Department for Environment Food & Rural Affairs

Rapid Pest Risk Analysis (PRA) for:

Tobacco ringspot virus (TRSV)

April 2018

Summary and conclusions of the rapid PRA

This rapid PRA shows that *Tobacco ringspot virus* is a quarantine virus that has become established in parts of the EU, and is very likely to be present in the UK. Though the virus is spread by nematode vectors not present in the UK, it can still establish via seed, pollen and clonal propagation of infected ornamental plants, though impacts in these hosts are small.

Risk of entry

Due to a lack of phytosanitary measures on plants entering from the EU, where the virus has been found in a variety of hosts, entry on plants for planting is considered very likely with high confidence. The virus can also be transmitted by seed in some host species; entry on this pathway is moderately likely with medium confidence and entry with import of pollen unlikely with low confidence. As nepoviruses can persist in their nematode vectors for some time, isolated populations of the vectors imported with growing medium or non-host plants may also introduce the viruses, this pathway is considered unlikely with low confidence.

Risk of establishment

Though the vectors are not present in the UK, TRSV is capable of establishing via seed transmission and clonal propagation of infected mother plants. Establishment both

outdoors and under protection in ornamental species is considered very likely with high confidence, establishment in systems such as fruiting crops is unlikely as symptoms are severe enough that propagation from infected stock is unlikely, and the virus is not seed transmitted in woody hosts.

Economic, environmental and social impact

Tobacco ringspot virus causes a serious disease of soybean and has been rated as causing medium impacts with medium confidence in its current range. Impacts in ornamental species are generally small, and occur due to unspecific foliar symptoms and a lack of vigour.

Since impacts would largely be limited to ornamentals in the UK, potential economic impacts are small with high confidence. No environmental or social impacts are reported and so these are rated as very small with high confidence.

Endangered area

The virus is likely to survive in plants across the UK. Largest impacts would likely occur in ornamental systems that rely heavily on clonal propagation.

Risk management options

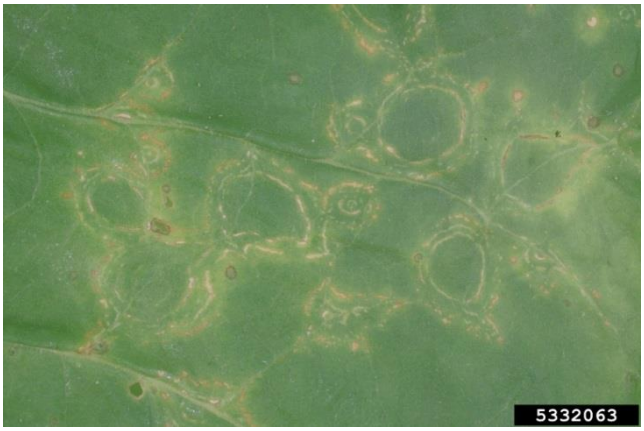
The current status of *Tobacco ringspot virus* as an Annex I quarantine pest is not appropriate, due to the fact it is established in a number of EU member states. Current phytosanitary measures are not strong enough to prevent the entry and spread of the viruses. Consideration should be given to deregulating the pest in ornamental species, with the possibility of industry led certification schemes to obtain clean propagating material, and listing as an RNQP on hosts such as various fruiting species in which economic impacts are incurred.

Key uncertainties and topics that would benefit from further investigation

- The status of the pest in the United Kingdom, in particular in *Pelargonium* and other ornamental production systems.
- If the virus may be more widespread in the EU than currently reported.
- The complete host list for the virus for which seed and pollen transmission occur.
- If small populations of the nematode vector *X. americanum s. l.* may be present in the UK undetected.

Images of the pest

Tobacco ringspot virus

	
Typical foliar symptoms of *Tobacco ringspot virus* on leaves of *Nicotiana* spp. Image courtesy of Virginia Tech Learning Resources Center, Virginia Polytechnic Institute and State University, Bugwood.org	Symptoms of bud blight on soybean (*Glycine max*) caused by *Tobacco ringspot virus* © - LSU AgCenter

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	X				
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?

Since *Tobacco ringspot virus* continues to be listed in Annex IAI of the EU plant health regulation, statutory action will be taken against any findings.

