Department
for Environment
Food & Rural Affairs

Rapid Pest Risk Analysis (PRA) for:

Iris Yellow Spot Virus

November 2016

Summary and conclusions of the rapid PRA

This rapid PRA is an update of a 2007 UK PRA which concluded *Iris Yellow Spot Virus* (IYSV) posed a risk to seed and bulb crops of edible *Allium* species in the UK. This PRA shows IYSV is an economically important pathogen of *Allium* crops in some regions, though it has a much wider host range and in Europe its impacts have been small. Spread is primarily by onion thrips (*Thrips tabaci*), its global range has increased significantly in recent years and the prospects of continued exclusion from the UK are very poor.

Risk of entry

The pest has previously entered the UK on ornamental plants for planting but not established. It is also associated with onion sets and transplants, and evidence suggests it has been dispersed in the trade of these and other *Allium* plants for planting. Entry on plants for planting is considered to be very likely, with high confidence. Entry on vegetable *Allium* (e.g. onion and garlic bulbs, leeks) is considered to be moderately likely with medium confidence: very large numbers are imported from the current range of IYSV and these can be associated with the vector, which is unregulated. If vegetables are kept or disposed of outside, the vector may transfer to suitable hosts, which include many widespread uncultivated plants. Viruliferous thrips hitchhiking on other commodities are considered to be unlikely with medium confidence to introduce IYSV.

Risk of establishment

Hosts and the primary vector, *T. tabaci*, are widespread in the UK both outdoors and in protected crops. Establishment is considered very likely with high confidence.

Economic, environmental and social impact

Reported impacts in the current range of the pest vary depending on the location and crop infected. In general, impacts in Europe appear to be small, with some countries reporting IYSV to be widespread without any significant yield losses. Symptoms can be confused with thrips-feeding damage, hail damage or fungal infection. However some severe outbreaks with crop losses have been recorded in other regions. The majority of impacts are reported on *Allium* crops, though leaf necrosis disease of *Eustoma* spp. (Lisianthus) caused by IYSV is also considered damaging. Impacts in the current range are rated as medium, with medium confidence.

Potential economic impacts in the UK are rated as small, with medium confidence. The vector *T. tabaci* is a damaging pest in its own right, and so controlled in UK *Allium* crops. The control of the vector would reduce disease incidence of IYSV and thus reduce the impacts. Where control of thrips is not performed, larger impacts may occur. There are no reported impacts on any of the uncultivated hosts of IYSV and environmental impacts are rated as very small with high confidence. Those who grow vegetables in allotments may be impacted by the disease, leading to very small social impacts with high confidence as IYSV is not expected to be more damaging than other pests of *Allium* already present in the UK.

Endangered area

All *Allium* growing regions are endangered by the pest.

Risk management options

Because of the pest's increasing global distribution, wide host range, sometimes cryptic symptoms and the unregulated nature of the vector, continued exclusion is very unlikely. Any outbreaks outdoors would be very unlikely to be eradicated, since the virus and thrips can shelter on weed and wild hosts. If the vector is not present, outbreaks under protection may be eradicated.

Control of the vector via use of insecticides should effectively mitigate the impacts of IYSV. Use of thrips or IYSV resistant cultivars of *Allium* vegetables could also be considered.

Key uncertainties and topics that would benefit from further investigation

- Given the increasing range of the pest, and the fact symptoms can be relatively cryptic or mistaken for other causes, IYSV may already be present in the UK but undetected.

Images of the pest

Symptoms on onion leaves. Image courtesy of Howard F. Schwartz, Colorado State University, Bugwood.org

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.

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

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

Given the increasing global distribution of the virus, and the fact that there is little prospect of exclusion since symptoms are difficult to distinguish from non-quarantine pests and the vector is not regulated, statutory action against interceptions or outbreaks is not considered appropriate. Continued management of the vector in both vegetable crops and protected ornamentals should provide mitigation against the impacts of this viral disease.

Yes Statutory action	☐	No Statutory action	✓

Stage 1: Initiation

1. What is the name of the pest?

Iris yellow spot tospovirus (IYSV).

IYSV belongs to the genus *Tospovirus* and the correct name according to the International Committee on Taxonomy of Viruses (ICTV) is *Iris yellow spot tospovirus* (ICTV, 2016), but in much of the literature it is referred to more simply as *Iris yellow spot virus.*

IYSV will be used throughout this PRA.

2. What initiated this rapid PRA?

Since the last UK PRA (Sansford & Woodhall, 2007), the distribution of the pest has increased significantly, and this PRA was triggered to help decide whether statutory action against future interceptions is justified.

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]?

IYSV is not listed in the EC Plant Health Directive and is not recommended for regulation as a quarantine pest by EPPO. The pest was on the EPPO Alert list between 1999 and 2011, after which it was withdrawn because no particular action was requested by EPPO countries (EPPO, 2011).

