

Data Sheets on Quarantine Pests

Globodera rostochiensis* and *Globodera pallida**IDENTITY**

Taxonomic position: Nematoda: Tylenchida: Heteroderidae

Notes on taxonomy and nomenclature: In 1973, a new species of potato cyst nematode (*Heterodera pallida*) was described (Stone, 1973a). Before then, most records and technical data refer to *H. rostochiensis sensu lato*, which included both species, so it is not always possible to determine which species was referred to in earlier publications. To accommodate the potato cyst nematodes and related species having round cysts, Skarbilovich (1959) erected the subgenus *Globodera* which was later elevated to generic status by Behrens (1975) (see also Mulvey & Stone, 1976).

- ***Globodera rostochiensis***

Name: *Globodera rostochiensis* (Wollenweber) Behrens

Synonyms: *Heterodera rostochiensis* Wollenweber

Common names: Yellow potato cyst nematode, golden potato cyst nematode, golden nematode (English)
Nématode doré de la pomme de terre (French)
Kartoffelnematode (German)
Nemátodo dorado (Spanish)

Bayer computer code: HETDRO

EPPQ A2 list: No. 125

EU Annex designation: I/A2

- ***Globodera pallida***

Name: *Globodera pallida* (Stone) Behrens

Synonyms: *Heterodera pallida* Stone

Heterodera rostochiensis Wollenweber *in partim*

Common names: White potato cyst nematode, pale potato cyst nematode (English)
Nématode blanc de la pomme de terre (French)

Bayer computer code: HETDPA

EPPQ A2 list: No. 124

EU Annex designation: I/A2

HOSTS

Potatoes are by far the most important host crop. Tomatoes and aubergines are also attacked. Other *Solanum* spp. and their hybrids can also act as hosts.

Both species of *Globodera* have several different pathotypes (Kort, 1974). The pathotypes are characterized by their ability to multiply on certain tuberous *Solanum* clones and hybrids used in breeding. Five pathotypes are recognized within *G. rostochiensis* (Ro1-Ro5 international notation) and three in *G. pallida* (Pa1-Pa3) (Kort *et al.*, 1977). Some of these pathotypes are recognized by their almost total inability to multiply on specific cultivars of potato (single-gene resistance); for example, the most commonly grown resistant potato cultivars (based on gene *H1* derived from clones of *S. tuberosum* subsp. *andigena*) are resistant to pathotype Ro1 of *G. rostochiensis* only. Other pathotypes show

different levels of ability to multiply on different cultivars; the testing of this form of resistance is discussed by Mugniéry *et al.* (1989).

The internationally recognized system of classification of pathotypes refers mainly to the pathotypes present in Europe (and spread from there) and may not have relevance to South America (Kort *et al.*, 1977). It is probable that pathotypes exist there which were never transferred from the Andean region (Canto-Saenz & Mayer de Scurrah, 1978).

GEOGRAPHICAL DISTRIBUTION

The centre of origin of the two species is in the Andes Mountains in South America from where they were introduced to Europe with potatoes, probably in the mid-19th century. From there, they were spread with seed potatoes to other areas. The present distribution covers temperate zones down to sea level and in the tropics at higher altitudes. In these areas, distribution is linked with that of the potato crop.

- ***Globodera rostochiensis***

EPPO region: Albania, Algeria, Austria, Belarus, Belgium, Bulgaria, Czech Republic, Cyprus, Denmark, Egypt, Estonia, Faroe Islands, Finland, France, Germany, Greece (including Crete), Hungary (one locality only), Iceland, Ireland, Latvia, Lebanon, Libya, Lithuania, Luxembourg, Malta, Morocco, Netherlands, Norway, Poland, Portugal (including Madeira; unconfirmed in Azores), Spain (including Canary Islands), Russia (Central Russia, Eastern Siberia, Far East, Northern Russia, Southern Russia, Western Siberia), Slovakia, Sweden, Switzerland, Tunisia, UK (England, Channel Islands), Ukraine, Yugoslavia (unconfirmed). Found in Israel on only two occasions in 1954 and 1965 in a small area in the Sharon region, and was successfully eradicated.