However, it is the recommendation of this PRA that the regulation should be reviewed, due to the presence of this pest in a number of EU Member States. If, as suggested in the PRA, the pest were to be given the status of an RNQP pest then the recommendation would be that action would only be taken on plants for planting or seed where there was a risk of the nematode vector being present, or a risk of further spread from the planting material i.e. mother plants or propagation material.

Yes Statutory action	✓	No Statutory action	

Stage 1: Initiation

1. What is the name of the pest?

Tobacco ringspot virus

Synonyms include: *Anemone necrosis virus, Blueberry necrotic ringspot virus, Nicotinana virus 12, Ringspot virus of nicotiana, Tobacco ringspot nepovirus,* TRSV

This virus will be referred to as TRSV throughout the PRA.

TRSV is a nepovirus, and spread by the nematode *Xiphinema americanum* Cobb *sensu lato* as discussed in section 9. These nematode vectors are absent from the UK, though present in the EU, and risk from these vectors has previously been assessed (Tomlinson, 2014).

2. What initiated this rapid PRA?

Whilst reviewing the Risk Register entry for TRSV in order to take into account the fact the virus is transmitted by pollen, UK files on the pest from the 1970s to the current year were reviewed. Due to the long association of this and *Tomato ringspot virus* (ToRSV) with ornamental plants in the UK, and the presence of both viruses in the EU despite their quarantine status, two PRAs were initiated to review the quarantine status of both of these viruses.

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]?

TRSV is listed in Annex IAI of Council Directive 2000/29/EC – which means it is classified as a harmful organism not known to occur in the community, and whose introduction and spread is banned on all commodities.

In addition, the nematode *Xiphenema californicum* and non-European populations of the nematodes *Xiphinema americanum* Cobb *sensu lato,* which are known vectors of this virus, are also listed in Annex IAI.

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

Distribution of this virus is summarised in Table 1. TRSV is widespread, being found on every continent except Antarctica. Further details on distribution are found below the tables, concentrating in particular on the presence of the virus in EU countries.

Older records (pre-1970) which may have only been based on indicator plants should be treated as unconfirmed and so have not been included in the distributions.

Table 1: Distribution of *Tobacco ringspot virus* taken from (EPPO, 2018)	
North America:	Canada (British Columbia, New Brunswick, Ontario, Quebec), Mexico, USA (Alabama, Arkansas, Connecticut, Delaware, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Vermont, Virginia, Washington, West Virginia, Wisconsin, Wyoming)
Central America:	Cuba, Dominican Republic
South America:	Brazil, Chile, Uruguay, Venezuela
Europe:	Hungary, Italy, Lithuania, Poland, Russia, Serbia, Turkey, Ukraine

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

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

Africa:	Democratic Republic of the Congo, Egypt, Malawi, Morocco, Nigeria
Asia:	China, Georgia, India, Indonesia, Iran, Japan, Kyrgyzstan, Saudi Arabia, Sri Lanka, Taiwan
Oceania:	Australia, New Zealand, Papua New Guinea

Tobacco ringspot virus – Further Details on Distribution

By EU country:

- Austria: There are records of TRSV dating from the 1950s, and EPPO list the pest as absent, no longer present (EPPO, 2018). There is no evidence in the available literature of findings since the 1950 records, which given their age should be treated as unconfirmed.
- Bulgaria: A single record of TRSV was recorded in the country in 1983 on grapevine. Surveys conducted on grapevine in 2002 and 2003 did not detect the virus, which is considered to now be absent from Bulgaria (EPPO, 2004). A 2012 review of the Longidoridae and their nepoviruses in Bulgaria and Slovenia listed TRSV as reported from Bulgaria (Peneva *et al.*, 2012), but it is assumed this is a reference to the previous 1983 report and not a more recent record.
- Czech Republic: TRSV is considered transient and under eradication in Czech Republic (EPPO, 2018). During an official inspection in 2001 infected mother plants of *Impatiens walleriana* were found at a nursery, and it is believed the virus was introduced to the site on infected plants as no vectors were found in the survey (Kundu *et al.*, 2015), but the origin of the infection could not be traced back (EPPO, 2012).
- Hungary: Present, restricted distribution as listed by EPPO on basis of information from the NPPO (National Plant Protection Organisation) (EPPO, 2018). No information about which hosts are infected in Hungary could be found in the literature. A survey of berry fruit crops in 1999 and 2000 did not detect the virus (Kölber *et al.*, 2000).
- Italy: Present, no details, as listed by EPPO. In March 2011 the virus was found in symptomatic plants (foliage showed chlorotic spots and rings) of *Aeonium* spp. in Salerno, Campania (Sorrentino *et al.*, 2012). There are some earlier records of TRSV in Italy, when it was found in association with imported *Gladiolus* bulbs (Bellardi & Marani, 1984).
- Lithuania: Present, restricted distribution. Four ornamental species were found to be infected in a survey in 2001 (Samuitienė & Navalinskienė, 2001), there are reports going back to 1977 in the literature (EPPO, 2018). Infected *Echinacea purpurea* (purple coneflower) showing ringspot symptoms were found in a Botanical Garden in 2010 (Samuitienė & Navalinskienė, 2010).
- Netherlands: Absent, pest eradicated. The Dutch have reported 4 outbreaks in the Netherlands on various ornamental plants, the last being on *Phlox* in several Dutch

