



Department for Environment Food & Rural Affairs

Rapid Pest Risk Analysis (PRA) for: *Globodera tabacum* s.l.

November 2014

Stage 1: Initiation

1. What is the name of the pest?

Preferred scientific name: *Globodera tabacum* s.l. (Lownsbery & Lownsbery, 1954) Skarbilovich, 1959

Other scientific names:

Globodera tabacum solanacearum (Miller & Gray, 1972) Behrens, 1975

syn. *Heterodera solanacearum* Miller & Gray, 1972

Heterodera tabacum solanacearum Miller & Gray, 1972 (Stone, 1983)

Globodera Solanacearum (Miller & Gray, 1972) Behrens, 1975

Globodera Solanacearum (Miller & Gray, 1972) Mulvey & Stone, 1976

Globodera tabacum tabacum (Lownsbery & Lownsbery, 1954) Skarbilovich, 1959

syn. *Heterodera tabacum* Lownsbery & Lownsbery, 1954

Globodera tabacum (Lownsbery & Lownsbery, 1954) Behrens, 1975

Globodera tabacum (Lownsbery & Lownsbery, 1954) Mulvey & Stone, 1976

Globodera tabacum virginiae (Miller & Gray, 1968) Stone, 1983

syn. *Heterodera virginiae* Miller & Gray, 1968

Heterodera tabacum virginiae Miller & Gray, 1968 (Stone, 1983)

Globodera virginiae (Miller & Gray, 1968) Stone, 1983

Globodera virginiae (Miller & Gray, 1968) Behrens, 1975

Globodera virginiae (Miller & Gray, 1968) Mulvey & Stone, 1976

Preferred common name: tobacco cyst nematode

This PRA has been undertaken on *G. tabacum* s.l. because of the difficulties in separating the subspecies. Further detail is given below. After the description of *H. tabacum*, two other similar cyst nematodes, colloquially referred to as horsenettle cyst nematode and Osbourne's cyst nematode, were later designated by Miller *et al.* (1962) from Virginia, USA. These cyst nematodes were fully described and named as *H. virginiae* and *H. solanacearum* by Miller & Gray (1972), respectively. The type host for these species was *Solanum carolinense* L.; other hosts included different species of *Nicotiana*, *Physalis* and *Solanum*, as well as *Atropa belladonna* L., *Hycoscyamus niger* L., but not *S. tuberosum*. Miller and Gray (1968, 1972) distinguished these nematode species from *H. tabacum* and from each other by minor differences in vulval plate structures and morphometrics. Stone (1983), using canonical discriminate analysis of morphometric characters, concluded that *G. tabacum* was a polytypic species containing the following subspecies: *G. tabacum tabacum* (Lownsbery & Lownsbery, 1954); *G. tabacum virginiae* (Miller & Gray, 1968) and *G. tabacum solanacearum* (Miller & Gray, 1972). All three subspecies develop on tobacco and horsenettle, but otherwise differ in host preference. Roberts & Stone (1981) concluded that host range data within *Solanum* spp. failed to differentiate these three subspecies of *G. tabacum*. Miller (1983) and Mugniery *et al.* (1992) obtained viable hybrids from different combinations of these nematodes that confirmed their subspecies relationship. Mota & Eisenbach (1993 a, b, c) made comparative morphological and morphometric studies and showed that it is difficult to reliably distinguish these subspecies from each other at any developmental stage. They further considered this complex of three subspecies as having a continuum of values for the majority of the observed characters and therefore confirmed Stone's conclusion regarding their rank as subspecies. *Globodera tabacum* is considered as a serious and important pest of shade and broadleaf tobacco.

2. What initiated this rapid PRA?

An assessment is required to update the short UK PRA written in 1999 for *G. tabacum tabacum* after it received a high score of the UK Plant Health Risk Register due to uncertainty over the host range.

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/EC¹) and in the lists of EPPO²?