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

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

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

IYSV has an expanding distribution, being found on every continent except Antarctica. Distribution is summarised in Table 1. First reported from Brazil in 1981, and formally described from the Netherlands in 1998, it has been described as being present in “most *Allium*-growing regions of the world” (Bag *et al.*, 2015). At the time of the 2007 PRA the pest had been recorded in 17 countries/overseas territories (Sansford & Woodhall, 2007). In Table 1 37 countries/overseas territories are listed showing the increasing range of IYSV. Based on the increasing distribution of the pest and, as discussed in the entry section, the fact that lesions caused by IYSV can be unspecific, it is possible the pest may be found in all *Allium* growing regions or countries where its principal vector, *Thrips tabaci*, is present, but is not reported.

Table 1: Distribution of *Iris yellow spot tospovirus* (EPPO, 2016) unless otherwise referenced.	
North America:	Canada, Mexico, USA (including Hawaii)
Central America:	Ecuador, Guatemala
South America:	Brazil, Chile, Peru, Uruguay
Europe:	Austria, Bosnia and Herzegovina, France, Germany, Greece, Italy, Netherlands, Poland (Balukiewicz & Kryczynski, 2005), Serbia (Bulajic *et al.*, 2009), Slovenia, Spain
Africa:	Egypt, Kenya, Mauritius, Reunion, South Africa, Uganda, Zimbabwe
Asia:	India, Indonesia, Iran, Israel, Japan, Pakistan, Sri Lanka, Tajikistan
Oceania:	Australia, New Zealand

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

There was an outbreak of IYSV in a glasshouse crop of *Eustoma grandiflorum* (lisianthus), which was detected in June 2007 – eradication action was taken and the crop was destroyed (Mumford *et al.*, 2008). There have been no further findings of IYSV in the UK since this outbreak, but no official surveys have been carried out. As discussed in section 8, IYSV can also be difficult to detect in plants and symptoms can be unspecific and may be attributed to other factors.

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?

Table 2 outlines the recorded natural hosts of IYSVbased on Sansford & Woodhall, 2007 unless otherwise cited. The main hosts for which IYSV causes economic damage on are *Allium* spp. and *Eustoma* spp. Many hosts are uncultivated species which do not suffer impacts and act as a reservoir of the disease. Additional *Iris* species may be affected, e.g. CABI (2017) states *I. xiphium* is a host, as well as including the whole genus in the host list. In Table 2, those hosts for which impacts have been recorded have been highlighted in yellow.

Experiments with wild onion relatives have been carried out under natural field conditions where the disease is endemic in the USA. These experiments showed that *Allium alticum, A. pskemense, A. royeli* and *A. vavilovii,* could all be infected in the field by IYSV and developed typical symptoms (Cramer *et al.*, 2011, Pappu *et al.*, 2006).

Table 2: Hosts naturally infected by *Iris yellow spot tospovirus.* Those with reports of economic impacts are highlighted in yellow.

Family	Species	Common Name
Alstroemeriaceae	*Alstroemeria*	Peruvian lily
Amaranthaceae	*Amaranthus retroflexus*	Rough pigweed
	Amaranthus sp. (Karavina & Gubba, 2016)	
	Bassia scoparia	Kochia
	Chenopodium album	Fat-hen
	Atriplex micrantha (Evans *et al.*, 2009b)	Saltbush
Amaryllidaceae	*Allium cepa*	Onion
	Allium cepa var. *aggregatum*	Shallot
	Allium fistulosum	Welsh onion
	Allium porrum	Leek
	Allium sativum	Garlic
	Allium schoenoprasum	Chives
	Allium tuberosum (Gawande et al., 2015)	Garlic chives
	Clivia miniata	Natal lily
	Hippeastrum x hybridum	Amaryllis
Araceae	*Scindapsus* sp.	
Asparagaceae	*Bessera elegans*	Coral drops

Asteraceae	*Ambrosia* sp.	Ragweed
	Arctium sp.	Burdock
	Articum minus	Common burdock
	Chrysanthemum sp.	Chrysanthemums
	Taraxacum sp.	Dandelion
	Lactuca serriola (Hsu et al., 2011)	Prickly lettuce
	Taraxacum officinale (Hsu et al., 2011)	Dandelion
	Cichorium intybus (Hsu et al., 2011)	Common chicory
	Sonchus asper (Nischwitz et al., 2012)	Prickly sow-thistle
Brassicaceae	*Chorispora tenella* (Schwartz et al., 2014)	Blue mustard
	Descurainia sophia (Schwartz et al., 2014)	Flixweed
Convolvulaceae	*Convolvulus arvensis* (Schwartz et al., 2014)	Field bindweed
Cycadaceae	*Cycas* sp.	Cycads
Fabaceae	*Vicia sativa*	Common vetch
Gentianaceae	*Eustoma grandiflorum*	Lisianthus
	Eustoma russellianum	Lisianthus
Geraniaceae	*Geranium carolinianum*	Carolina crane's-
	Pelargonium hortorum	Zonal geranium
Iridaceae	*Iris x hollandica*	Dutch iris
Poaceae	*Eleusine indica* (Karavina & Gubba, 2016)	Indian
	Setaria viridis (Evans *et al.*, 2009a)	Green foxtail
Polygonaceae	*Rumex crispus* (Hsu et al., 2011)	Curly dock
Portulacaceae	*Portulaca oleracea*	Common
	Portulaca sp.	Purslane
Rosaceae	*Rosa* sp.	Roses
	Rubus sp.	Brambles
Scrophulariaceae	*Nuttallanthus canadensis*	Canada toadflax
Zygophyllaceae	*Tribulus terrestris*	Puncturevine