nurseries and it was pointed out it may have been present in nuclear stock for some time (EPPO, 2010). EPPO make reference to findings in *Iris hollandica* in 1979 (EPPO, 2018). Though previous outbreaks were thought to be related to imported material, it appears the *Phlox* outbreak was on material that would be considered Dutch in origin. The outbreak was declared eradicated in 2015 after further survey work (EPPO, 2018).

- Poland: Present no details. Present, detected in a blueberry crop in Central Poland in 2009 and confirmed with further work in 2010 and 2011 (Chodorska *et al.*, 2012), the origin of the plants was not stated. Previous records date back to the 1970s including on *Gladiolus* (EPPO, 2018, Kaminska, 1974).
- Slovakia: EPPO do not provide a status for TRSV in Slovakia, but a published survey of small fruits and fruit trees in Slovakia conducted over 3 years states the virus was found (Šubíková *et al.*, 2002). The status of TRSV in Slovakia is uncertain.

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

A full summary of the status of TRSV in the UK is provided in Appendix I of this PRA. There is a long history of findings of this virus in the UK – the first reference in the literature is an outbreak of Anemone necrosis in Somerset in 1957, which was attributed to TRSV after investigation (Hollings, 1965). There have been repeat findings in *Pelagonium* stocks in the UK, with the most recent survey being from 2003 (Defra, unpublished data). Many of the infected plants did not show symptoms. The results of the most recent survey did indicate that levels of viral contamination had dropped, but there is no evidence the pest has ever been fully eradicated from *Pelagonium* – especially since the virus can be transmitted via seed (Scarborough & Smith, 1977).

In 2011, there was a UK finding of TRSV on lettuce seeds at pre-export testing. The seeds originated in France and were destined for Thailand, and action was taken against this finding (Defra, unpublished data).

Based on the evidence as presented in Appendix I and in section 7 concerning the likelihood of entry, it is very likely the virus is still present within *Pelagonium* and possibly other ornamental hosts in the UK. A survey would be required to confirm the extent of the establishment and which plants the virus is found in.

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?

The host lists given in this section are correct, but not comprehensive. TRSV is polyphagous with a wide host range encompassing both cultivated and uncultivated plants, herbaceous and woody species and many experimental hosts in addition to those found to be naturally infected.

CABI (2017) list the following as the main hosts of TRSV: *Capsicum* (peppers), *Citrullus lanatus* (watermelon), *Cucumis melo* (melon), *Cucumis sativus* (cucumber), *Cucurbita pepo* (marrow), *Gladiolus, Glycine max* (soybean), *Nicotinana tabacum* (tobacco), *Solanum lycopersicum* (tomato) and *Vaccinium* (blueberries).

TRSV has been found causing both disease and symptomless infection in a wide range of ornamentals. Naturally infected *Iris*, *Lamprocapnos spectabilis* (bleeding heart) and *Tulipa* were found in Lithuania, with the main symptoms being *"chlorotic and necrotic spots and streaks and ringspots"* (Samuitienė & Navalinskienė, 2001). As discussed in the UK distribution, this pest is also regularly found in *Pelargonium* (Kemp, 1967, Scarborough & Smith, 1977, Stone, 1980). In Czech Republic, an outbreak occurred on *Impatiens walleriana* (Kundu et al., 2015).

A strain of TRSV has also been found in *Fraxinus americana* (white ash) in the USA (Castello *et al.*, 1984, Hibben & Bozarth, 1972, Hibben & Walker, 1971).

