agrees, reporting that, as the outdoor vegetation in Kentucky starts to die off, the whitefly seeks growing plants, and as a result moves into glasshouses. Hamon (1991) states that it is only able to survive the winter in northern areas of the USA under protection.

Trialeurodes abutiloneus has temperature requirements that are broadly the same as the common UK glasshouse whitefly, *T. vaporariorum*, though calculated values for the latter species vary quite widely (Table 1). Greenberg *et al.* (2000) noted that, though degree day calculations should not be affected by the experimental temperatures for a given species, in fact calculated values varied from 436 DD (at 21°C) to 528 DD (at 15°C) for *T. vaporariorum*, and this may help to explain some of the variability in Table 1. *Trialeurodes vaporariorum* is essentially a glasshouse pest in the UK, with very few outdoor records even in summer (though the reasons for this are unknown, as temperature alone should not be a limiting factor), and it does not seem able to overwinter outdoors in the UK. Therefore, in common with *T. vaporariorum*, *T. abutiloneus* is considered unlikely to be capable of overwintering

outdoors in the UK, though transient summer populations may establish. The autumn move into glasshouses by *T. abutiloneus* in the USA, apparently caused by the whitefly seeking growing vegetation as the outdoor foliage dies off (White 2013; Anon [accessed 2014]) suggests this species might be more mobile than *T. vaporariorum*, but it is not known if glasshouse populations move into the wider environment at other times of year. No data could be found either on the origin of summer field populations, or on overwintering strategies for *T. abutiloneus* in northern parts of the USA, so the ability of this species to develop transient outdoor populations in the UK is very uncertain. Overall, establishment outdoors is considered unlikely.

Table 1. Calculated threshold development temperatures and accumulated degree days for two species of *Trialeurodes*.

Species	Life stage	Lower threshold development temperature (°C)	Degree days above threshold	Source
<i>T. abutiloneus</i>	Egg	7.3	137	Calculated by MacLeod (2005) from data in Butler (1967)
	Egg & larva	6.5	476	
	Egg – pupa	6.5	588	
<i>T. vaporariorum</i>	Egg-adult	2.9	483	Greenberg <i>et al.</i> (2000)
	Egg	5.2	154	Soto <i>et al.</i> (2000)
	Egg & larva	3.9	436	
	Egg – pupa	3.5	514	
	Egg-adult	8.3	381	Osborne (1982)
	Egg & larva	8.9	357	Yano (1981)

However, if sufficient numbers were able to enter protected cultivation, then the species would seem capable of persisting. Plants for planting are imported from the pest's native range. This species is known from glasshouses in north-eastern states in the USA, e.g., Vermont (Frank and Skinner 2008), New York (Sanderson 2010) and Massachusetts (Smith 2012), as well as those further south, such as Kentucky (White 2013). Overall, establishment in protected cultivation is considered to be likely.

Outdoors:	Very unlikely	<input type="checkbox"/>	Unlikely	<input checked="" type="checkbox"/>	Moderately likely	<input type="checkbox"/>	Likely	<input type="checkbox"/>	Very likely	<input type="checkbox"/>
Under protection:	Very unlikely	<input type="checkbox"/>	Unlikely	<input type="checkbox"/>	Moderately likely	<input type="checkbox"/>	Likely	<input checked="" type="checkbox"/>	Very likely	<input type="checkbox"/>

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

Natural spread will be slow. Although adults can fly, and may be blown by the wind, they do not routinely travel long distances. First instars may also be carried by wind or on other animals but there is no evidence that this would be significant.

Spread in trade could be much faster. Eggs and early- instars of all whitefly are tiny and difficult to detect. Puparia of *T. abutiloneus* could be misidentified as the related glasshouse whitefly, *T. vaporariorum*, which is a common glasshouse pest in the UK. The puparia of the two species (especially the ones without pigmentation) are very similar, unless they are slide-mounted and examined by a specialist. However, adults are easily separated: *T. abutiloneus* has dark bands on its white wings, while *T. vaporariorum* wings are white with no markings at all. Thus, *T. abutiloneus* may be mis-identified as *T. vaporariorum*, and infested plants could be moved widely in trade.