Many of the *Allium* crops are of economic importance to the UK, with approximately 450 000 tonnes of onions produced each year (British Onions, 2016). As well as being commercially produced, the leek is one of the national symbols of Wales (Visit Wales, 2016). *Eustoma* spp. are grown for ornamental purposes in the UK. The UK also grows ornamental *Allium* species but records of these as an IYSV host could not be found.

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?

Plants for Planting

There is no evidence that IYSV is transmitted by seed. IYSV may be introduced with sets or bulbs (e.g. onion sets, garlic bulbs) for planting, seedlings of *Allium* crops (e.g. transplants) for planting or ornamental plants for propagation or retail. The thrips species which vector IYSV may also be associated with all of these commodities.

Affected onion seed crops in the first South African outbreak were planted from bulbs, and authors suggested this to be the likely pathway of entry for IYSV into the country (Toit *et al.*, 2007). In Canada, the first finding of IYSV was in a remote area of Ontario, and, since the crop had been grown from sets, these were thought to be the source of the infestation (Hoepting *et al.*, 2008). IYSV and *T. tabaci* have been recorded in association with onion transplants in Colorado, which were imported from other US states. In a 5 year study in Colorado, 23% (19 out of 83) of imported onion transplant lots were positive for IYSV on testing, and in some years up to 100% of lots were infested with *T. tabaci* (Schwartz *et al.*, 2014). IYSV was also found to be widespread in onion nurseries during a survey in Mexico (Velásquez-Valle *et al.*, 2016).

IYSV has previously entered the UK on ornamental plants for planting (*E. grandiflorum*) (Mumford *et al.*, 2008). It appears to be common on *Eustoma* in Israel and the Netherlands (Hoedjes *et al.*, 2008, Kritzman *et al.*, 2000), from where the UK imports a significant amount of ornamentals. The UK also imports *Allium* cuttings and young plants from Israel: 30.4 tonnes of *Allium* cuttings and young plants were imported from Israel between 23rd October 2011 and 23rd October 2016, as well as a single import of young plants from South Korea in 2012 (APHA, unpublished data).

Though there is a commodity code for “onion sets, fresh or chilled”, the significant volumes imported into the UK under this code indicate it is being used for onions imported for consumption, as well as potentially those imported for planting. As a consequence there are no accurate data on the import on *Allium* crops for planting (including transplants, bulbs for planting and onion sets). Transplants are less likely to be imported than bulbs or onion sets for planting, as there is an industry producing transplants in the UK from seed.

IYSV is difficult to detect in plants. Firstly, the symptoms of small necrotic lesions can be caused by a number of factors including thrips feeding damage, fungal infections and hail damage (Hoedjes *et al.*, 2008). In addition, a survey done in the Netherlands utilising ELISA found that small infected areas could occur next to healthy areas on the same plant – implying that when ELISA is used as a test it may fail to detect the virus if the wrong part of the plant is tested (Hoedjes *et al.*, 2008). These results were in line with an early study from Israel, which found the virus was not evenly distributed within onion leaves (Kritzman *et al.*, 2001).

Entry on plants for planting is **very likely with high confidence**. The very likely rating is due to the wide host range of the pest, the difficulty of detecting it, the evidence it has moved in trade on onion sets and transplants as well as in ornamentals, and the fact that it has previously entered the UK.

Allium Vegetables

Allium vegetables for consumption, in particular onion and garlic bulbs, may harbour viruliferous thrips which could transfer to other hosts, spreading IYSV. Despite the trade data difficulties discussed above, it is clear that very large amounts of *Allium* vegetables are imported from the current range of IYSV. For example, approximately 50 000 tonnes of onion bulbs are imported from the EU each year, with imports also recorded from Brazil, India, Chile, New Zealand, Sri Lanka, Pakistan, Egypt and Kenya between 2011 and 2015. Approximately 14 000 tonnes of garlic (fresh or chilled) are imported each year from the EU and nearly 80 000 tonnes of leeks and other alliaceous vegetables (Eurostat data, extracted 21.10.2016). Leeks and garlic are also imported in smaller quantities from other countries known to have IYSV and thus have potential to enter with viruliferous thrips.

Only a proportion of the imported *Allium* vegetables will be infected and associated with thrips – though disease incidence can be very high within a crop and the virus is becoming increasingly widespread. Thrips may be able to transfer to a suitable host in limited situations where vegetables are disposed of or kept outdoors – this could either be disposal of green waste via composting etc., or vegetables being kept in outdoor displays in greengrocers or in markets. Because of the very wide host range of IYSV and *T. tabaci*, transfer may initially be to weeds or other alternative hosts which are widespread in the UK – transfer from here to vegetable or ornamental crops may then take some time, however the pest still would have entered.

