IDENTIFICATION SHEET

RADOPHOLUS SIMILIS, MELOIDOGYNE SPP.

Nematodes

JUNE 2021

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IDENTITY

Latin name	*Radopholus similis*	*Meloidogyne* spp.
Common name	Banana root nematode or burrowing nematode	Root-knot nematodes
Taxonomic classification	*Animalia*: *Tylenchida*: *Pratylenchidae*: *Radopholus similis*	*Animalia*: *Panagrolaimida*: *Meloidogynidae*: *Meloidogyne* spp.

MORPHOLOGY

- Round microscopic worms.
- Size: average length 0.4mm to 0.8mm.
- Non-segmented body covered in a thick cuticle (protective skin).
- Rigid, thick, elastic and impermeable cuticle: exoskeleton.
- The rings around the cuticle vary depending on the type of nematode.
- A hollow, protrusible stylet which is used to pierce and cross cell walls when feeding or moving through plant tissue.
- Nematodes usually have a full digestive tract.

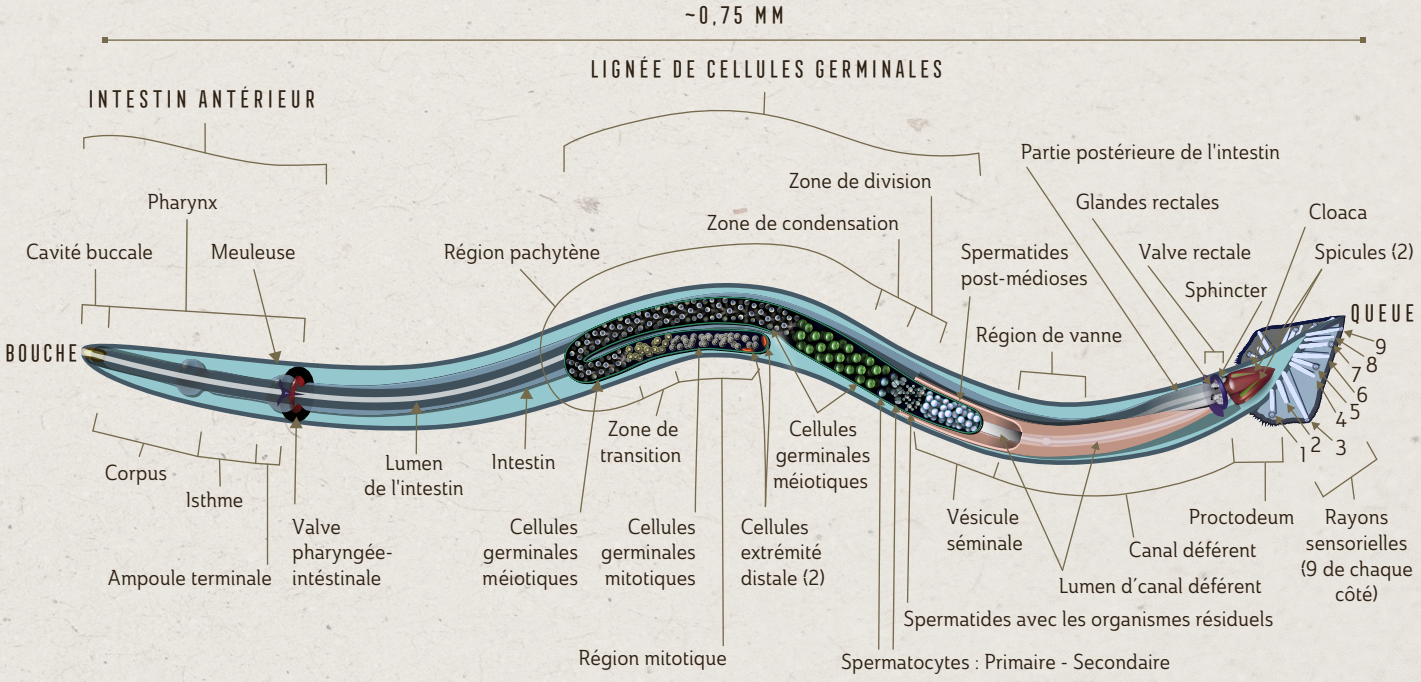

Figure 1 - Morphology of nematodes

DEVELOPMENT CYCLE

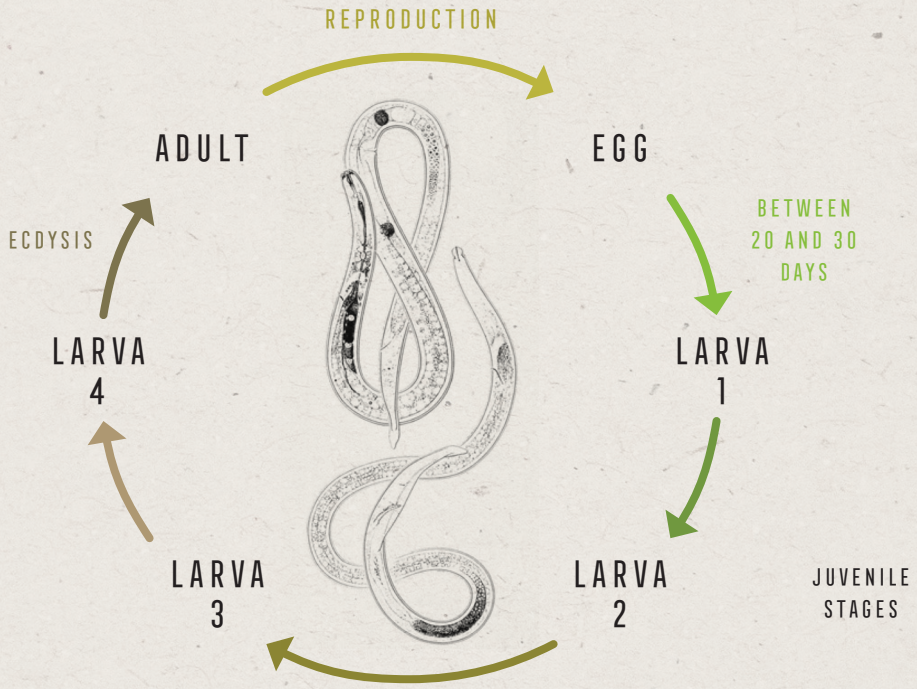

Figure 2 - Nematode life cycle

- Nematodes have a very complex reproduction method.
- Nematodes' development cycle is usually divided into six stages:
  The egg stage, four juvenile stages and the adult stage.
- Life cycle in two phases:
  - An exophytic phase in the soil: from egg-laying until the juveniles penetrate plant roots.
  - An endophytic phase to create a feeding site in the root:
    Enables the creation, development and reproduction of the nematode.