TRSV is also found in uncultivated hosts, for example one study in North Carolina found the following to be hosts of TRSV: *Apocynum cannabinum* (hemp dogbane), *Daucus carota* (wild carrot), *Erigeron annuus* (annual fleabane), *Erigeron canadensis* (horseweed), *Eupatorium capillifolium* (dog fennel), *Helenium amarum* (bitterweed), *Melilotus alba* (honey clover), *Plantago lanceolata* (ribwort plantain). *Rubus allegheniensis* (Allegheny blackberry), *Rubus argutus* (sawtooth blackberry), *Rubus flagellaris* (northern dewberry), *Rumex crispus* (curly dock), *Rumex obtusifolius* (broad-leaved dock), *Solanum nigrum* (black nightshade) and *Xanthium strumarium* (common cocklebur) (Rush & Gooding, 1970).

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 (excluding seeds and pollen)

It is important to note that although TRSV is listed in Annex IAI as a quarantine pest, which implies the pest is absent from the EU, as shown in section 5 this is not the case.

As summarised in Appendix I, there have been a number of findings related to plants traded in the UK, demonstrating this is a pathway for this virus.

Due to the presence of the virus in both ornamental and edible crops within the European Union from which large numbers of plants are imported, the wide host range of the virus and the lack of measures on plants in relation to the virus being imported from both the EU and third countries, **entry on plants for planting is rated as very likely with high confidence.** It is also possible that host plants may be associated with the nematode vectors, especially if transported with soil or growing medium attached.

Seeds

TRSV has been shown to be seed transmitted in some hosts, in particular transmission in *Glycine max* is documented (Laviolette & Athow, 1971, Yang & Hamilton, 1974). Soybean is growing in area in the UK (400 Ha grown commercially in 2016, and likely to have increased in following year according to Farmers Weekly), however soybean seed certification schemes are common, which would reduce the likelihood of seed being contaminated with TRSV. Seed transmission of both ToRSV and TRSV is known in *Pelargonium* (Scarborough & Smith, 1977).

Thus seed transmission of TRSV has only been demonstrated in a few hosts. *Pelargonium* seeds may represent the most likely host seed to introduce both ToRSV and TRSV since contamination of *Pelargonium* stocks with virus appears to be a common issue and these seeds are imported and sold commercially in the UK. **Entry on seeds is rated as moderately likely with medium confidence**, as there is little information of the efficiency of seed transmission in *Pelargonium.*

Pollen

There is evidence that TRSV can be transmitted by pollen in some species, In a review of pollen transmitted viruses, TRSV was stated to be vertically transmitted (e.g. through pollen to the offspring) in *Cucumis* spp., *Glycine max, Solanum* spp. and *Vaccinium* spp. (Card *et al.*, 2007). TRSV has also been shown to be pollen transmitted in *Nicotiana* spp. (Zadeh & Foster, 2004). However it should be noted that pollen transmission has been relatively poorly studied, and it is unclear how efficient it is as a pathway of transmission. Significantly less pollen was viable in TRSV infected *G. max* (Yang & Hamilton, 1974) which reduces the likelihood of transmission on this pathway.

Though Card *et al.* (2007) list ToRSV as pollen transmitted in *Prunus*, the 2013 EFSA opinion on risks posed by *Prunus* pollen listed both ToRSV and TRSV as “agent known to be vertically transmitted by pollen in hosts other than *Prunus*” and that these viruses are “not reported to be pollen transmitted in its woody hosts” (The EFSA Panel of Plant Health, 2013) – though both viruses were rated as unlikely to moderately likely, with high uncertainty, to enter on *Prunus* pollen.

It is very uncertain how much pollen of these hosts is imported into the UK, as no specific commodity code records import of pollen. It is also unclear if pollen of other host species

may also be capable of transmitting the viruses, as capacity to be transmitted via pollen in one host does not mean all hosts will show pollen transmission (The EFSA Panel of Plant Health, 2013).

Entry of this virus on pollen has been rated as **unlikely with low confidence**, as there is a paucity of data on the efficiency of pollen transmission, how many hosts may have pollen transmission and how much pollen of host species is imported into the UK.