Natural spread:	Very slowly	<input type="checkbox"/>	Slowly	<input checked="" type="checkbox"/>	Moderate pace	<input type="checkbox"/>	Quickly	<input type="checkbox"/>	Very quickly	<input type="checkbox"/>
In trade:	Very slowly	<input type="checkbox"/>	Slowly	<input type="checkbox"/>	Moderate pace	<input type="checkbox"/>	Quickly	<input checked="" type="checkbox"/>	Very quickly	<input type="checkbox"/>

11. What is the area endangered by the pest?

Due to the wide host range of this species, any protected crops in the UK could be considered at risk from this whitefly. In Kentucky, White (2013) states it is a sustained greenhouse pest of ornamentals such as *Euphorbia*, *Geranium* and *Petunia*, but won't lay eggs on many other hosts. However, it is capable of reproducing on some weed species, thus providing a supply of adults to attack other crops. The temperature requirements of this species and a comparison with *T. vaporariorum* would suggest that *T. abutiloneus* is unlikely to be able to overwinter outdoors in the UK, though field crops in summer may be at risk from transient populations. As noted above, the ability of *T. abutiloneus* to form transient outdoor populations is unknown, due to lack of data from the northern USA. There is some evidence that *T. abutiloneus* moves into glasshouses in the autumn in northern states of the USA (Smith 2012; Anon [accessed 2014]), but whether they move from protected cultivation out into the wider environment in spring or summer is unknown.

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

Like many sap-feeding Hemiptera, *T. abutiloneus* causes direct damage by feeding on the phloem (which can weaken the plant when there are high numbers of whitefly present), and contaminates plants with excreted honeydew, on which sooty moulds may develop, further reducing the affected plants' value.

In the USA, *T. abutiloneus* is an occasional pest of field and ornamental plants (Liu and Stansly 2000). Its populations are usually held in check by natural enemies (Butler 1967). However, in Texas, problematic infestations can occur in cotton: high numbers were reported in Texas cotton fields in 2000 (but not in other years); however, the honeydew was less sticky than *B. tabaci* (as *B. argentifolii*), so cotton lint quality was less affected (Slosser *et al.* 2005). Johnson *et al.* (1982) reported large populations of *B. tabaci* and *T. abutiloneus* on cotton and vegetable crops in southern California and western Arizona in 1981 causing multiple injuries, including direct feeding damage, contamination of plants by honeydew and sooty mould, and transmission of pathogens. When compared to *B. tabaci*, *T. abutiloneus* is not such a significant pest, for instance McPherson and Lambert (1995) measured seasonal abundance of *B. tabaci* (as *B. argentifolii*) and *T. abutiloneus* in soybean in Georgia (USA). At the population peak, there were over four times more *B. tabaci* than *T. abutiloneus* per unit leaf area (14.4 *B. tabaci* versus 3.3 *T. abutiloneus* nymphs per 2.54cm² leaf area). However, in Arizona in 1983, in an experiment on yellow sticky trap design in cotton and lettuce fields, more *T. abutiloneus* than *B. tabaci* were captured on almost every type of trap (Byrne *et al.* 1986). *Trialeurodes abutiloneus* were most abundant on upper, younger, leaves (Slosser *et al.* 1992), and damage to individual leaves near the growing tip can be more significant than damage to older leaves. Vazquez *et al.* (1995) reported *T. abutiloneus* causing some damage to sweet peppers in Cuba.

In protected cultivation, there is very little information available on the impacts of *T. abutiloneus*, though it would seem to cause less damage than *B. tabaci* or *T. vaporariorum*, and is not usually considered a major pest (e.g., Frank and Skinner 2008; Smith 2012).