Asia: Cyprus, India (Kerala, Tamil Nadu), Japan (Hokkaido), Lebanon, Pakistan, Philippines, Sri Lanka, Tajikistan, Russia (Eastern Siberia, Far East, Western Siberia).

Africa: Algeria, Egypt, Libya, Morocco (intercepted only), Sierra Leone, South Africa, Tunisia.

North America: Canada (Newfoundland, British Columbia Vancouver Island only), Mexico, USA (New York; eradicated in Delaware).

Central America and Caribbean: Costa Rica, Panama.

South America: Throughout the high Andean region: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Peru, Venezuela. More southerly in range than *G. pallida*.

Oceania: Australia (two outbreaks, one in Western Australia in 1986, the other in Victoria in 1991; both are subject to official eradication programmes), New Zealand, Norfolk Island.

EU: Present.

- ***Globodera pallida***

EPPO region: Algeria, Austria, Belgium, Cyprus, Faroe Islands, France, Germany, Greece (Crete only), Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal (mainland), Russia (unconfirmed in European Russia), Slovakia, Spain (including Canary Islands), Sweden, Switzerland, Tunisia, UK (England, Scotland, Channel Islands), Yugoslavia.

Asia: Cyprus, India (Himachal Pradesh, Kerala, Tamil Nadu), Pakistan.

Africa: Algeria, Tunisia, South Africa.

North America: Canada (Newfoundland).

Central America and Caribbean: Panama.

South America: Throughout the high Andean region. Argentina, Bolivia, Chile, Colombia, Ecuador, Peru, Venezuela. More northerly in range than *G. rostochiensis*.

Oceania: New Zealand.

EU: Present.

BIOLOGY

Second-stage juveniles hatch, under stimulus from host root exudates, from eggs within cysts in the soil, and invade the roots. Each individual nematode feeds on a group of cells in the pericycle, cortex or endodermis, transforming them into a syncytium or transfer cell. The nematode remains here for the rest of its development, as it passes through two more juvenile stages to become either male or female. Females swell and break through the root surface but remain attached. They are fertilized by the vermiform, actively moving males. After copulation the males die and the females remain on the roots while eggs develop within them. Females are white when they protrude from the root surface and those of *G. pallida* remain so, but those of *G. rostochiensis* later pass through a golden yellow phase lasting 4-6 weeks. When the females are fully mature they die and their skin hardens and turns brown to become a protective cover (the cyst) around the eggs within. There are, on average, 500 eggs per cyst. At this point they generally drop from the surface of the root into the soil, where the eggs can either hatch immediately to attack the crop or remain dormant to act as a source of inoculum for future crops. Cysts can remain infective for many years in the absence of solanaceous hosts (Stelter, 1971; Stone, 1973b; Jones & Jones, 1974).

DETECTION AND IDENTIFICATION

Symptoms

The symptoms of attack by *Globodera* spp. are not specific. Patches of poor growth occur generally in the crop, sometimes with yellowing, wilting or death of the foliage. Even with minor symptoms on the foliage, the size of the tubers can be reduced.

Morphology

Second-stage juveniles are vermiform and about 470 µm in length, with a strong stylet in the mouth for puncturing cell walls, and a pointed tail. Males are similar in general appearance, about 1200 µm in length, with copulatory spicules close to the tail which is short and blunt.

Females are virtually spherical with a projecting neck containing the oesophagus and associated glands; diameter approximately 450 µm. The cysts are similar in shape, but with a tanned skin and degeneration of the internal organs (Golden & Ellington, 1972; Stone, 1973a; 1973b).