The pest is not listed in the EC Plant Health Directive and is not recommended for regulation as a quarantine pest by EPPO, nor is it on the EPPO Alert List.

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

Table : Distribution of *Globodera tabacum* s.l.

North America:	Canada (Bélair & Miller 2006); Mexico (Becerra & Sosa-Moss 1976, CABI/EPPO, 2004); USA (Lownsbery & Lownsbery, 1954, CABI/EPPO, 2004)
Central America:	
South America:	Argentina (Chaves 1993, CABI/EPPO, 2004); Colombia (Shepherd & Barker, 1990; CABI/EPPO, 2004)
Europe:	EU: Bulgaria (CABI/EPPO, 2004); France (Shepherd & Barker, 1990; CABI/EPPO, 2004); Greece (Shepherd & Barker, 1990; CABI/EPPO, 2004); Italy (Ambrogioni & D'Errico, 1998; CABI/EPPO, 2004); Slovenia (CABI/EPPO, 2004); Spain (CABI/EPPO, 2004). Non-EU: Former Yugoslavia (Shepherd & Barker, 1990; CABI/EPPO, 2004); Former USSR ((Kir'janova ES, 1963, CABI/EPPO, 2004).
Africa:	Madagascar (Shepherd & Barker, 1990; CABI/EPPO, 2004); Morocco (Shepherd & Barker, 1990; CABI/EPPO, 2004).
Asia:	China (Shepherd & Barker, 1990; CABI/EPPO, 2004); Japan (Uehara et al 2005); Pakistan (Brown 1962, CABI/EPPO, 2004); Republic of Korea (Shepherd & Barker, 1990; CABI/EPPO, 2004).
Oceania:	

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

² <https://www.eppo.int/QUARANTINE/quarantine.htm>

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

The pest has been reported as occurring in a number of European countries but has not thus far been recorded in the UK. No interceptions of this pest have been reported to Europhyt between 1996 and 2014, although there have been a number of interceptions of *Globodera* sp. in this period.

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?

Main

Nicotiana rustica (wild tobacco)
Nicotiana tabacum (tobacco)
Solanum lycopersicum (tomato)
Solanum melongena (aubergine)

Other

Solanum tuberosum (potato)¹
Solanum gilo (gilo)
Solanum indicum
Solanum mauritianum (tree tobacco)
Solanum nigrum (black nightshade)
Solanum quitoense (Narangillo)
Atropa belladonna
Capsicum annuum
Hyoscyamus niger
Nicandra physalodes

¹Status as a host uncertain but unlikely

Globodera tabacum virginiae can develop on *Nicotiana x sanderae*, 50-B, whereas other subspecies do not. *Globodera tabacum tabacum* is unable to develop on *N. acuminata* 2-G-58, unlike the other subspecies.

Tomato and aubergine are considered as hosts of *G. tabacum* s.l. and, therefore, of potential economic importance on these crops in the UK, although reports on the impact of *G. tabacum* s.l. on these species are limited in number. LaMondia (1996) reported that *G. tabacum tabacum* reproduced slowly after root penetration of tomato, compared with tobacco or eastern black nightshade (*Solanum ptycanthum*), suggesting that tomato was not a good host for this sub-species of *G. tabacum* s.l. In Italy, the pest is present on aubergine in the province of Naples where it is capable of producing five generations during a single cropping season (Ambrogioni and d'Errico, 1998). Host range studies also demonstrated that it could reproduce on tomato (Ambrogioni et al., 2000).

According to Goodspeed (1954) *G. tabacum* and its sub species *G. tabacum solanacearum* and *G. tabacum virginiae* do not develop on potato but do develop on non-tuberous wild solanaceae and several *Nicotiniae* spp. However, Stelter (1987) and Stone and Miller (1974) have reported that various combinations of the *G. tabacum* s.l. complex are able to reproduce on certain potato cultivars experimentally.

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?