Very small Small Medium Large Very large

A key area of uncertainty is the vector capacity of the whitefly. As a known vector of eight viruses, none present in the UK (and some with high economic impacts), *T. abutiloneus* may have higher impacts in the existing distribution than the ratings for direct damage given here, though there is high uncertainty about any vector impacts. Data in Table 2 (part of the answer to question 14) summarises information on each virus currently known to be vectored by *T. abutiloneus*, including distribution and relative efficiency of the whitefly vector(s) of that virus. The vector capability studies on *T. abutiloneus* are usually laboratory-based, and it is not clear whether the spread of the virus studied is naturally whitefly-mediated. Additionally, many of the viruses vectored by *T. abutiloneus* have also been

shown to be vectored by other whiteflies, such as *T. vaporariorum* or *B. tabaci*, which further increases the uncertainty of the impact of *T. abutiloneus* as a vector.

13. What is the pest's potential to cause economic, environmental or social impacts in the UK?

The main crops at risk are all glasshouse crops as this species is considered unlikely to be capable of overwintering outdoors in the UK. In protected cultivation in the USA, *T. abutiloneus* appears to cause less impact and be present in lower numbers than two other glasshouse whiteflies, *T. vaporariorum* and *B. tabaci* (e.g., Frank and Skinner 2008; Smith 2012; White 2013). Thus, ornamental crops would seem to be most at risk from the presence of this whitefly, as consumers typically have a very low tolerance for whitefly on growing plants and even a low infestation rate will have impacts on the quality of the plants sold. Overall, potential impacts to UK protected cultivation from *T. abutiloneus* are considered very small to small. Due to the very high uncertainty over the possibility of transient field populations developing in the UK, impacts to the wider UK environment were not assessed.

Very small Small Medium Large Very large

However, if *T. abutiloneus* were to be introduced carrying viruses, then tomato crops would seem most at risk, as this whitefly is a vector of four tomato viruses, two of which are present in Europe (but not the UK); none of the eight viruses this species vectors are present in the UK (pers. comm., A. Fox 28 April 2014). See Table 2 and the answer to question 14 for more information on each virus vectored by *T. abutiloneus*.

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

Trialeurodes abutiloneus is a known vector of plant pathogenic viruses: at the time of writing, it has been recorded transmitting eight species of virus (Table 2). *Trialeurodes abutiloneus* was first reported as a vector in 1991 (Larsen *et al.*); just over 10 years later, the list of viruses it could vector had increased to four (Jones 2003), and now stands at eight. Thus, it seems likely that this whitefly will ultimately be found to be capable of transmitting more viruses than listed here.

However, there is high uncertainty about the impacts of *T. abutiloneus* as a virus vector. As previously stated, most studies are experimental, and it is not clear exactly how several of the viruses are transmitted in the field (especially those only recently described). Additionally, many of these viruses are also vectored by *T. vaporariorum* or *B. tabaci*, so the impact of *T. abutiloneus* alone is hard to quantify. To infect UK crops with a virus, *T. abutiloneus* would have to be carrying the virus, and, once in the UK, would need to transfer to host suitable for both virus and whitefly. Further, all eight viruses are transmitted in a semi-persistent manner by *T. abutiloneus* (e.g., Tzanetakis *et al.* 2013; Verbeek *et al.* 2013), which means a new host must be found within the period the individual whitefly is infective.

ToCV is present in many parts of the world, including a number of European countries (EPPO 2014). While the virus causes yellowing of tomato leaves and does not directly affect the fruit (Wisler *et al.* 1998), the fruit is smaller in size, and the plant has early senescence (Wintermantel *et al.* 2008). *Trialeurodes abutiloneus* and *B. tabaci* (biotype B) are equally efficient at transmitting ToCV, but the virus persists for up to 5 days in *T. abutiloneus* and only 2 days in *B. tabaci*; *B. tabaci* (biotype A) and *T. vaporariorum* are less efficient vectors and the virus only persists in these whitefly for 1 day (Wintermantel and Wisler 2006). Of the three tomato torradoviruses, ToTV is found in North America, Australia and several countries in Europe (EPPO 2014). It can cause severe necrosis of both leaves and fruit (giving the plant a 'burnt' appearance), with resultant economic losses to the crop (Verbeek *et al.* 2007). ToMarV and the tentative species ToChV are described as having a similar impact to ToTV in susceptible tomato cultivars (Verbeek *et al.* 2008; Verbeek *et al.* 2010), though these two viruses are only recently described and their known distribution is quite restricted. All three are vectored by *T. abutiloneus*, *T. vaporariorum* and *B. tabaci*; *T. abutiloneus* has the same