A potentially more direct route of transmission of viruliferous thrips to growing crops is when *Allium* vegetables are imported and packed in the UK close to production sites. For example, a *Meloidogyne fallax* outbreak in a leek crop in the UK was thought to have been introduced by the use of green waste from the processing of imported vegetables (Everatt *et al.*, 2016). Such green waste could be associated with thrips, which may then infest the growing crop, or thrips may simply escape packing sheds and move outdoors to the crop.

Due to the very large import of *Allium* vegetables imported from the current range of the pest; the fact no symptoms of IYSV may be visible on some crops, in particular bulbs; and that no action is taken against the vector, it is very likely vegetables harbouring viruliferous thrips will be imported. However, there are only limited cases where vegetable material will be kept or disposed of outdoors, allowing for transfer of the thrips and IYSV to new hosts. Therefore, **entry on vegetables is rated as moderately likely with medium confidence.**

Viruliferous thrips (Hitchhiking on non-host plants, fruits or vegetables)

Once infected, *T. tabaci*, the principal vector of IYSV, is capable of transmitting the virus for life. This means the vector may become associated with some other commodities, such as cut flowers or branches, or other fruit and vegetable commodities. The thrips may then be able to transfer to host production sites and introduce the virus.

Thrips tabaci is regularly found on traded material, and no action is taken against these findings unless the commodity is also infested with a pest of quarantine concern. However only a small fraction of *T. tabaci* that enter on non-host material are likely to have previously acquired IYSV. Adults can fly tens of metres (CABI, 2016), and their limited flight capacity might inhibit transfer to suitable IYSV hosts. However, since IYSV hosts do include many widespread weed species as well as cultivated plants, this could occur. As for the *Allium* vegetables pathway, it could then take some time for the virus to spread into IYSV host production.

Entry with hitchhiking viruliferous thrips is rated as unlikely, with medium confidence, due to the fact that only a limited number of *T. tabaci* imported on non-IYSV host material will have previously acquired the virus.

Plants for planting	Very unlikely	☐	Unlikely	☐	Moderately likely	☐	Likely	☐	Very likely	✓
Confidence	High Confidence	✓	Medium Confidence	☐	Low Confidence	☐				

Allium vegetables	Very unlikely	☐	Unlikely	☐	Moderately likely	✓	Likely	☐	Very likely	☐
Confidence	High Confidence	☐	Medium Confidence	✓	Low Confidence	☐				

Viruliferous thrips	Very unlikely	☐	Unlikely	✓	Moderately likely	☐	Likely	☐	Very likely	☐
Confidence	High Confidence	☐	Medium Confidence	✓	Low Confidence	☐				

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

Yes, the main vector of IYSV is *Thrips tabaci* (onion thrips), which is present and widespread in the United Kingdom, and is found both outdoors and in glasshouses. IYSV is transmitted persistently by *T. tabaci* (Birithia et al., 2013), meaning that once the virus has been taken up by an individual (as a larvae or adult) it will be able to replicate, and thus the insect will transmit it for the rest of its life. It can be transmitted by both adults and larvae (Inoue *et al.*, 2010).

Transmission trials have shown that tobacco thrips, *Frankliniella fusca*, can also transmit IYSV, albeit at a lower efficiency (18.3%) compared to *T. tabaci* (76.6%) (Srinivasan *et al.*, 2012). *Frankliniella fusca* is not present in the UK (Defra, 2016).

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

The vector, *T. tabaci*, is common across the UK and is regularly found infesting *Allium* crops. The 2013 pesticide usage survey showed that 82% of the insecticides applied to onions and leeks were for the control of thrips (Garthwaite *et al.*, 2013), demonstrating that this species is a common problem in outdoor onion and leek crops. Since the hosts and vector are widespread, **establishment outdoors is rated as very likely with high confidence.**

As detailed in section 6, there have previously been outbreaks of IYSV in protected ornamental crops in the UK (Mumford *et al.*, 2008). Outbreaks reported from other nations have shown that viruliferous *T. tabaci* can enter protected cultivation from surrounding *Allium* production sites (Hoedjes *et al.*, 2008, Zen *et al.*, 2008). Thrips are very small and so are extremely difficult to exclude from glasshouses, so, even if clean planting material is used, infection via vectors can still occur. **Establishment under protection is rated as very likely with high confidence.**

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

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

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

Natural spread of the virus would be via the primary vector, *T. tabaci.* IYSV may initially be introduced to *Allium* field crops through the planting of infected sets or transplants, and then spread further by the feeding behaviour of *T. tabaci,* or it may be introduced by adults of *T. tabaci* that have overwintered on infected weed hosts and reinvaded the *Allium* fields after planting (Smith *et al.*, 2011). In a survey in Colorado over 3 years, IYSV spread from a single field to nearly all fields surveyed in the Front Range region (a total of 36 fields) (Gent *et al*., 2004). However, some growers in Colorado use imported onion transplants, so not all spread may have been natural but rather the virus was introduced with young onion plants.