EUROPHYT records from 1996 to 2014 show no interceptions of this pest in consignments from either third countries or EU MS, although there have been a number of interceptions of *Globodera* sp. in this period.

On the roots of growing plants. The pest could be introduced as viable eggs contained within a cyst or infective juvenile stage in soil associated with rooted plants, or as sedentary females attached to host roots. Multiple interceptions made by the Canadian plant protection services on infected nursery stock from the USA show that the pest has moved along this pathway in the past (data provided in Belair & Miller 2006).

The pest is very unlikely to enter the UK on rooted plants from third countries, other than European and Mediterranean countries, as plants of Solanaceae intended for planting are prohibited (Annex III listing) in the EU Plant Health Directive. However, the importation of rooted cuttings or seedlings of tomato, aubergine or other Solanaceae intended for the horticultural market from the European or Mediterranean countries where it is present could present a risk of entry to the UK. Importation of potential hosts from EU MS is covered by the plant passport system and inspections carried out in exporting countries before shipment and in the UK should limit the risk of entry of the pest from these countries. At least a proportion of the seedlings imported are also likely to have been produced using sterile growing media, further reducing the risk. Overall, entry on the roots of growing plants is considered unlikely, with medium confidence.

<i>On the roots of growing plants</i>	Very unlikely	<input type="checkbox"/>	Unlikely	<input checked="" type="checkbox"/>	Moderately likely	<input type="checkbox"/>	Likely	<input type="checkbox"/>	Very likely	<input type="checkbox"/>
<i>Confidence</i>	High Confidence	<input type="checkbox"/>	Medium Confidence	<input checked="" type="checkbox"/>	Low Confidence	<input type="checkbox"/>				

Soil. The pest could be introduced as viable eggs contained within a cyst or infective juvenile stage in soil. The movement of soil from Turkey, Belarus, Moldavia, Russia, Ukraine and third countries not belonging to continental Europe, other than Egypt, Israel, Libya, Morocco and Tunisia, is prohibited (Annex III listing) in the EU Plant Health Directive. Movement from the European or Mediterranean countries where it is present

could present a risk of entry, though it is unclear how much soil is imported from these countries, and what the end use is.

Soil	Very unlikely	<input type="checkbox"/>	Unlikely	<input checked="" type="checkbox"/>	Moderately likely	<input type="checkbox"/>	Likely	<input type="checkbox"/>	Very likely	<input type="checkbox"/>
Confidence	High Confidence	<input type="checkbox"/>	Medium Confidence	<input checked="" type="checkbox"/>	Low Confidence	<input type="checkbox"/>				

Contaminated soil attached to other planting material or vegetables/tubers. The pest is normally confined to roots and not known to be associated with other planting material. Contamination of other plant parts with soil, however, could present a risk of entry, but the risk of transfer to suitable hosts is low.

Other plant parts, incl. tubers	Very unlikely	<input type="checkbox"/>	Unlikely	<input checked="" type="checkbox"/>	Moderately likely	<input type="checkbox"/>	Likely	<input type="checkbox"/>	Very likely	<input type="checkbox"/>
Confidence	High Confidence	<input type="checkbox"/>	Medium Confidence	<input checked="" type="checkbox"/>	Low Confidence	<input type="checkbox"/>				

Contaminated seed of Solanaceae. There is a suggestion that *G. tabacum* was introduced into Italy in contaminated seed of tobacco originating from the Eastern States of North America (Ambrogioni and d'Errico, 1995), though no evidence is provided to support this statement. The movement of tobacco seed into the UK for the purposes of planting is very unlikely. While ornamental tobacco is grown from seed in the UK, no outbreaks of *G. tabacum* have been associated with ornamental crops. A cyst could also potentially become associated with seed of tomato or aubergine.