vector efficiency as the other two species for ToTV and probably ToMarV, but is slightly less efficient at transmitting ToChV (Verbeek *et al.* 2013). Tomatoes are an important commercial crop for the UK, with a total area of over 200 Ha, valued at £96 million, in 2012 (Defra 2013). As tomatoes are grown in protected cultivation, if *T. abutiloneus* were able to transfer to a production glasshouse, conditions would be favourable for the whitefly to establish. Impacts on tomatoes grown under protected cultivation in the UK are likely to be similar to those seen in other countries where the viruses are present.

Table 2. Viruses that *Trialeurodes abutiloneus* has been shown to vector, with notes on virus distribution and relative efficiency of identified whitefly vectors. Virus taxonomy follows the International Committee on Taxonomy of Viruses (2013); other sources are listed in the individual discussion of each virus that follows.

Virus genus	Virus species	Virus distribution		Vectors, ranked in efficiency, high–low (= equal efficiency)
		Europe	Rest of world	
<i>Crinivirus</i>	<i>Abutilon yellows virus</i> (AbYV)	Absent	North America	<i>T. abutiloneus</i>
	<i>Blackberry yellow vein associated virus</i> (BYVaV)	Absent	North America	<i>T. abutiloneus</i> <i>T. vaporariorum</i>
	<i>Diodia vein chlorosis virus</i> (DVCV)	Absent	North America	<i>T. abutiloneus</i> <i>T. vaporariorum</i>
	<i>Sweet potato chlorotic stunt virus</i> (SPCSV)	Spain	North America Caribbean South America Africa Asia	<i>Bemisia tabaci</i> <i>T. abutiloneus</i>
	<i>Tomato chlorosis virus</i> (ToCV) (EPPO A2 list)	Cyprus France Greece Hungary Italy Portugal Spain Turkey	North America Caribbean South America Africa Asia	<i>T. abutiloneus</i> <i>B. tabaci</i> (biotype B) <i>B. tabaci</i> (biotype A) <i>T. vaporariorum</i>
<i>Torradovirus</i>	<i>Tomato marchitez virus</i> (ToMarV)	Absent	North America	= <i>B. tabaci</i> = <i>T. vaporariorum</i> ? = <i>T. abutiloneus</i>
	<i>Tomato torrado virus</i> (ToTV)	Poland Spain	Central America South America Australia	= <i>T. abutiloneus</i> = <i>T. vaporariorum</i> = <i>B. tabaci</i>
	(Previously on the EPPO Alert list)	<i>Hungary + Italy</i> (both under eradication)		
<i>Torradovirus</i> (tentative species and placement)	<i>Tomato chocolate virus</i> (ToChV)	Absent	Central America	= <i>B. tabaci</i> = <i>T. vaporariorum</i> <i>T. abutiloneus</i>

BYVaV is only known from the USA. Blackberries with only BYVaV have a latent infection, with symptoms of blackberry yellow vein disease (BYVD) only showing when plants are infected with at least one other virus in a complex interaction (Martin *et al.* 2012; Poudel *et al.* 2013). However, BYVaV is a contributory cause of BYVD, which affects the fruit flavour, causes die back of canes (Susaimuthu *et al.* 2007), has led to replanting rates 3-4 times more than usual, and has caused total yield loss (Martin *et al.* 2012; Poudel *et al.* 2013). *Trialeurodes abutiloneus* appears to be a slightly more efficient vector of BYVaV than *T.*

vaporariorum (Poudel *et al.* 2013), while two other *Trialeurodes* species tested (*T. packardii* and *T. ruborum*) do not appear to transmit BYVaV (Susaimuthu *et al.* 2007). Blackberries are not a common commercial soft fruit in the UK. However, they are widely distributed outdoors, both as wild plants and in gardens: *Rubus fruticosus* (aggregate) is found throughout the UK (BSBI 2014). No reports could be found of BYVaV infecting raspberries (*Rubus idaeus*), which is in a different subgenus of *Rubus* to blackberries.