Thrips tabaci move to new fields, or as observed in the Netherlands into glasshouses, once the *Allium* crop they are currently utilising has been lifted (Hoedjes *et al*., 2008, Hsu *et al*., 2010), increasing the secondary spread of the pest. It would still be expected that most natural spread would occur at a local level e.g. to nearby fields and glasshouses. Adults are not strong fliers, moving tens of metres, but can be moved longer distances via air currents (CABI, 2016). **Natural spread is rated as slowly, with medium confidence, as** local spread in a production region may occur relatively quickly but longer distance spread by thrips is limited.

As described in section 8, IYSV and viruliferous thrips can easily be associated with *Allium* vegetables, transplants and sets, as well as various ornamental species. The global spread of the pest in trade, including to remote island nations, demonstrates how easily the pest can be disseminated. **Spread in trade is rated as very quickly, with high confidence.**

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?

Reports of losses vary significantly between regions. The variability of these impacts may be caused by several factors, including the fact that strains of IYSV which vary in virulence and symptom severity have been identified (Bag *et al*., 2012).

In their 2014 review of IYSV, Bag *et al.* summarised symptoms and impacts as follows*: "IYSV symptoms in* Allium *spp. are yellow- to strawcoloured, diamond-shaped lesions on leaves and flowering scapes. Diamond-shaped lesions are particularly pronounced on scapes. As the disease progresses, the lesions coalesce, leading to lodging of the scapes. In seed crops, this could lead to a reduction in yield and quality. Early to mid-season infection in bulb crops results in reduced vigour and bulb size."*

There are limited data on yield losses caused by IYSV in both vegetable and ornamental production. In many countries where IYSV has been reported, the only publication relates to the first finding of the virus. This suggests that in general the virus has not gone on to be economically significant in that region, or that the impacts may be very similar to feeding damage by the vector and so not separately recorded. Impacts may still be emerging where the virus has only recently been introduced.

In the **USA**, some detailed information on impacts on *Allium* crops is available from certain states. In **Colorado,** a three year study of IYSV in onion production showed the virus was associated with reduction in bulb size, but there were no significant overall yield losses even though IYSV was widespread in some of the survey years (Gent *et al.*, 2004). In **Central Oregon** in 2005, an outbreak of IYSV in onion seed crops led to major impacts, with 100% of plants in one 4 ha area showing symptoms, and 95% of these lodged, leading to near total crop failure (Crowe & Pappu, 2005). In contrast, an outbreak in **Western Oregon** on onion bulb and seed crops and leek seed crops in 2007 only caused very small impacts. In the onion bulb and leek seed crops disease incidences were less than 5%, while in the onion seed crop disease incidence was 20%, with 1% of the crop developing lesions large enough to lead to lodging (Gent *et al.*, 2007). It is not clear why impacts were so different between these regions, though climate does vary and this may affect the vector. In **Texas**, the first outbreak of IYSV occurred on onion plants in 2005: disease incidence approached 100% leading to yield loss and quality problems (Miller *et al.*, 2006).

In **Australia** IYSV was thought to be established for some time before it was identified and, based on observations, was thought to be causing serious damage in the spring onion industry (Coutts *et al.*, 2003). In **South Africa**, after the discovery of the virus, a survey of crops in that region showed about 5% disease incidence in an onion seed crop (Toit *et al.*, 2007). In **Israel** 20 - 30% of onion crops in Bet Shean Valley showed symptoms, though effects on yield were not known (Gera *et al.*, 1998).A survey in **New Zealand** found the virus to be widespread in onion and shallot crops, which showed significant thrips damage but no IYSV symptoms – two ornamental species were also found to be infected without obvious symptoms (Ward *et al.*, 2009).

Impacts in **Europe** appear to be limited. A survey in the **Netherlands** found high infestation rates in onion of IYSV (20 – 44%) with the virus being widespread, however impacts in the Netherlands appear to be small, with most plants being described as showing unspecific and nonobvious lesions (Hoedjes *et al.*, 2008). Surveys in **Germany** also found it to be present in numerous *Allium* production sites in Southwest Germany, with no indications of any economically significant yield losses (Krauthausen *et al.*, 2012).

Those crops where foliar parts of the plant are marketed, in particular *A. fistulosum*, may suffer greater impacts than bulb crops because of the reduction in the marketability of the crop (Krauthausen *et al.*, 2012, Tabassum *et al.*, 2016), in Indonesia up to 25% of an infected crop showed symptoms (Pappu & Rauf, 2014).