Solanaceae seed	Very unlikely	<input type="checkbox"/>	Unlikely	<input checked="" type="checkbox"/>	Moderately likely	<input type="checkbox"/>	Likely	<input type="checkbox"/>	Very likely	<input type="checkbox"/>
Confidence	High Confidence	<input type="checkbox"/>	Medium Confidence	<input checked="" type="checkbox"/>	Low Confidence	<input type="checkbox"/>				

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

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"/>
Confidence	High Confidence	<input type="checkbox"/>	Medium Confidence	<input checked="" type="checkbox"/>	Low Confidence	<input type="checkbox"/>				
Under Protection	Very unlikely	<input type="checkbox"/>	Unlikely	<input type="checkbox"/>	Moderately likely	<input checked="" type="checkbox"/>	Likely	<input type="checkbox"/>	Very likely	<input type="checkbox"/>
Confidence	High Confidence	<input checked="" type="checkbox"/>	Medium Confidence	<input type="checkbox"/>	Low Confidence	<input type="checkbox"/>				

Its reported presence in a number of European countries would suggest that it might establish outdoors in parts of the UK. Soil temperature minimum for penetration and development of the pest in host plant roots is reported to be around 15°C. For example, Wang et al (2001) showed that the number of vermiform juveniles of *Globodera tabacum solanacearum* peaked after 14 days after infestations at 22 and 27°C respectively. At 31°C numbers peaked after 21 days and then fell whilst at 17°C very few juveniles were detected, implying slow development and reproduction at this temperature. Wang et al (1997) also found little or no hatching of *G. tabacum solanacearum* at 15°C compared to 20 and 25°C suggesting that mean soil temperatures around this level may inhibit development of *G. tabacum solanacearum*. Ambrogioni and d'Errico (1998) reported that *G. tabacum* could complete five generations in the climate of southern Italy and in France it is mainly observed in the southwest (Blancard, 2013). This data suggests that it may not readily establish in the northern regions of the UK, though the potential risk to more southerly areas is less clear. However, information is currently lacking on the climatic/environmental factors related to its limits for establishment in different regions.

Given that potato is not considered to be a natural host of this pest, outdoor establishment may be more likely to occur on solanaceous weeds. Establishment on tomato, aubergine or solanaceous horticultural plants under protection is more likely than establishment in the open environment, though, in the case of tomato and aubergine, may be limited to organic systems where plants are grown in soil. It is not clear if the nematode could establish and cause economic damage in solanaceous crops grown in hydroponic systems, but there are no records of this occurring in the literature.

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

The pest does not require a vector.

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

<i>Natural Spread</i>	Very slowly	<input type="checkbox"/>	Slowly	<input checked="" type="checkbox"/>	Moderate pace	<input type="checkbox"/>	Quickly	<input type="checkbox"/>	Very quickly	<input type="checkbox"/>
<i>Confidence</i>	High Confidence	<input type="checkbox"/>	Medium Confidence	<input checked="" type="checkbox"/>	Low Confidence	<input type="checkbox"/>				
<i>With trade</i>	Very slowly	<input type="checkbox"/>	Slowly	<input type="checkbox"/>	Moderate pace	<input checked="" type="checkbox"/>	Quickly	<input type="checkbox"/>	Very quickly	<input type="checkbox"/>
<i>Confidence</i>	High Confidence	<input type="checkbox"/>	Medium Confidence	<input checked="" type="checkbox"/>	Low Confidence	<input type="checkbox"/>				

Globodera tabacum s.l., once established outdoors on solanaceous weeds, or under protection on tomato, aubergine or other solanaceous horticultural species, is likely to

spread slowly under natural conditions. Within-field spread via irrigation is likely and field to field spread on soil associated with farm machinery is also likely.

Spread on soil associated with agricultural or other products would be a possibility from those EU states where the pest is present. Spread in trade of tomato, aubergine and other plants grown under protection and sold as rooted cuttings is, however, a more likely means of spread between nurseries. In the unlikely event of the pest being able to establish on potato, it is unlikely to spread rapidly in trade given the fact that it is normally confined to roots and is not known to be associated with potato tubers.