SPCSV is known from many parts of the world where sweet potatoes are grown, including Spain (Valverde *et al.* 2004a), as well as the Americas, Africa and Asia (CABI 2014). It is transmitted by *T. abutiloneus* at a rate of approximately 3%, which is a slower transmission rate than *B. tabaci*, which transmits SPCSV at a rate of around 15% (Sim and Valverde 1999; Valverde *et al.* 2004b).

DVCV is only recorded in the USA from *Diodea* spp. (Larsen *et al.* 1991): *T. abutiloneus* transmits the virus with about 36% efficiency, but it is also transmitted by *T. vaporariorum* with about 12% efficiency (Tzanetakis *et al.* 2011). AbYV is again only recorded in the USA, from *Abutilon* spp., *Nicotiana clevelandii* (experimentally) (Liu *et al.* 1997), and other hosts in the Malvaceae, though no crops species are known to be affected (Tzanetakis *et al.* 2013). No other whitefly species is known to transmit the virus (Jones 2003; Tzanetakis *et al.* 2013), though this may be due to lack of research. Both these viruses are little-studied, and apparently of minor importance.

In summary, none of these eight viruses vectored by *T. abutiloneus* are known to be present in the UK (pers. comm., A. Fox 28 April 2014). Three are known to be present in Europe (namely ToCV, ToTV and SPCSV); ToCV is on the EPPO A2 list of organisms recommended for regulation, while ToTV was on the EPPO alert list between 2009 and 2013 (EPPO 2014). Five are only known from North America: while two are of minor significance, one affects blackberry and two affect tomato. Seven of the eight viruses are also transmitted by *T. vaporariorum* and/or *B. tabaci*, though vector capabilities of the individual whitefly species differ according to the virus transmitted.

STAGE 3: PEST RISK MANAGEMENT

15. What are the risk management options for the UK? (Consider exclusion, eradication, containment, and non-statutory controls; under protection and/or outdoors).

As this whitefly vectors eight viruses not found in the UK (five only known from the Americas, and three that are found in parts of Europe and elsewhere), continued exclusion is the best risk management option for the UK. However, this may be problematic due to the similarity of the species with *T. vaporariorum*, meaning that non-specialists may misidentify *T. abutiloneus* as a species of no quarantine concern to the UK, thus allowing an outbreak of *T. abutiloneus* to increase in numbers and/or spread due to the misidentification. All *Trialeurodes* originating from the Americas which are submitted to the Fera laboratory for identification are routinely slide-mounted to confirm the species, though it is not known what protocols are used by other EU member states. However, since whitefly eggs are difficult to detect without a microscope, low levels of *T. abutiloneus* may not consistently be detected on imported plants. Destruction or re-export would be the best options for imported plants that were found to be infested.

Based on the UK experience of *B. tabaci*, eradicating outbreaks of whitefly species can be problematic, especially at large ornamental nurseries and in protected salad crops. Eradication of *B. tabaci* in ornamental crops is usually based on monitoring with yellow sticky traps, chemical treatments, the destruction of infested plants and movement restrictions. In protected salad crops, biological control agents and crop breaks have been used to achieve eradication.

For chemical control, the insecticides that are currently available for the control of *T. vaporariorum* would be expected to be effective against *T. abutiloneus*, for example certain insecticides from the neonicotinoids and tetrone and tetramic acid derivatives groups.

Natural enemies attacking *T. abutiloneus* in its native range include the parasitoid, *Eretmocerus staufferi*, the entomopathogenic fungus, *Orthomyces aleyrodes*, the predatory bug *Orius insidiosus* and a variety of coccinellid beetles, although none of these are commercially sold in the UK, other *Eretmocerus* and *Orius* spp. are available. Generalist predators that are sold in the UK such as *Orius* sp. and *Amblyseius swirskii* (sold under

licence) would be expected to be effective against *T. abutiloneus* in the right conditions. *Eretmocerus eremicus* is sold under licence in the UK, but is reported to be more effective against *B. tabaci* than *T. abutiloneus*.

