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| | **FACTSHEETS OF PESTS OF PHYTOSANITARY SIGNIFICANCE TO KENYA** | **23** |

# *Globodera rostochiensis* and *Globodera pallida* **(Potato Cyst Nematode)**

## 1. Identity

Potato Cyst Nematode (PCN) exists as two main species, *Globodera rostochiensis* and *Globodera pallida*. So far, only *G. rostochiensis* has been reported as a pest of potato in Kenya (Mwangi *et al*., 2015).

**Preferred Scientific Name:**

- *Globodera rostochiensis* (Wollenweber, 1923) Behrens, 1975

**Preferred Common Name**;

- Yellow potato cyst nematode

**Other Scientific Names;**

- *Globodera rostochiensis* (Wollenweber, 1923) Mulvey& Stone, 1976,
- *Heterodera (Globodera) rostochiensis* Wollenweber, 1923 (Skarbilovich, 1959),
- *Heterodera rostochiensis* Wollenweber, 1923,
- *Heterodera schachtii rostochiensis* Wollenweber, 1923,
- *Heterodera schachtii solani* Zimmerman, 1927

**Figure 1:**Creamy white immature and dark brown mature potato cyst nematode cysts adhering to a potato root.(Photo credit; department of Agriculture and Food Western Australia)

**Preferred Scientific Name;** *Globodera pallida* (Stone, 1973) Behrens, 1975

**Preferred Common Name;** White potato cyst nematode

**Other Scientific Names;** *Heterodera pallida* Stone, 1973

**Taxonomic Tree: Domain**: Eukaryota **Kingdom**: Metazoa **Phylum**: Nematoda **Order**: Tylenchida **Family**: Heteroderidae **Genus**: Globodera

## 2. Host

Potato is the most common host for both *Globodera rostochiensis and Globodera pallida.* Other hosts include tomato, eggplant, thorn apple (datura) and black night shade (FERA 2009 and CABI, 2016).

## 3. Growth Stages affected

Pre-emergence, seedling stage and vegetative growing stage

## 4. Biology and Ecology

Potato cyst nematodes have the following key developmental stages: eggs, juveniles (larvae/young ones), adults and cysts (Figure 2). The female PCN is the one that is transformed into a cyst as it dies. The cyst, which is a survival structure, can contain upto 450 eggs. A curled-up immobile nematode, referred to as the first-stage juvenile (J1), develops inside a fertilized egg. Upon hatching, the egg releases young/immature mobile nematodes referred to as the second-stage juveniles (J2). The hatching is stimulated by chemicals (exudates) leaking from the roots of a host plant (e.g. potato). The juvenile nematodes then enter hair roots by puncturing the cells near the growing tip and continue feeding on the plant sap (Golinowski *et al.*, 1997).