Detection and inspection methods

The symptoms described for *Globodera* spp. can have many other causes and cannot be taken as proof of presence of nematodes. For positive detection it is necessary to find cysts in soil samples or females or cysts on host roots. Mature females and cysts are just visible to the naked eye and can be seen as minute white or yellow globes on the root surface. Specific identification is just possible by observation of the female colour at the appropriate stage of development, either a change from white to yellow in *G. rostochiensis* or prolonged white (slightly cream but no yellow phase) in *G. pallida*. Several methods are available for extracting juveniles or larvae from the soil (Southey, 1986; OEPP/EPPO, 1991), and thereafter specialist microscopical examination of juveniles, females or cysts is necessary for precise identification. The species can also be distinguished by morphological characters and measurements of 2nd-stage juveniles and cysts. The use of biochemical techniques such as DNA probes is being investigated as morphological identification can be difficult.

MEANS OF MOVEMENT AND DISPERSAL

These nematodes have no natural means of dispersal, and can only move the short distances travelled by juveniles attracted towards roots in the soil. They are spread into new areas as cysts on, in order of importance, seed potatoes, nursery stock, soil, flower bulbs, potatoes for consumption or processing. The last named are only important if there is a risk of their being planted or if care is not taken with disposal of waste soil.

PEST SIGNIFICANCE

Economic impact

Potato cyst nematodes are major pests of the potato crop in cool-temperate areas. This is particularly the case when, because of the pathotypes present, no resistant cultivars are available for planting. This situation is, at present, more serious in the case of *G. pallida* because of the lack of commercially available potato cultivars having resistance to this species. The amount of damage, particularly in relation to the weight of tubers produced, is closely related to the number of nematode eggs per unit of soil. It has been estimated that approximately 2 t/ha of potatoes are lost for every 20 eggs/g soil (Brown, 1969). Up to 80% of the crop can be lost when nematode populations are raised to very high levels by repeated cultivation of potatoes.

Control

Control is traditionally by crop rotation, as it is recognized that several years in the absence of potato cultivation will reduce the population of nematodes to a significant degree; 7 years without potatoes is a common recommendation. More recently, crop rotation has been supplemented by use of resistant potato cultivars and nematicides (fumigants or granular systemic compounds). An integration of these methods can be used to keep the nematode population levels below economic thresholds. Control on tomatoes is chiefly by soil fumigants.

Phytosanitary risk

Both species of potato cyst nematode are A2 quarantine pests for EPPO (OEPP/EPPO, 1978; 1981). They are also of quarantine significance for APPPC and NAPPO. In addition, *G. rostochiensis* is a quarantine pest for CPPC and IAPSC.

The nematodes are already established in most or all areas in the EPPO region that are important for the cultivation of potatoes for consumption or the production of starch; therefore, regular attention to control is needed in such areas. Where domestic legislative measures are in force, import regulations are justified to ensure comparable standards for imported material. It is essential that areas of seed potato production be kept as free as possible from these nematodes.

G. pallida is generally less common than *G. rostochiensis* in most of the EPPO region (with the exception of the southern part of the UK) and is absent from some countries; it therefore merits greater attention from the phytosanitary standpoint.

At some time in the future, it may be worthwhile to consider the individual pathotypes as being the quarantine organisms, rather than the two species themselves. It is obvious that some pathotypes are very widely distributed, and furthermore some are more important economically than others. Unfortunately, information is still limited on the precise distribution of the pathotypes.

PHYTOSANITARY MEASURES

Measures to prevent the introduction of the nematodes to areas where they are not already established include soil sampling surveys and regulations concerning movement of

seed potatoes, nursery stock, flower bulbs and soil. These apply nationally as well as internationally (CEC, 1969). Consignments of potato tubers, rooted plants and bulbs from countries where the nematodes occur may be examined to check amounts of adhering soil, if any, or to take samples of soil for laboratory examination. Additional safeguards during transit of consignments could be washing of tubers and flower bulbs to remove soil, although it should be noted that cysts can remain embedded in tubers, especially in the eyes. Alternatively, tubers may be dipped in dilute sodium hypochlorite solution (Wood & Foot, 1975).

The EPPO specific quarantine requirements (OEPP/EPPO, 1990) for these nematodes require that the field in which seed potatoes or rooted plants being imported were grown was inspected by taking soil samples according to an EPPO-recommended method (OEPP/EPPO, 1991) and found free from viable cysts of both species. The sampling must have been performed after harvest and after removal of the previous potato crop.

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