- Eggs:
  - Made up of a double-loop shell.
  - Egg-laying: begins once the female is inside the host.
  - Average fertility: around two eggs per day.
  - Maximum fertility: 300 to 1,000 eggs/cycle.
  - Several cycles possible per year.
  - Bisexual reproduction, but with parthenogenetic ability.
  - Hatching: 3 to 7 days.
- Juvenile stages (larval stages): L4
  - Larvae broadly similar to adult nematodes, apart from the reproductive system.
  - The growth of the larvae leads to an ecdysis at the end of each larval stage.
  - Larval stage L1: develops inside the egg.
  - Series of juvenile stages (L2, L3, L4 larvae) leading to the formation of an immature adult.
  - The L3 larvae is the infectious form.
  - Mature adult following ecdysis.

Figure 3 - Nematode eggs

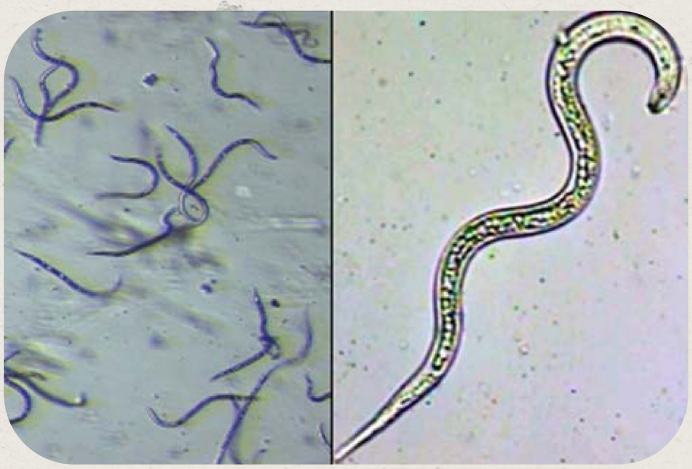

Figure 4 - Nematode larvae

- Adult:
  - Males

Radopholus similis

- Very evident sexual dimorphism.
- Highly developed cephalic hood.
- Thin labial discs.
- Curtailed stylet.
- Reduced oesophagus.
- Probably unable to feed.

***Meloidogyne* spp.**

- Mobile and generally rare.
- Filiform.
- Length: 1 to 3µm
- Rounded head.
- Short and powerful stylet with very evident basal bulging.

  - Females

Radopholus similis

- Large stylet with strong basal knobs.
- Thick labial discs.

***Meloidogyne* spp.**

- Distinctive neck.
- Soft body.
- Off-white, pyriform.
- Size: Around 0.5mm in diameter and 0.8mm in length.
- Sedentary and attached to the host's root system.