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

Impacts	Very small	<input type="checkbox"/>	Small	<input type="checkbox"/>	Medium	<input checked="" type="checkbox"/>	Large	<input type="checkbox"/>	Very large	<input type="checkbox"/>
Confidence	High Confidence	<input type="checkbox"/>	Medium Confidence	<input checked="" type="checkbox"/>	Low Confidence	<input type="checkbox"/>				

The pest has been associated with average 15% yield losses in tobacco in the US (Wang et al, 2001) although complete crop loss has occasionally been recorded (Komm et al, 1983). Parkunan et al (2009) reported that in 2007, in Virginia, total estimated costs related to yield loss and pesticide usage of infestation of tobacco by *G. tabacum solanacearum* to have been of the order of two million dollars. Osborne (1990) reported greater than 40% losses in field grown tobacco and tomato and greater than 45% losses in aubergine in the US.

Nematode infestation is often associated with increased damage from bacterial wilt, black shank and Fusarium wilt and significantly decreases tobacco leaf quality. A high density of nematode populations early in the growing season can reduce flue-cured tobacco yield by 25-50%, although tobacco may escape significant losses from moderate populations especially under favourable growing conditions. In field microplot experiments it has been shown that initial nematode densities of 0.1 to 1097 J2 cm⁻³ of soil was negatively correlated with leaf yield, total shoot weight and normal plant height 5 to 6 weeks after transplanting (LaMondia, 1995). Initial population density above 600 J2 cm⁻³ can reduce shoot weight of shade and broadleaf tobacco by 60% and 40% respectively (Johnson et al., 2005).

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

<i>Economic Impacts</i>	Very small	<input type="checkbox"/>	Small	<input checked="" type="checkbox"/>	Medium	<input type="checkbox"/>	Large	<input type="checkbox"/>	Very large	<input type="checkbox"/>
<i>Confidence</i>	High Confidence	<input type="checkbox"/>	Medium Confidence	<input checked="" type="checkbox"/>	Low Confidence	<input type="checkbox"/>				
<i>Environ - mental Impacts</i>	Very small	<input checked="" type="checkbox"/>	Small	<input type="checkbox"/>	Medium	<input type="checkbox"/>	Large	<input type="checkbox"/>	Very large	<input type="checkbox"/>
<i>Confidence</i>	High Confidence	<input checked="" type="checkbox"/>	Medium Confidence	<input type="checkbox"/>	Low Confidence	<input type="checkbox"/>				
<i>Social Impacts</i>	Very small	<input checked="" type="checkbox"/>	Small	<input type="checkbox"/>	Medium	<input type="checkbox"/>	Large	<input type="checkbox"/>	Very large	<input type="checkbox"/>
<i>Confidence</i>	High Confidence	<input checked="" type="checkbox"/>	Medium Confidence	<input type="checkbox"/>	Low Confidence	<input type="checkbox"/>				

Tobacco, the main host of this pest, is not grown in the UK except as an ornamental and there are no reports of impacts on ornamental tobacco. With the exception of a report by Osborne (1990) the paucity of reports of losses on aubergine and tomato from EU states and third countries where the pest is established suggests that the pest would have only minor economic effects on these crops. Economic effects may be greater in the horticultural trade as a number of solanaceous garden plants, particularly species of *Nicotiniae* may be hosts to the pest. The pest is also highly unlikely to have adverse environmental or social impacts were it to become established in the UK.

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

Unknown, but there are no reports in the literature of *Globodera* species acting as vectors.

15. What is the area endangered by the pest?

Areas where tomato, aubergine and other solanaceous horticultural species are grown in soil under protection will be at risk. As potato is not considered to be a natural host for *Globodera tabacum* s.l., potato growing areas are highly unlikely to be at risk of infestation.

