

RAPID RISK ASSESSMENT (RRA)

Movement of Potato Cyst Nematode from an infested block to other blocks on the same land parcel

Scientific name: *Globodera rostochiensis* (Wollenweber) Behrens

Synonyms: *Heterodera rostochiensis*

Common Names: Golden potato cyst nematode; Golden nematode

Taxonomic Uncertainty: Nil

Type of Pest: Insect

SUMMARY

This rapid risk analysis assesses the likelihood of moving Potato cyst nematode (PCN) between an infested component of land to linked growing blocks within the one infested parcel of land. It is proposed that an approved accreditation is developed to establish formal means to mitigate identifiable risk associated with the infested component. The need for this risk assessment arose as a result of an investigatory audit which identified a grower was operating on linked blocks¹ within an infested parcel of land, which also contained one or more infested blocks.

Seven pathways were assessed as the most likely means of spreading the pest. The estimated risk for pathways 1 to 5 were found to be **below** 'very low' and therefore the risk is considered acceptable without restrictions. Pathways 6 and 7 do not meet Australia's Appropriate Level of Protection as they are categorised **above** 'very low' risk. Pathway 7, seed potatoes, was included to provide an example of a high-risk pathway if no controls were in place.

BACKGROUND

Pest: Juvenile nematodes hatch from cysts in soil after stimulus from exudates from susceptible host roots and then invade roots by piercing the plant cell with a needle-like stylet and embeds itself near the vascular tissues to feed. Under suitable conditions susceptible solanaceous hosts can cause more than 80% hatch of juvenile nematodes from a cyst. In the absence of host plants, a variable spontaneous hatch occurs, averaging about 30% annually (Turner and Evans 1998). In the presence of susceptible host plants females mate and burrow into the root surface developing eggs as they mature. The female dies and the eggs become enclosed by a resistant covering (the cyst). Cysts are reported to contain from about 200 to 500 eggs (Turner and Evans, 1998), though an average of 200 is commonly assumed (Moxnes and Hausken, 2007). Cysts usually detach in the soil when the roots die or are removed through cultivation. Cysts hatch within 7-10 years but reports of viable cysts range up to 20 or 30 years or more (Turner 1996, Ferris 1999, Hockland 2002).

Because the pest can survive for long periods in soil (or plant debris), anything contaminated with infested soil including potatoes, nursery stock, bulbs of unrelated plants, machinery or packing material could spread the pest. Local spread (within and between fields) is attributed mainly to farming activities. Long distance spread (within and between continents) is mainly associated with movement of used machinery, seed potato (tubers), root crops or their packaging material (Brodie 1993). Spread of PCN can occur in soil attached to potato tubers, farm machinery or footwear (Anon. 2003). Brodie found 10% of unwashed tubers contained at least one cyst with viable eggs when grown in soil with low populations of PCN (0.01 – 0.4 eggs/cm³). This number increased to 76% when tubers were grown in soil with high populations of PCN (>50 eggs/cm³).

Planting resistant potato cultivars is an effective control method to reduce populations of cysts in the soil. In the absence of a host to feed on, populations decrease, as does the risk of soil contaminated with PCN being attached to tubers at harvest. Population decreases can also be assisted by long crop rotations and rotations with a non-host crop. Annual rotations with a non-host can reduce PCN populations by around 20% (Lane and Trudgill 1999). Through effective legislation and education, high cyst loads can be managed to reduce the risk of spreading PCN. Permit conditions and the requirement to operate under accreditations are management options for landowners operating on PCN affected land, to gain market access.

Turner and Evans in Marks and Brodie (1998) consider that most movement within a field or to new localities is by passive transport from soil movements from:

- Contaminated seed potatoes
- Farm machinery
- Livestock (hooves)
- Farm workers (boots and shoes)
- Soil (e.g. from building schemes)
- Contaminated crops (root crops, nursery stock)
- Water runoff
- High winds over large exposed areas of light sandy soils can blow cysts to new areas.

The CABI data sheet on quarantine pest "*Globodera rostochiensis* (yellow potato cyst nematode)", (CABI 2008), details the pathway vectors for spread of PCN as:

- Clothing footwear and possessions
- Containers and packaging
- Land vehicles
- Livestock
- Machinery and equipment
- Plants or parts of plants
- Soil, sand and gravel
- Water
- wind

¹ Land component was tested and found to be free of PCN in accordance with standard 10 x 10 sample collection and Fenwick can testing.