Many species of *Allium* are grown as ornamentals, but not evidence of impacts of IYSV on these hosts or even records of an ornamental *Allium* species as a host of IYSV could be found. *Eustoma* spp. is the main ornamental which incurs impacts from IYSV, where it causes leaf necrosis disease (Kritzman *et al.*, 2000). As a popular cut flower, the disease is described as “hampering” production in Japan (Zen *et al.*, 2008). Top necrosis and stunting has been observed in Israel on this host (Gera *et al.*, 2000). However, *Eustoma* spp. are generally susceptible to viral diseases (Kritzman *et al.*, 2000), and it is not clear if IYSV causes greater impacts compared to the other viruses known to infect this genus. Symptoms in *Iris hollandica*, from which the virus was first isolated and described, can occur in up to 90% of a crop depending on the cultivar (Cortes *et al.*, 1998), however reports appear sporadic with no further publication on impacts in iris found since the characterisation of the virus in 1998.

Impacts in the current range are rated as medium, with medium confidence. In general, impacts in Europe appear to be small, but greater impacts have been recorded elsewhere in the virus’ range, leading to an overall medium rating.

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?

Damage caused by IYSV is very similar to damage caused by the feeding of the principal vector, *T. tabaci* as well as other factors such as fungal infection or mechanical damage, e.g. from hail. For this reason, any impacts of the virus may go largely unnoticed by those producing *Allium* crops. Since *T. tabaci* is a damaging pest in its own right, measures are already taken by the majority of UK *Allium* growers to control the pest. Data from the pesticide usage survey indicate that vegetable crops receive at least two sprays a year for thrips control (Garthwaite *et al.*, 2013). This control action would help to reduce any disease incidence and thus the impacts of IYSV. It is expected that impacts in the UK would be similar to the Netherlands and elsewhere in Europe, where the virus appears to be widespread with only small impacts reported.

Crops where *Thrips* are not controlled by conventional pesticide applications may suffer greater impacts, in particular where foliar lesions would reduce marketability, such as for spring or bunching onions.

Potential economic impacts in the UK are rated as small, with medium confidence, as for the majority of crops control of the vector will control the disease impacts**.**

IYSV does have hosts which are native species in the UK, but impacts on these uncultivated hosts have not been reported. **Potential environmental impacts are rated as very small with high confidence.**

Allium vegetables are a popular crop grown by people in gardens and allotments. Damage caused by IYSV may reduce the enjoyment of growing these vegetables, leading to very small social impacts. However allotment gardeners will also be dealing with a range of established pests and diseases that cause similar symptoms, including onion thrips themselves, and it is not expected IYSV would cause increased impacts compared to these pests. **Potential social impacts are rated as very small with high confidence.**

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?

IYSV is not a vector of plant pathogens.

15. What is the area endangered by the pest?

All *Allium* growing regions in the UK are endangered by the pest.

Stage 3: Pest Risk Management

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

Exclusion, Eradication and Containment

Given the continued range expansion of IYSV, the fact that it is difficult to detect and because no action is taken against interceptions of the vector which may be viruliferous, the prospects for continued exclusions (if the pest is not already present but unreported) are very poor.

The polyphagous nature of the vector, the fact that uncultivated plants can act as a reservoir for the virus and the difficulty in detecting IYSV (both in distinguishing symptoms from other damage and diagnostically) means that the pest could establish and spread quickly in the PRA area, and if outbreaks occur outdoors eradication or containment is very unlikely to be feasible.

Eradication measures were previously taken on a protected crop of ornamentals in the UK (Mumford *et al.*, 2008). If thrips were not present in a glasshouse, eradication may be possible via the destruction of infected material. However if thrips are present they are likely to exit the glasshouse (at least during the warmer parts of the year), and may then go on to infest other hosts (crop or uncultivated hosts).

Cultural Controls

The review of IYSV by Bag *et al.* (2014) contains a section summarising disease management, which suggests integrated disease management is required to reduce impacts of the disease including the development and use of disease or thrips-resistant cultivars and good sanitation by removing crop volunteers and weed management. Control of the vector through use of insecticides, following current UK practices, would also be likely to provide mitigation against impacts from the vector.

17. References

Bag S, Schwartz H & Pappu H (2012): Identification and characterization of biologically distinct isolates of Iris yellow spot virus (genus Tospovirus, family Bunyaviridae), a serious pathogen of onion. *European journal of plant pathology* **134**, 97-104.

Bag S, Schwartz HF, Cramer CS, Havey MJ & Pappu HR (2015): Iris yellow spot virus (Tospovirus: Bunyaviridae): from obscurity to research priority. *Molecular plant pathology* **16**, 224-237.

Balukiewicz A & Kryczynski S (2005): Tospoviruses in chrysanthemum mother stock plants in Poland. *Phytopathol. Pol* **37**, 59-67.

Birithia R, Subramanian S, Pappu H, Muthomi J & Narla R (2013): Analysis of Iris yellow spot virus replication in vector and non-vector thrips species. *Plant Pathology* **62**, 1407-1414.

British Onions (2016) FAQs. British Onions, UK. Available at: http://britishonions.co.uk/faqs/ (accessed 21/10/2016.