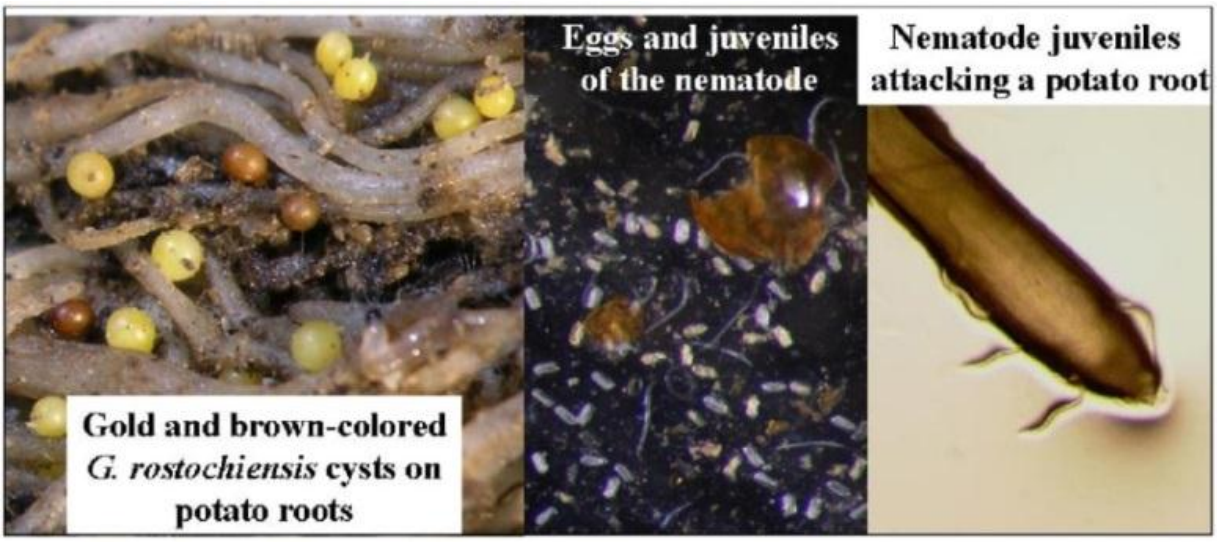


**Figure 2:** Different developmental stages of Potato Cyst Nematodes (Photo credit; Nematology: USDA ARS)

Female nematodes which establish feeding sites on the roots become immobile and progressively grow bigger, bursting open the outer root tissue. Slender, male nematodes exit the roots and mate with females which, by then, only have their heads embedded in the root with the rest of their bodies exposed. After fertilization, eggs develop inside the females. With time, the females die and become white cysts, which can be found on the surface of the roots; this is normally around the time the potato crop flowers (Golinowski *et al.*, 1997). When potato plants are uprooted, the mature cysts drop off and stay dormant in the soil until the next crop is planted or until volunteer potato plants start growing. In general, only a single life cycle, which can take 38-48 days, occurs on each growing potato crop.

*G. pallida* hatches at soil temperatures of around 10°C or less and is adapted to develop at cool temperatures between 10 and 18°C, whereas *G. rostochiensis* seems to be adapted to a temperature range of 15 to 25°C (Franco, 1979). Day length also influences egg hatching, which is faster where the host has continuous light rather than prolonged hours of darkness (Hominick, 1986).

## 4. Symptoms and signs

Infested plants appear stunted and may wilt; leaves become yellow or display a dull colour (Figure 3). As a result of the disruption of root cells, an infested potato plant has a reduced root system, which is abnormally branched and brownish in colour. The affected roots have a decreased capacity for water uptake, with the possibility of eventual plant death. However, many other causes can lead to these symptoms. Therefore, plants should be uprooted for a visual check for the presence of cysts and young females on the roots.

**Figure 3;** PCN infested potato field in Scotland, UK (Reference: M. Phillips, Scottish Crop Research Institute, Scotland, UK)

## 6. Means of dispersal and spread

The main routes of spread are infested seed potatoes and movement of soil from infested land to other areas. Cysts and other stages can be carried in soil attached to the seed tubers, farm machinery, tools, boots, bins and plants or through runoff water or by wind. Infested cysts are easily carried within and between farms through soils sticking on tools and footwear.

In heavily infested crops, PCN cysts can develop on the potato tubers themselves. Once introduced into an area, PCN can survive for long periods (up to 30 years) in form of cysts, even in the absence of a host plant.

## 7. Movement in trade

*G. pallida* and *G. rostochiensis*can be carried by different plant part during trade/transport which includes (CABI, 2016):-

- Bulbs/Tubers/Corms/Rhizomes in form of juveniles and adults borne either internally or externally and is visible under light microscope.
- Roots in form of juveniles and adults borne either internally or externally.
- Stems (above Ground)/Shoots/Trunks/Branches in form of juveniles and adults borne either internally or externally and is visible under light microscope.

The pest can also be transported for long distances through:-

- Non-host plant material in form of cysts as contamination
- Containers and packing in form of cysts as contamination
- Soil, gravel, water, etc. In form of cysts in water and dust storm

## 8. Impact

PCN causes extensive damage, particularly in temperate areas when virulent pathotypes occur and any resistance has failed. The situation is worse with *G. pallida*, where commercial cultivars with good resistance are still few and often have undesirable characteristics. The damage is more severe when susceptible crops are planted in monoculture without rotation. Damage is related to the number of viable eggs per unit of soil, and is reflected in the weight of tubers produced (Elston *et al.,* 1991; Phillips *et al.,* 1991).