Host species: Host plants are any plant of the *Solanaceae* family. The potato (*Solanum tuberosum*) is by far the most important host. Tomatoes (*Lycopersicon esculentum*), and eggplants (*Solanum melongena*) are also attacked, and 90 other *Solanum* spp. and their hybrids can also act as hosts.

Note that potato ground keepers (volunteer potato plants leftover from previous crops) from susceptible varieties rather than other hosts, are considered to be the main cause for concern between potato crops in the UK (Hockland 2002). Their elimination is therefore an important part of managing PCN, in order to prevent build-up of populations during “rotations”.

Damage: Symptoms are not specific but include patches of poor growth in a crop sometimes with yellowing, wilting or death of the foliage. Even with minor symptoms on foliage, the size of tubers can be reduced (Smith *et al* 1997). No symptoms appear with low populations of nematode but as numbers increase symptoms occur, which may resemble water or mineral deficiency. This is due to nematodes feeding on roots disrupting water and nutrient movement in the plant. Roots of infected plants show small white bodies which are the immature females which have erupted through the root surface (Ferris 1999).

Rapid Risk Assessment Method

Risk assessment comprises six steps

- 1. Pest categorisation.** This is a screening procedure designed to establish whether there appears to be caused to proceed with a detailed PRA. (For our purposes I have omitted this step because we know that there is a requirement to do a PRA).
- 2. Determination of likelihood of entry.** This involves consideration of the likelihood of **importation** to and **distribution** within the PRA area of the pest in association with a given commodity.
- 3. Determination of likelihood of establishment.** This is based on comparative assessment of factors that operate in the pest source area and the PRA area, as relevant to the pest’s ability to survive and reproduce.
- 4. Determination of likelihood of spread.** This is based on a comparative assessment of biological information from the source area and the PRA area as this relates to the ability of the pest to disperse.
- 5. Assessment of consequences.** Conceivably, certain plant pests may have positive impacts. However, for the purpose of the PRA, only potential to cause harm is considered. The impacts of a potential plant pest may be described as direct or indirect and may occur in economic, environmental and social contexts.
- 6. Determination of risk.** This involves integration of the estimates for likelihood of entry, establishment and spread (Steps 2, 3 and 4) with the estimate of consequences (Step 5). The three likelihood estimates must be combined and how this is done will depend upon whether the distribution pathways indicate single or multiple categories of suitable hosts. In addition, it is important to consider the effects of trade volume. Thereafter, integration of likelihood and consequence occurs with reference to a risk estimation matrix.

The risk level indicated by the matrix is interpreted against the risk level specified for Australia’s Appropriate Level of Protection (ALOP) which is ‘very low’. If the estimated risk lies in a category above ‘very low’, the threat from the particular pest posed by the unrestricted import of the particular commodity is considered unacceptable. If the estimated risk falls into the ‘very low’ category or below it, risk is considered acceptable. This means the commodity may be recommended for import without restriction in respect of the pest concerned – i.e. risk management is not justifiable

Table 1. Nomenclature for semi-quantitative likelihoods

Likelihood	Descriptive definition	Probability (P)
High	The event would be very likely to occur	Range = 0.7 →1
Moderate	The event would occur with an even probability	Range = 0.3 →0.7
Low	The event would be unlikely to occur	Range = 0.05 →0.3
Very low	The event would be very unlikely to occur	Range = 0.001 →0.05
Extremely low	The event would be extremely unlikely to occur	Range = 10 ⁻⁶ →0.001
Negligible	The event would almost certainly not occur	Range = 0 →10 ⁻⁶

The likelihoods of entry, of establishment and of spread are **combined** using the tabular matrix shown in Table 2

The likelihood of entry P [entry] is determined by combining the likelihood that the pest will be imported into the PRA area and the likelihood that the pest will be distributed within the PRA area, using a matrix of rules (Table 2). This matrix is then used to combine the likelihoods of entry P [entry] and establishment P [establishment].