Nematode Vectors

A review of nepoviruses lists TRSV as transmitted by *Xiphinema americanum sensu lato, X. americanum sensu stricto* and *X. rivesi,* and the virus can persist once associated with the nematode vectors. In plant free laboratory conditions nepoviruses persisted in *Xiphinema* spp. for 8 to 12 months (Brown *et al.*, 1995). This means that *Xiphinema* spp., which are ectoparasites feeding on the outside of roots and found free in soil and growing medium, could introduce the virus if associated with imports of non-host plants of the viruses or other soil and growing medium.

A rapid UK PRA on European populations of *X. americanum sensu lato* rated them as likely to enter in association with plants for planting, unlikely with soil associated with commodities and moderately likely with bulk soil imports (Tomlinson, 2014). However, the PRA also identified *X. rivesi* as the only known virus vector species within the European population of *X. americanum s.l*., and this nematode is described as locally distributed, with presence in 7 Member States: Bulgaria, France, Germany, Italy, Portugal, Slovenia and Spain, of which only Italy is known to have TRSV present. The risk of importing non-European strains of *X. americanum sensu lato* is much less likely, as these are listed in Annex IAI and there are phytosanitary measures associated with the import of plants and soil/growing medium to reduce the likelihood of nematodes remaining associated with either commodity.

This pathway is made difficult to judge due to the fact that TRSV is likely to be more widespread in Europe then currently reported. **The likelihood of infectious vectors being associated with commodities other than host plants for planting is unlikely with low confidence.** Confidence is low because the majority of plants, soil associated with other commodities, and bulk soil imports imported from the EU will not be tested for nematodes, and so there is insufficient data on how often *X. americanum sensu lato* is associated with commodities other than virus host plants.

Plants for planting (excl. seeds and pollen)	Very unlikely	☐	Unlikely	☐	Moderately likely	☐	Likely	☐	Very likely ☑
Confidence	High Confidence	☑	Medium Confidence	☐	Low Confidence	☐			

Seeds	Very unlikely	☐	Unlikely	☐	Moderately likely	☑	Likely	☐	Very likely ☐
Confidence	High Confidence	☐	Medium Confidence	☑	Low Confidence	☐			
Pollen	Very unlikely	☐	Unlikely	☑	Moderately likely	☐	Likely	☐	Very likely ☐
Confidence	High Confidence	☐	Medium Confidence	☐	Low Confidence	☑			
Nematode vectors	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?

TRSV, is transmitted by *Xiphinema americanum sensu lato, X. americanum sensu stricto* and *X. rivesi.*

The vectors of TRSV are not known to occur in the UK, though the rapid PRA for these nematodes acknowledged that some populations may have been inadvertently imported in large containerised plants. If nematode vectors were to enter they are very likely to be able to establish both outdoors and in protected conditions (Tomlinson, 2014).

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

Though nematode vector populations are not established in the UK, the history of virus findings in *Pelargonium* indicates that TRSV is capable of establishing in the UK in the absence of vectors. This is due to the ability of the virus to spread in seed and clonally propagated material, with infection often asymptomatic. In *Pelargonium* and similar ornamentals, establishment of TRSV is rated as **very likely with high confidence both outdoors and under protection.**

However, establishment in some other crop systems such as soft fruits and grapevines is unlikely unless nematode vectors are introduced, as the viruses are not spread by

seed/pollen in these hosts and symptoms are severe enough that continued propagation from infected mother material is unlikely.

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?

TRSV would be expected to spread **very slowly by natural means with high confidence**, even if the nematode vectors were introduced. Without vectors, natural spread could only occur in a limited number of hosts for which pollen and seed transmission occurs. As the vectors are not endemic to the UK, and have very low mobility, it would take many decades before they would become widespread enough to have any significant impact on the ability to spread the viruses.

The fact that this virus has a long history of contaminating *Pelargonium* stocks in the UK and elsewhere demonstrates the ability of this pest to be readily moved in trade, especially in terms of mother plant material used for propagation. **Spread with trade is rated as 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?

Impacts in crops

The majority of impacts of TRSV are reported on *G. max* where it causes bud blight. Severe yield losses are occasionally reported especially when high numbers of infected

seeds are planted or plants are infected when they are young (Laboratory for Soybean Disease Research, 2017).

TRSV also causes disease in *Vaccinium corymbosum* and mixed infections with ToRSV leading to dieback and reduced yield have been recorded in the literature (Fuchs, 2010). It is also recorded as causing disease in grapevine (*Vitis* spp.), leading to decline of vines and production of small fruits. During a 2003 outbreak in Michigan vines of 'Maquis' and 'Vanessa', table grapes were eventually killed by the virus (Schilder *et al.*, 2003).