Bulajic A, Djekic I, Jovic J, Krnjajic S, Vucurovic A & Krstic B (2009): Incidence and distribution of Iris yellow spot virus on onion in Serbia. *Plant Disease* **93**, 976-982.

CABI (2017). *Iris yellow spot virus*. In *Crop Protection Compendium*. CAB International Wallingford, UK.

CABI (2016) Thrips tabaci. In *Crop Protection Compendium*. CAB International Wallingford , UK.

Cortes I, Livieratos I, Derks A, Peters D & Kormelink R (1998): Molecular and serological characterization of Iris yellow spot virus, a new and distinct tospovirus species. *Phytopathology* **88**, 1276-1282.

Coutts B, McMichael L, Tesoriero L, Rodon B, Wilson C, Wilson A, Persley D & Jones R (2003): Iris yellow spot virus found infecting onions in three Australian states. *Australasian Plant Pathology* **32**, 555-557.

Cramer C, Bag S, Schwartz H & Pappu H (2011): Susceptibility of Onion Relatives (Allium spp.) to Iris yellow spot virus. *Plant Disease* **95**, 1319-1319.

Crowe F & Pappu H (2005): Outbreak of Iris yellow spot virus in onion seed crops in central Oregon. *Plant Disease* **89**, 105-105.

Defra (2016) UK Risk Register Details for Frankliniella fusca. Department for Environment, Food and Rural Affairs, UK. Available at: https://secure.fera.defra.gov.uk/phiw/riskRegister/viewPestRisks.cfm?cslref=15468 (accessed 26/09/2016.

EPPO (2011) Iris yellow spot tospovirus (a new tospovirus of iris and onions). EPPO, Paris, France. Available at: https://www.eppo.int/QUARANTINE/Alert_List/deleted%20files/virus/IYSV.doc (accessed 26/09/2016.

EPPO (2016) Iris Yellow Spot Virus. EPPO, Paris, France. Available at: https://gd.eppo.int/taxon/IYSV00/distribution (accessed 26/09/2016.

Evans C, Bag S, Frank E, Reeve J, Ransom C, Drost D & Pappu H (2009a): Green foxtail (Setaria viridis), a naturally infected grass host of Iris yellow spot virus in Utah. *Plant Disease* **93**, 670-670.

Evans C, Bag S, Frank E, Reeve J, Ransom C, Drost D & Pappu H (2009b): Natural infection of Iris yellow spot virus in twoscale saltbush (Atriplex micrantha) growing in Utah. *Plant Disease* **93**, 430-430.

Everatt M, Eyre D & Prior T (2016) The nematode Meloidogyne fallax in sports turf: symptoms, biosecurity guidance and control. Defra, UK. Available at: https://secure.fera.defra.gov.uk/phiw/riskRegister/plant-health/documents/notifiable_pests/meloidogyne_fallax_turf_biosecurity_guide_draft v7.pdf (accessed 21/10/2016.

Garthwaite D, Barker I, Parrish G, Smith L, Hudson S & Pietravalle S (2013) Pesticide usage survey report 257: outdoor vegetable crops in the United Kingdom Food and Environment Research Agency, York, UK, p. 78.

Gawande S, Gurav V, Ingle A & Gopal J (2015): First Report of Iris yellow spot virus Infecting Allium tuberosum in India. *Archives of Virology*.

Gent D, Martin R & Ocamb C (2007): First report of Iris yellow spot virus on onion and leek in western Oregon. *Plant Disease* **91**, 468-468.

Gent DH, Schwartz HF & Khosla R (2004): Distribution and incidence of Iris yellow spot virus in Colorado and its relation to onion plant population and yield. *Plant Disease* **88**, 446-452.

Gera A, Cohen J, Salomon R & Raccah B (1998): Iris yellow spot tospovirus detected in onion (Allium cepa) in Israel. *Plant Disease* **82**, 127-127.

Gera A, Kritzman A, Beckelman H, Cohen J & Raccah B (2000) Detection of Iris yellow spot virus in lisianthus. In *X International Symposium on Virus Diseases of Ornamental Plants 568*, pp. 43-49.

Hoedjes K, Verhoeven JTJ, Goldbach R & Peters D (2008) Iris yellow spot virus in the Netherlands: occurrence in onion and confirmation of transmission by Thrips tabaci. In *XII International Symposium on Virus Diseases of Ornamental Plants 901*, pp. 199-206.

Hoepting C, Allen J, Vanderkooi K, Hovius M, Fuchs M, Pappu H & McDonald M (2008): First report of Iris yellow spot virus on onion in Canada. *Plant Disease* **92**, 318-318.

Hsu CL, Hoepting CA, Fuchs M, Shelton AM & Nault BA (2010): Temporal dynamics of Iris yellow spot virus and its vector, Thrips tabaci (Thysanoptera: Thripidae), in seeded and transplanted onion fields. *Environmental entomology* **39**, 266-277.

Hsu CL, Hoepting CA, Fuchs M, Smith EA & Nault BA (2011): Sources of Iris yellow spot virus in New York. *Plant Disease* **95**, 735-743.