The result is then combined with the likelihood of spread P [spread] to determine the overall likelihood of entry, establishment and spread P [EES]. A working example is provided below;

P [importation] x P [distribution] = [entry] e.g. **low x moderate = low**
 P [entry] x P [establishment] = P [EE] e.g. **low x high = low**
 P [EE] x [spread] = P [EES] e.g. **low x very low = very low**

Table 2. Matrix of rules for combining descriptive likelihoods

	High	Moderate	Low	V. Low	E. Low	Negligible
High	High	Moderate	Low	V. Low	E. Low	Negligible
Moderate		Low	Low	V. Low	E. Low	Negligible
Low			V. Low	V. Low	E. Low	Negligible
Very low				E. Low	E. Low	Negligible
E. low					Negligible	Negligible
Negligible						Negligible

Assessment of consequences involves consideration of direct and indirect consequences associated with a pest, estimated at local, district, regional and national levels. The requirements for assessing potential consequences are given in Article 5.3 of the SPS Agreement (WTO 1995), ISPM 5 (FAO 2009) and ISPM 11 (FAO 2004).

Direct consequences include consideration of effect on

1. Plant life or health
2. Human life or health
3. Any other aspects of environmental effects

Indirect consequences include consideration of effect on:

4. Control, eradication etc
5. Domestic and international trade
6. Environment
7. Communities

For each of the seven above criteria, the consequences are estimated over four geographic levels, defined as

Local: an aggregate of households or enterprises (a rural community, a town or a local government area).

District: a geographically or geopolitically associated collection of aggregates (generally a recognised section of a state or territory, such as 'Far North Queensland').

Regional: a geographically or geopolitically associated collection of districts in a geographic area (generally a state or territory, although there may be exceptions with larger states such as Western Australia).

National: Australia wide (Australian mainland states and territories and Tasmania).

For our purposes, we are working on the regional (state/territory) level.

For each criterion, the magnitude of the potential consequence at each of these levels was described using four categories, defined as:

Indiscernible: pest impact unlikely to be noticeable.

Minor significance: expected to lead to a minor increase in mortality/morbidity of hosts or a minor decrease in production but not expected to threaten the economic viability of production. Expected to decrease the value of non-commercial criteria but not threaten the criterion's intrinsic value. Effects would generally be reversible

Significant: expected to threaten the economic viability of production through a moderate increase in mortality/morbidity of hosts, or a moderate decrease in production. Expected to significantly diminish or threaten the intrinsic value of non-commercial criteria. Effects may not be reversible

Major significance: expected to threaten the economic viability through a large increase in mortality/morbidity of hosts, or a large decrease in production. Expected to severely or irreversibly damage the intrinsic 'value' of non-commercial criteria.

The estimates of the magnitude of the potential consequences over the four geographic levels were translated into a combined qualitative impact score (A–G) using Table 3. For example, a consequence with a magnitude of 'significant' at the 'district' level will have a consequence impact score of D

Table 3. Assessment of local, district, regional and national consequence impact scores based on the magnitude of the consequences at four geographic scales.

		Geographic scale			
		Local	District	Region	Nation
Magnitude	Indiscernible	A	A	A	A
	Minor significance	B	C	D	E
	Significant	C	D	E	F
	Major significance	D	E	F	G

The overall consequence for each pest is achieved by combining the qualitative impact scores (A–G) for each direct and indirect consequence using a series of decision rules (Table 4). These rules are mutually exclusive, and are assessed in numerical order until one applies.

Table 4. Decision rules for determining the overall consequence rating for each pest

1	Any criterion has an impact of 'G'; or more than one criterion has an impact of 'F'; or a single criterion has an impact of 'F' and each remaining criterion an 'E'.	Extreme
2	A single criterion has an impact of 'F'; or all criteria have an impact of 'E'.	High
3	One or more criteria have an impact of 'E'; or all criteria have an impact of 'D'.	Moderate
4	One or more criteria have an impact of 'D'; or all criteria have an impact of 'C'.	Low
5	One or more criteria have an impact of 'C'; or all criteria have an impact of 'B'.	Very Low
6	One or more but not all criteria have an impact of 'B', and all remaining criteria have an impact of 'A'.	Negligible

The unrestricted risk (see note below) for each pathway is determined by combining the likelihood estimates of entry, establishment and spread with the overall consequences, using the risk estimation matrix (Table 5). The unrestricted risk is then compared with Australia's ALOP to determine the need for risk management measures. Australia's ALOP is 'very low risk'.