Stage 3: Pest Risk Management

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

Current import controls on plants for planting and soil are likely to minimise the risk of introduction of *Globodera tabacum* s.l. to the UK from third countries. However, controls are lower on plants imported from other EU MS and so risk of introduction from these states is likely to be higher. If more evidence becomes available that *G. tabacum* s.l. may be capable of being moved with seed, then this pathway will need urgent review, as solanaceous seeds may be imported from third countries, although subject to phytosanitary requirements.

Given that the pest is present in a number of European countries it is possible that it might also survive in parts of the UK in association with solanaceous weeds and horticultural plants. As there is no evidence that *G. tabacum* reproduces on potato in the field, even in its centre of origin in S. America (Grenier et al 2010), it is extremely unlikely to establish on this crop in the UK despite its reported ability to reproduce on some potato cultivars experimentally (Stelter, 1987; Stone and Miller, 1974).

Were the pest to establish, in the field, on any of its solanaceous hosts in the UK, eradication would likely be difficult and economically unviable in view of the fact that eggs and young larvae, protected within the cysts, can survive several years in the soil in the absence of host plants (Blancard 2013). The pest is more likely to establish under protected cultivation in the UK. Crops at risk include soil grown tomato, aubergine or, given its host range, other solanaceous plants. However, control and/or eradication is likely to be more feasible under such circumstances.

17. Summary and conclusions of the rapid PRA

This rapid PRA shows: *Globodera tabacum* s.l. consists of three closely related nematode subspecies which are hard to separate, and for which the literature has been confused in the past. Accordingly, all three subspecies are considered together in this PRA. They are distributed in every continent except Oceania, including a limited distribution within the EU. They infest the roots of tobacco, aubergine and tomato. There are also records from other Solanaceae, though the record on potato is thought to be unreliable and this may not be a true host.

Risk of entry

All pathways were assessed as unlikely with medium confidence. On the roots of living plants, growing Solanaceae are banned from third countries and thus only plants from infested areas within the EU would pose a risk. As soil is banned from third countries, again, only EU countries where *G. tabacum* s.l. is present would pose a risk to the UK.

Contaminated soil attached to other plant parts or tubers is considered an unlikely pathway, as this pest is associated with roots and the chance of transfer to a suitable host is considered low. While there has been a suggestion *G. tabacum* s.l. has been associated with tobacco seed, the UK only imports ornamental tobacco seed for planting and there have been no outbreaks associated with ornamental crops. Tomato or aubergine seeds could pose a risk.

Risk of establishment

Unlikely in open cultivation (medium confidence), but moderately likely under protected cultivation, with high confidence.

Economic, environmental and social impact

In its existing range, this is considered to be medium, with medium confidence. Potential economic impacts to the UK are small, with medium confidence, while potential environmental and social impacts are considered very small with high confidence. The paucity of reports of damage to tomato and aubergine crops from countries where the pest is established suggests that it would have only minor economic effects on these crops. Effects may be greater on the horticultural industry, simply due to the higher number of potential hosts.

Endangered area

Protected solanaceous crops, such as aubergine, tomato and solanaceous horticultural plants, grown in soil.

Risk management options

Exclusion is considered difficult, as this pest is present in parts of the EU, meaning that trade is unregulated. Eradication is considered unlikely to be successful if the nematode was able to establish in the wider environment, but is judged more likely to succeed if the pest was in protected cultivation.

Key uncertainties and topics that would benefit from further investigation

The exact status of potato as a host requires clarification. The potential association of the pest with tobacco seeds also needs to be kept under review, though for the UK, association with seeds of other Solanaceae would be of more importance.

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

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

No	<input checked="" type="checkbox"/>				
Yes	<input type="checkbox"/>	PRA area: UK or EU		PRA scheme: UK or EPPO	

19. Images of the pest

Photo 1 (pest)	Photo 2 (e.g. symptoms?)
Source/ copyright owner	Source/ copyright owner

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

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

Yes	<input type="checkbox"/>	No	<input checked="" type="checkbox"/>
Statutory action		Statutory action	

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