Damage to potato crops varies from small patches of poor growing plants to complete crop failure. Diseased plants first occur in isolated patches and these become larger with each subsequent crop if potatoes are continually grown on the infested land. In light infestations, potato plants may show no above ground symptoms, but yield can be decreased. Light infestations can reduce tuber size, whereas heavy infestations reduce both number and size of tubers. If left uncontrolled infestations by PCN can reduce yields by up to 80% (Vasyutin and Yakoleva, 1998), causing serious debilitation of potato production and high costs of management.

PCN infected plants are also much more susceptible to diseases such as bacterial wilt. PCN reduce the sugar content and quality of the tubers, leading to darker flesh, a lower fry rating and shorter shelf life.

## 8. Inspection and detection

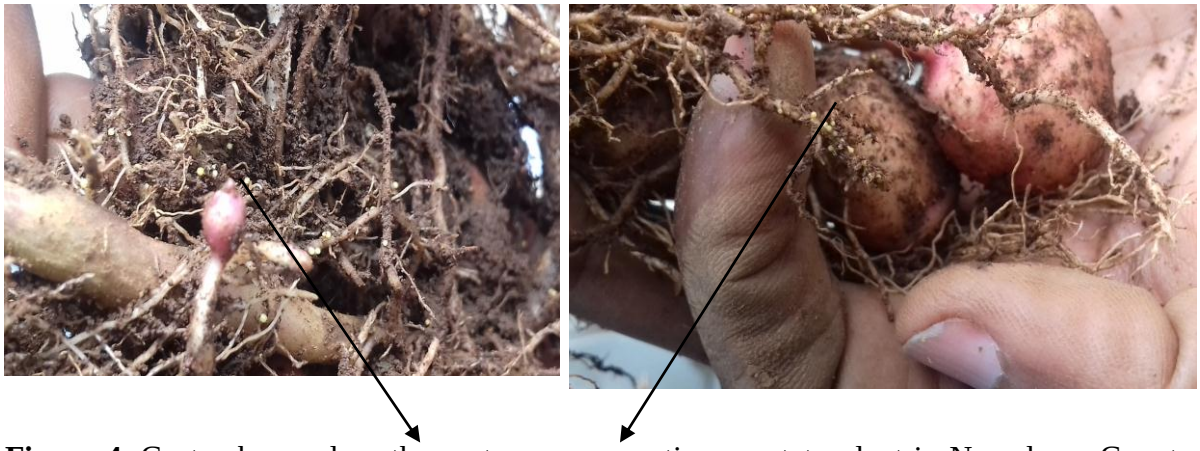

**Figure 4.** Cysts observed on the roots upon uprooting a potato plant in Nyandarua County. (Photo credit: E.Ringera and M Mwangangi-KEPHIS)

When a potato crop is in the field, plants can be lifted (uprooted) and examined for signs of adult female nematodes or cysts that form as females die. Minute spheres, approximately the size of a pin head (0.5mm), can be seen on the surface of roots. The female nematodes or cysts are easily observable when a potato plant is at an advanced stage of growth (for instance from flowering onwards). In the absence of a crop in the field, this approach is not applicable. Therefore, soil sampling and subsequent analysis is more commonly recommended, particularly for statutory decisions such as seed certification.

Detection can be based on host plant symptoms and identification by morphological and molecular methods are detailed in OEPP/EPPO (2009).

## 9. Phytosanitary Significance

Potato cyst nematodes are A2 quarantine pests for the European Plant Protection Organisation (EPPO) (OEPP/ EPPO, 1978, 1981). They are also of quarantine significance for Asia, Pacific Plant Protection Commission (APPPC) and North American Plant Protection Organization (NAPPO).

Potato cyst nematode (PCN) is also a quarantine pest in Kenya. This means all imported and locally produced seed is tested for PCN in KEPHIS (PQBS) for seed certification. Since *Globodera rostochiensis* was recently reported in Kenya, its distribution is being determined and surveillance undertaken to determine pest free areas. Reports indicate that cysts containing eggs can remain viable in the soil for up to 30 years; hence the pest poses a serious pest management challenge. Major efforts should be geared towards locking PCN out of non-infested areas.