Table 5. Risk assessment matrix

LIKELIHOOD of Pest Entry, Establishment and Spread (EES)	High	Negligible	Very Low	Low	Moderate	High	Extreme
	Moderate	Negligible	Very Low	Low	Moderate	High	Extreme
	Low	Negligible	Negligible	Very Low	Low	Moderate	High
	Very Low	Negligible	Negligible	Negligible	Very Low	Low	Moderate
	Extremely Low	Negligible	Negligible	Negligible	Negligible	Very Low	Low
	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Very Low
		Negligible	Very Low	Low	Moderate	High	Extreme
CONSEQUENCES of Pest Entry, Establishment and Spread (EES)							

Source PRA reports:

FAO (2004) Pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms. International Standards for phytosanitary Measures No. 11. Secretariat of the International Plant Protection Convention, Food and agriculture Organization of the united Nations, Rome.

FAO (2007) Framework for pest risk analysis. International Standards for phytosanitary Measures No. 2. Secretariat of the International Plant Protection Convention, Food and agriculture Organization of the united Nations, Rome.

FAO (2008) Glossary of phytosanitary terms. International Standards for phytosanitary Measures No. 11. Secretariat of the International Plant Protection Convention, Food and agriculture Organization of the united Nations, Rome.

RISK PATHWAYS REVIEWED:

Seven pathways were identified for this rapid risk analysis, which assesses the likelihood of moving PCN between an infested component of land and linked growing blocks within the one infested parcel of land. Consequence was assessed at a geographic scale of 'local' since the risk analysis is assessing a risk within a parcel of land, within a rural community.

Pathways 1-7 are considered the most likely means of spreading the pest and pathway 7 has been included to provide an example of a high-risk pathway if no controls were in place. However, current regulatory controls prohibit the movement of seed potatoes off infested and linked land.

Pathway 1 – Natural spread (unaided movement of juveniles)

Pathway 2 – High winds

Pathway 3 – Water runoff

Pathway 4 – Wild animals

Pathway 5 – Used equipment, general vehicles

Pathway 6 – Used equipment, used in association with the cultivation, harvesting, handling, transport or processing of potatoes

Pathway 7 – Seed potatoes

Table 1 - RISK ESTIMATION for Potato Cyst Nematode (PCN) movement from an infested block to other blocks on the same land parcel
(Risk to be estimated in conjunction with above method).

No.	Risk Pathway	State	Entry (Table 1) Note 1	Establishment (Table 1) Note 1	Spread (Table 2) Note 1	Total EES (Table 2) Note 1	Consequences Magnitude (Table 3)	Consequences Geographic scale (Table 3)	Consequence (Table 3) Refer Fig 1	Consequences Overall Consequence (Table 4)	Unrestricted Risk Estimate (URE) Total EES x Consequences (Table 5)	Justification (see Appendices)
1	Natural spread (unaided movement of juveniles)	Vic	Extremely Low	High	Moderate	Extremely Low	Local: Major Significance	Local	Local: 3 A and 4 D	Local: Low	Negligible	<i>Juvenile nematodes</i> only move in soil about a maximum of 1-2 metres per year (Turner and Evans 1998, Robinson 2004) when trying to locate a host. A juvenile will not survive nearly as well as cysts without a host.
2	High winds	Vic	Very Low	High	Moderate	Very Low	Local: Major Significance	Local	Local: 3 A and 4 D	Local: Low	Negligible	<i>High winds</i> over large areas of light sandy soils can blow nematode cysts to new locations (Turner and Evans 1998). Evidence indicates a distance of around 400m is possible (Chitwood, 1951). The likelihood of cysts loose on the soil surface moving in this way is very low and would be lower than those moved by water.
3	Water runoff	Vic	Very Low	High	Moderate	Very Low	Local: Major Significance	Local	Local: 3 A and 4 D	Local: Low	Negligible	<i>Water runoff</i> from infested land can disperse cysts – distance would depend on topography, regularity and intensity of runoff. Spread of PCN by water is probably aided by their ability to float when partially dried (Potter and Olthof 1993).
4	Wild animals	Vic	Extremely Low	High	Moderate	Extremely Low	Local: Major Significance	Local	Local: 3 A and 4 D	Local: Low	Negligible	<i>Wild animals</i> moving cysts in soil on their feet by walking, or birds by flying. Longer distance would present extremely low risk as soil and cysts would be highly likely to be removed with extensive movement. Significant numbers of native animals would be generally low in most cultivated fields.
5	Used equipment, general vehicles	Vic	Moderate	High	Moderate	Low	Local: Major Significance	Local	Local: 3 A and 4 D	Local: Low	Very Low	<i>Used equipment, general vehicles</i> are likely to be driven mostly on the headlands and do not dig into the soil. General vehicles are therefore not as exposed to contaminated soil or roots with cysts attached.
6	Used equipment, used in association with the cultivation, harvesting, handling, transport or processing of potatoes	Vic	High	High	Moderate	Moderate	Local: Major Significance	Local	Local: 3 A and 4 D	Local: Low	Low	<i>Use equipment, used in association with the cultivation, harvesting, handling, transport or processing of potatoes</i> will become contaminated with soil which could contain cysts since the equipment is digging the soil and coming into contact with roots which could have cysts attached. Other equipment such as tractors also enter the production area and would be at high risk of becoming contaminated with soil containing cysts.
7	Seed potatoes	Vic	High	High	Moderate	Moderate	Local: Major Significance	Local	Local: 3 A and 4 D	Local: Low	Low	<i>Seed potatoes</i> contaminated with soil containing cysts will readily be imported to other parcels of land when planted for production of ware and processing potatoes or further seed potatoes. Since the eggs already have a host, they are most likely to establish when infested seed potatoes are grown into plants.