Impacts in Ornamentals

TRSV will infect numerous ornamental species – in some cases disease is asymptomatic but ringspot disease is recorded in some hosts.

TRSV caused sporadic chlorotic rings and patterns on leaves in *Impatiens walleriana* during an outbreak in the Czech Republic (Kundu *et al.*, 2015). In *Gladiolus*, symptoms included white and rusty spots on the foliage that sometimes joined together to form streaks, flowers also displayed streaks and plants were sometimes stunted (Bellardi & Marani, 1984). Though some flowers exhibited colour break symptoms in India other infected *Gladiolus* were asymptomatic (Katoch *et al.*, 2003).

TRSV and ToRSV both cause a ringspot disease of *Pelargonium* (Hollings *et al.*, 1972, Kemp, 1967, 1969, Rydén, 1972). Symptoms of ringspot increase in severity on older leaves until mid-July, when they begin to fade, and new leaves produced from the summer onwards are generally symptomless. Infection may occasionally affect flowers and reduce vigour, leading to economic impacts (University of Illinois, 1989). Severity of the disease is dependent upon the cultivar of *Pelargonium* infected, but reports of significant losses in the literature could not be found.

In Lithuania, both viruses were found infecting a range of ornamentals during surveys, the fact that these viruses had not previously been reported in the literature may indicate their impacts were relatively small.

Impact Conclusions

Impacts of TRSV vary depending on host and region. In general, impacts in Europe have been small, and the majority of cases associated with infection of ornamentals.

However TRSV can cause economically important diseases of fruit crops and soybean, especially in fields where the nematode vectors are found. **Overall impacts are rated as medium with medium confidence,** as many reports are several decades old which may indicate the viruses are of decreasing importance.

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?

The potential impacts in the UK are limited due to the absence of the nematode vectors, and it is expected that the majority of impacts will occur in ornamental species as has been recorded in the past. Economic impacts will be incurred when ringspot diseases of *Pelargonium* or other ornamentals occur and reduce the marketability of the plants and their ability to be used for further propagation.

Should the vectors be introduced and disseminated through trade, their long lifecycles and very low natural dispersal capacity would also limit impacts, it would take many decades without any control measures for the vectors to become widespread enough in fruit production for significant impacts to occur.

Potential economic impacts in the UK are rated as small with high confidence, and are expected to be largely limited to ornamentals and similar to impacts seen in the past in the UK and in other EU countries.

There are no known environmental impacts caused by TRSV though significant numbers of uncultivated plants are host species. **Potential environmental impacts have been rated as very small with high confidence.**

Though TRSV will cause disease in commonly grown ornamentals, symptoms are not significantly worse than other widespread viral diseases in the UK. **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?

TRSV is not capable of acting as a vector of plant pathogens.

15. What is the area endangered by the pest?

TRSV is likely to be already established in ornamental production within the UK, with the largest impacts likely to occur in those industries which rely heavily on clonal propagation. Fruit crops and soybean could incur greater impacts, but unless the vectors are introduced any effects are likely to be limited by controlling planting material.

Stage 3: Pest Risk Management

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

Exclusion

Current phytosanitary measures are not adequate to exclude TRSV from the UK: there are no specific measures on hosts entering from the EU. Many of the host species are unregulated from 3rd countries, however, all plants for planting from third countries need to be accompanied by a phytosanitary certificate and the listing of the pathogen in Annex IAI means that all material should be free from TRSV regardless of whether there are specific requirements associated with that host. As discussed in section 6, it is likely that the virus is already present in some ornamental production systems and the prospect of continued exclusion is very poor.

Due to the confirmed presence in several EU member states, TRSV no longer meets the criteria of an Annex I quarantine pest, and its regulatory status should be reviewed. Since this virus primarily causes economic impacts on fruiting crops and soybean, status as an RNQP in crops in which economic impacts occur could be considered, as well as deregulation in other hosts species. However, this pest was not put forward for consideration in the recent EPPO RNQP project.

Containment and Eradication

Statutory action to contain and eradicate outbreaks of the viruses that occur in non-ornamental crops may be justified, in particular in cases where the nematode vectors are also detected. Eradication or containment measures would be dependent on the crop, but at a minimum would include the destruction of infected plants and prohibition on the movement of soil if vectors are known to be present.