ICTV (2016) ICTV Taxonomy History for Iris yellow spot tospovirus. International Committee on Taxonomy of Viruses. Available at: http://www.ictvonline.org/taxonomyHistory.asp?taxnode_id=20152199&taxa_name=Iris%20yellow%20spot%20tospovirus26/09/2016).

Inoue T, Murai T & Natsuaki T (2010): An effective system for detecting Iris yellow spot virus transmission by Thrips tabaci. *Plant Pathology* **59**, 422-428.

Karavina C & Gubba A (2016): Amaranthus sp. and Eleusine indica are natural hosts of Iris yellow spot virus in Zimbabwe. *Plant Disease*.

Krauthausen H-J, Leinhos GM, Müller J, Radtke P & Jehle J (2012): Identification and incidence of Iris yellow spot virus in Allium field crops in Southwest Germany. *European journal of plant pathology* **134**, 345-356.

Kritzman A, Beckelman H, Alexandrov S, Cohen J, Lampel M, Zeidan M, Raccah B & Gera A (2000): Lisianthus leaf necrosis: a new disease of lisianthus caused by Iris yellow spot virus. *Plant Disease* **84**, 1185-1189.

Kritzman A, Lampel M, Raccah B & Gera A (2001): Distribution and transmission of Iris yellow spot virus. *Plant Disease* **85**, 838-842.

Miller M, Saldana R, Black M & Pappu H (2006): First report of Iris yellow spot virus on onion (Allium cepa) in Texas. *Plant Disease* **90**, 1359-1359.

Mumford R, Glover R, Daly M, Nixon T, Harju V & Skelton A (2008): Iris yellow spot virus (IYSV) infecting lisianthus (Eustoma grandiflorum) in the UK: first finding and detection by real-time PCR. *Plant Pathology* **57**, 768-768.

Nischwitz C, Srinivasan R, Sundaraj S, Mullis S, McInnes B & Gitaitis R (2012): Geographical Distribution and Survival of Iris yellow spot virus in Spiny Sowthistle, Sonchus asper, in Georgia. *Plant Disease* **96**, 1165-1171.

Pappu H, Hellier B & Dugan F (2006): Wild Allium spp. as natural hosts of Iris yellow spot virus. *Plant Disease* **90**, 378-378.

Pappu H & Rauf A (2014): First report of Iris yellow spot virus infecting green onion in Indonesia. *Gene* **547**, 111-118.

Sansford C & Woodhall J (2007) Pest Risk Analysis for Iris Yellow Spot Virus. CSL, York, UK. Available at: https://secure.fera.defra.gov.uk/phiw/riskRegister/downloadExternalPra.cfm?id=3882 (accessed 27/09/2016.

Schwartz H, Gent D, Fichtner S, Otto K, Boateng C, Szostek S, Cranshaw W & Mahaffey L (2014): Thrips tabaci (Thysanoptera: Thripidae) and Iris yellow spot virus associated with onion transplants, onion volunteers, and weeds in Colorado. *Southwestern Entomologist* **39**, 691-704.

Smith EA, Ditommaso A, Fuchs M, Shelton A & Nault B (2011): Weed hosts for onion thrips (Thysanoptera: Thripidae) and their potential role in the epidemiology of Iris yellow spot virus in an onion ecosystem. *Environmental entomology* **40**, 194-203.

Srinivasan R, Sundaraj S, Pappu HR, Diffie S, Riley DG & Gitaitis RD (2012): Transmission of Iris yellow spot virus by Frankliniella fusca and Thrips tabaci (Thysanoptera: Thripidae). *Journal of economic entomology* **105**, 40-47.

Tabassum A, Reitz S, Rogers P & Pappu H (2016): First Report of Iris yellow spot virus Infecting Green Onion (Allium fistulosum) in the United States. *Plant Disease*, PDIS-05-16-0599-PDN.

Toit Ld, Burger J, McLeod A, Engelbrecht M & Viljoen A (2007): Iris yellow spot virus in onion seed crops in South Africa. *Plant Disease* **91**, 1203-1203.

Velásquez-Valle R, Reveles-Torres L, Salas-Muñoz S, Mauricio-Castillo J & Pappu H (2016): First Confirmed Report of Iris yellow spot virus in Onion Nurseries in Zacatecas, Mexico. *Plant Disease*.

Visit Wales (2016) National Symbols of Wales. Welsh Government, UK. Available at: http://www.visitwales.com/explore/traditions-history/national-symbols (accessed 21/10/2016.

Ward L, Perez-Egusquiza Z, Fletcher J, Ochoa Corona F, Tang J, Liefting L, Martin E, Quinn B, Pappu H & Clover G (2009): First report of Iris yellow spot virus on Allium cepa in New Zealand. *Plant Pathology* **58**, 406-406.

Zen S, Okuda M, Fuji S & Iwanami T (2008): The seasonal occurrence of viruliferous Thrips tabaci and the incidence of Iris yellow spot virus disease on lisianthus. *Journal of Plant Pathology*, 511-515.

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