Table 2 RISK MANAGEMENT Potato Cyst Nematode (PCN)

No.	Risk Pathway	State	URE	Recommended risk mitigation for other blocks	Trade relevance for other blocks (Low, Medium, High)	Environmental relevance for other blocks (Low, Medium, High)	Exposure for other blocks (Low, Medium, High)	Risk mitigation for other blocks		SUMMARY
								Short term	Long term	
1	Natural spread (unaided movement of juveniles)	Vic	Negligible	Segregated infested component of the land through installation of a permanent barrier fence. Implement a solanaceous weed and self-sown potato plan to eliminate hosts.	Low	Low: no native vegetation present.	Low	PS and ICA procedures. Permit audits.	PS and ICA procedures. Permit audits.	Risk mitigation includes: <ul style="list-style-type: none"> - Segregating infested component of the parcel of land through the installation of a permanent barrier fence - Plant to pasture the infested component - Implement a solanaceous weed and self-sown potato plan - Only growing resistant cultivars on linked blocks - Sample and test negative on linked growing blocks - Operate under an approved accreditation for the management of PCN linked blocks on an infested parcel of land - Operate under an ICA-44 accreditation for interstate consignments - Permit audits
2	High winds	Vic	Negligible	Plant the infested component of land to pasture to reduce exposed soil and restrict movement of soil.	Low	Low: no native vegetation present.	Low	PS and ICA procedures. Permit audits.	PS and ICA procedures. Permit audits.	
3	Water runoff	Vic	Negligible	Where the topography of the land slopes downwards onto linked growing blocks, install a barrier to divert water away.	Medium	Low: no native vegetation present.	Low	PS and ICA procedures. Permit audits.	PS and ICA procedures. Permit audits.	
4	Wild animals	Vic	Negligible	Plant the infested component of land to pasture to reduce exposed soil and restrict movement of soil which could attach to animal's feet.	Low	Low: no native vegetation present.	Low	PS and ICA procedures. Permit audits.	PS and ICA procedures. Permit audits.	
5	Used equipment, general vehicles	Vic	Very Low	Operate as per permit conditions for the movement of machinery. Prohibit solanaceous crops including potatoes from being grown on infested blocks where a business is operating under an accreditation for the management of linked blocks on infested parcels of land. This prevents the use of equipment such as a potato harvester being used on infested blocks. Only grow resistant cultivars on linked blocks.	Medium	Low: no native vegetation present.	Low	PS and ICA procedures. Permit audits.	PS and ICA procedures. Permit audits.	
6	Used equipment, used in association with the cultivation, harvesting, handling, transport or processing of potatoes	Vic	Low	Operate as per permit conditions for the movement of machinery. Prohibit solanaceous crops including potatoes from being grown on infested blocks where a business is operating under an accreditation for the management of linked blocks on infested parcels of land. This prevents the use of equipment such as a potato harvester being used on infested blocks. Only grow resistant cultivars on linked blocks.	High	Low: no native vegetation present.	Low	PS and ICA procedures. Permit audits.	PS and ICA procedures. Permit audits.	
7	Seed potatoes	Vic	Low	Regulatory controls which prohibit the growing of potatoes intended for propagation or sale as seed potatoes.	High	Low: no native vegetation present.	High	Permit audits.	Permit audits.	