Non-Statutory Controls

There are few treatment options for viruses and their nematode vectors. Crop rotation can be used to reduce the populations of nematode vectors, and thus disease incidence (Evans *et al.*, 2007, Pinkerton & Martin, 2005). Use of clean propagating material or certified seed can also be effective at reducing impacts.

17. References

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Appendix I – History of TRSV and ToRSV in the UK

There is a long history of TRSV causing symptomless infection of *Pelargonium* (geranium) in the UK. Unpublished Defra records begin in 1979. Within the literature, there are earlier references. A publication refers to TRSV being occasionally reported from *Gladiolus* in Scotland in in the 1960s (Bellardi & Pisi, 1985) but the original reference cannot be found. Cases of Anemone necrosis, which was reported from Somerset in 1957, were attributed to TRSV after investigation (Hollings, 1965). In June 1979 a stakeholder wrote to what was then MAFF to inform them of a finding of TRSV in *Pelargonium.* MAFF replied that TRSV had been found on a variety of hosts in the UK and was regarded as *"having been established for a long time"* and it was concluded statutory action was not appropriate, though the grower was advised to destroy the plants (Defra, unpublished data).

A survey of *Pelargonium* was then proposed that would also encompass ToRSV and was carried out during 1979-1980. The conclusion was that "ToRSV is distributed throughout the UK pelargonium industry but only a small foci of infected cultivars are present on individual holdings" (Defra, unpublished data).

Further work in 1983 stated that all ToRSV findings were related to imports from North America, and that TRSV was quite rare, and so it was advised that both viruses be treated as non-indigenous and action taken against them. Advice from others in MAFF appears to have led to the conclusion that eradication was not possible, but that action could be taken to limit introduction and spread of the pest (e.g. destruction of plants when recently imported).

New files were opened on TRSV and ToRSV ten years later in 1994, and it is not known if any other discussions on the pests occurred in the gap of a decade. A survey was commissioned after TRSV and ToRSV were found in pelargoniums being traded in the UK, as these viruses, "do not usually occur in Europe" and were ECIAI listed. The survey took place between November 1996 and April 1997 and involved testing mother plants. ToRSV was found in seven nurseries across seventeen varieties, and one case of mixed infection of TRSV and ToRSV was found (Defra, unpublished data).

Another survey took place in 1997/98 and instructions on eradication and containment supplied to the PHSI. The survey concluded that the viruses were "not uncommon" in *Pelargonium* cultivars and were being spread in the horticultural industry by cuttings (Defra, unpublished data).

The matter was to be discussed at an EU level at Plant Health Standing Committee in 1998, and the UK informed the EU the viruses were absent except in Pelagonium and asked for clarification on if they should continue to be considered quarantine. The UK position was that RNQP status was not suitable for these viruses though certification

schemes may offer a useful element to a package of management measures. It was decided the issue would be considered by the comparative trial of *Pelargonium*, however the trial did not address the issue as no testing for latent infection was carried out.

Surveys in 2001-2002 found 8 positive findings and in 2002-2003 only 2 findings were made (Defra, unpublished data). A paper was also published in 2001 concerning an isolate of TRSV from cherry of UK origin (Zadeh & Foster, 2000). This isolate was apparently obtained from the University of Birmingham as an infected tobacco leaf but no other information is given, so it is unclear if this is truly of "UK" origin.

In 2011, there was a UK finding of TRSV on lettuce seeds at pre-export testing. The seeds originated in France and were destined for Thailand, and action was taken against this finding (Defra, unpublished data). In 2011 advice was given that both viruses should be listed as "not occurring in the UK" as they were only found occasionally whilst screening *Pelargonium* stocks.

However, it is the conclusion of this PRA that there is no evidence that TRSV has ever been eradicated from *Pelargonium* stocks, especially since no surveys have been carried out since 2003. Though very few nurseries in the UK now keep their own propagation material, both TRSV and ToRSV can be transmitted via *Pelargonium* seed – even if mother plants were clean, the viruses may have continued to persist in garden plants through this pathway. Given infections are usually latent, and the findings in other ornamentals in Europe, it is very likely that TRSV and ToRSV are present in the UK.

This publication is available at https://planthealthportal.defra.gov.uk/

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