It should be noted that, though *T. abutiloneus* is considered the North American whitefly of most concern to the UK, there are other species of *Trialeurodes* present in the Americas that may also pose a risk. These include *T. floridensis*, *T. packardi* and *T. variabilis*, all polyphagous and with a similar risk of being confused with *T. vaporariorum* under field conditions.

16. Summary and conclusion of rapid assessment.

This rapid assessment shows:

Trialeurodes abutiloneus is a highly polyphagous whitefly pest widely found in North America, Central America, South America and the Caribbean. It is known to be present in glasshouses in north-eastern states in the USA, as well as field crops in southern states. It has not been recorded outside the Americas, but it has been intercepted on North American plants arriving in the UK. This whitefly is a known vector of 8 plant pathogenic viruses (all 8 absent from the UK, and 5 of these also absent from Europe), but a key area of uncertainty in this assessment is the impact of this species due to its vectoring capacity.

Risk of entry

Trialeurodes abutiloneus is moving in trade: the UK has intercepted this species on two occasions (in 2005 and 2010), on plants for planting. Unless the specimens are examined by a specialist, there is a possibility of confusing *T. abutiloneus* pupae with *T. vaporariorum*, a species found widely in protected cultivation in the UK. Part of the first interception of *T. abutiloneus* reached a nursery before being destroyed due to the presence of the whitefly, while the second interception consisted of an illegal postal import of three species of plant. Overall, entry is considered moderately likely on plants for planting, but unlikely on produce, due to lack of a pathway into protected cultivation on the latter.

Risk of establishment

Due to temperature requirements of the whitefly, establishment outdoors in the UK is considered unlikely, though transient populations may be able to develop in summer, though the latter statement is uncertain as no formal research on origins of field populations and overwintering strategies in northern parts of the USA could be found. Establishment of *T. abutiloneus* is considered likely in protected cultivation, due to previous interceptions on plants for planting, the wide potential host range, and the fact this species is known from glasshouses in northern parts of the USA. If a population were to occur in the UK, there is a potential for it to be moved widely in trade before detection, due to confusion of immature stages with *T. vaporariorum*.

Economic impact

This whitefly is considered a minor pest in the USA, with impacts usually related to honeydew excretion and/or sooty moulds affecting crop quality. Although direct impacts due to feeding damage have occasionally been recorded, this appears to be the exception and overall the impacts were rated as small in the existing range, and the potential for direct impacts are considered to be very small to small in the UK.

Potentially higher impacts could occur due to this species' ability to vector viruses. However, the impact of this species as a virus vector is highly uncertain, as little work has been done on the impacts of this species as a vector in its native range. *Trialeurodes abutiloneus* is currently known to vector 8 viruses. Of these 8 viruses:

- None are present in the UK
- Three are found in parts of Europe
- Five are only known from the Americas
- Seven can also be vectored by *T. vaporariorum* and/or *B. tabaci*
- Four affect tomato: two are present in Europe (and one is on the EPPO A2 list)
- One affects blackberry, and is only known from the USA

Endangered area

All protected cultivation in the UK is at risk due to the wide host range of this species.

Risk management

While *T. abutiloneus* is a minor pest due to feeding damage and associated impacts, as a vector of viruses (the majority not found in Europe), continued exclusion of *T. abutiloneus* would seem the best risk management option for the UK.

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	<input checked="" type="checkbox"/>
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Yes	<input type="checkbox"/>	PRA area: UK or EU	<input type="checkbox"/>	PRA scheme: UK or EPPO	<input type="checkbox"/>
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18. IMAGES OF PEST

Images comparing eggs, larval instars and adults of *T. abutiloneus* and *T. vaporariorum* can be found in Malumphy *et al.* (2010).



Puparium of *Trialeurodes abutiloneus* showing pigmented spots.
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Puparium of *Trialeurodes abutiloneus* without pigmented spots.
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Adult *Trialeurodes abutiloneus* showing banded wing markings.
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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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