## 10. Management

An integrated pest management package for the control of the PCN includes the following management strategies;

### Cultural Practices

- Use of high quality certified seed from registered seed merchants. Plant the high quality seeds in clean (disease/pest free) fields.
- Practice crop rotation with non-solanaceae crops since these are not hosts to PCN for a period of at least 7 years. Such crops include maize, beans, cabbages, carrots, wheat, onions and peas. During this period uproot volunteer crops from the solanaceae family including potatoes, tomatoes, black nightshade and eggplants as these are hosts to PCN (CABI 2015 & 2016).
- Avoid movement of infested soil from affected areas through farm tools and foot wear. Clean and disinfect tools using 40% Kerol. Rogue affected plants and destroy by burning

or burying in deep pits. This is an important management strategy since it reduces population levels of the pest on the farm.

- Do not to leave the uprooted plant materials on the farm since this contributes to pest build up which can be carried over from one season to another through infested plant residues and soils.
- Control surface runoff water and direct it away from fields as this could spread PCN from infested to non-infested areas.

**Soil Solarization**

Plough fields to a fine tilth to expose infested soils to the sun during the hot months. This desiccates the juvenile nematodes that may be in the soil hence lowering PCN levels (Plantwise, 2015 and 2016). Ploughed fields may be covered by polythene sheets to enhance temperature build up based on affordability since this could greatly inflate the cost of production.

**Bio-fumigation**

Crops in the brassica family including kale, cabbage, canola, can be ploughed into soil decompose and produce chemical substances that are able to destroy soil borne pests including PCN.

**Trap Cropping**

Plants from the solanaceae family including potato, eggplant, tomato and black night shade are host plants of PCN (CABI 2016). These crops may be planted as trap crops to trigger hatching of eggs from cysts and development into juveniles. In this case sufficient crop growth time is allowed for the juvenile nematodes to penetrate the roots and develop into young adults (5-6 weeks), but not enough time for them to form new eggs. The crop is then destroyed through uprooting and burning or burying in deep pits.

**Chemical Control**

Bio-pesticides are environmentally safe products and are available in the Kenyan market. These products include Neemraj Super, Neemark, Ozoneem and Nimbecidine (PCPB, 2016). These products should be drenched into the soil at 2-4 weeks after germination, since at this time eggs have hatched into juveniles, hence are killed.

**References**


CAB International (2016). Crop Protection Compendium, 2006 Edition. Wallingford, UK on www.cabi.org, Accessed 4th November 2016

CAB International (2015). Crop Protection Compendium, 2006 Edition. Wallingford, UK www.cabi.org, Accessed on 1st November 2016

Elston DA, Phillips MS, Trudgill DL, (1991. The relationship between initial population density of potato cyst nematode Globodera pallida and the yield of partially resistant potatoes. Revue de Ne^acute~matologie, 14(2):221-229; 14 ref

Golinowski W, Sobczak M, Kurek W, Grymaszewska, (1997). The structure of Syncytia. In: Fenoll C, Grundler FMW, Ohl SA, eds. Cellular and Molecular Aspects of Plant Nematode Interactions. Dordhecht, Netherlands: Kluwer Academic Publishers, 80-97

Hominick W.M, (1986). Photoperiod and diapause in the potato cyst-nematode Globodera rostochiensis. Nematologica, 32:408-418

J.M. Mwangi, G.M. Kariuki, J.W. Waceke and F.M. Grundle,(2015).First report of Globoderarostochiensisinfesting potatoes in Kenya ,New Disease Reports31, 18

OEPP/EPPO, (1978). Data sheet on quarantine organism's no. 124: Globodera pallida. Bulletin OEPP/EPPO Bulletin 8 (2)

OEPP/EPPO, (1981). Data sheet on quarantine organism's no. 125: Globoderarostochiensis. Bulletin OEPP/EPPO Bulletin 11 (1)

PCPB,(2016). Registered pesticide Products used to control nematodes on potato http://www.pcpb.or.ke/cropproductsviewform.php

Phillips MS, Hackett CA, Trudgill DL, (1991). The relationship between the initial and final population densities of the potato cyst nematode Globodera pallida for partially resistant potatoes. Journal of Applied Ecology, 28(1):109-119; 20 ref

Plantwise,(2016).Potato cyst nematode datasheethttp://www.plantwise.org/knowledgebank/datasheet.aspx?dsid=27033,Acces on 2nd November 2016

Vasyutin AS, Yakovleva VA, (1998). Globodera in potatoes in Russia. Kartofel' i Ovoshchi, No. 6:29, 32