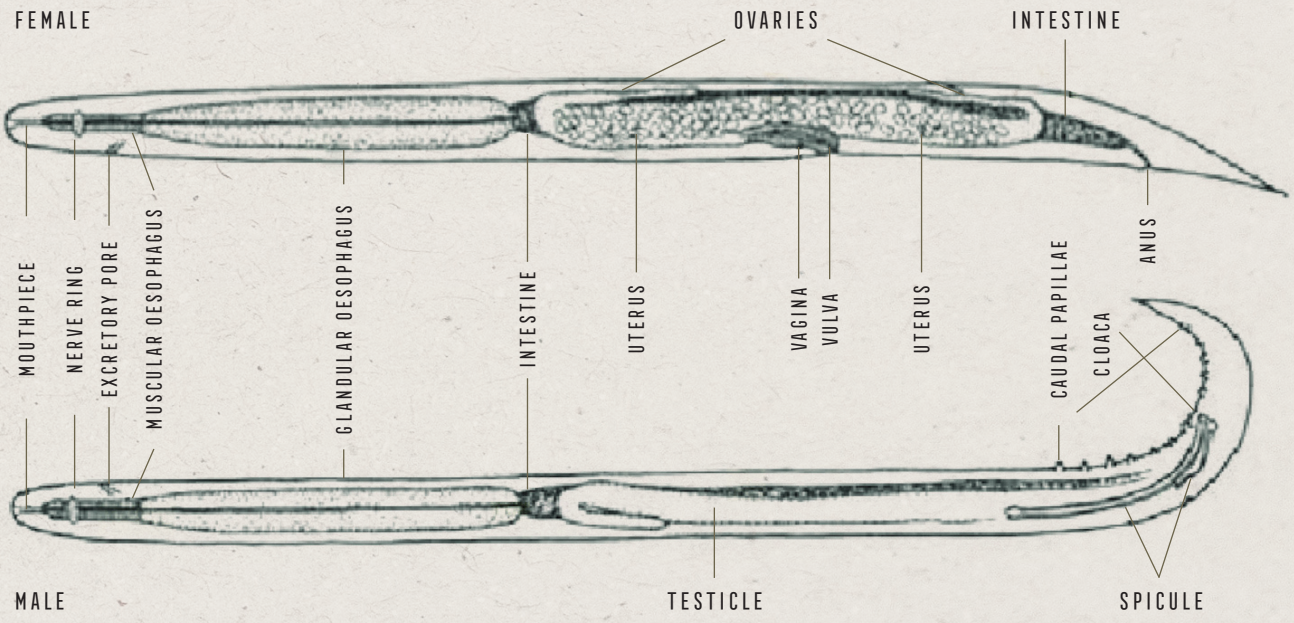

Figure 5 - Organs of male and female nematodes

HABITAT AND CONDITIONS CONDUCIVE TO ITS DEVELOPMENT

The following crop, soil (edaphic) and climatic conditions in the Penja region are conducive to the development of nematodes:

- Crop combinations: pepper crops combined with or near to other nematode host plants (banana tree, plantain tree, maize, etc.).
- Soil texture: sandy soils are easier for nematodes to move through and allow males and females to encounter each other more easily, enabling reproduction and a rapid increase in population sizes.
- Soil humidity: a film of water is essential for the larvae or adults to move through the soil or the attacked organs with undulating movements.
- Temperatures: higher temperatures and wet conditions are conducive to the development of nematodes. Symptoms often appear during the dry season.

SYMPTOMS AND DAMAGE

Figure 6 - Roots infested by *Meloidogyne*: formation of galls

Figure 7 - Destruction of roots by *Radopholus similis*

These two nematodes (*Radopholus similis, Meloidogyne* spp.) attack the roots of the plant, leading to:

- A reduction in the plant's ability to absorb minerals.
- The above-ground part is undersized.
- Delayed growth.
- Yellowing of leaves (fewer and smaller leaves).
- Reduction in flowering and fruiting.
- Slow decline (withering).
- Penetration of fungi into the roots.

Radopholus similis

- Dig into and penetrate living roots of pepper plants and support trees at all development stages.
- Live and reproduce in root tissue.
- Cause damage and necrosis.
- Gradual dieback of roots.

***Meloidogyne* spp.**

- Appearance of bulges (galls or cysts) on infested pepper plants or support trees.
- General deficiency resulting from the reduced ability of the root system to absorb and assimilate.
- Sedentary endoparasites which can cause considerable falls in yield.

MONITORING STRATEGY

Careful inspection must be carried out regularly on the farm. This enables you to identify individual plants or clusters of plants with gradually yellowing leaves, a loss of vigour, delayed growth (stunted growth) or even dying plants.

If one of these symptoms appears, the roots should be inspected to detect damage caused by nematodes: lesions and necroses *(Radopholus simili),* or characteristic bulging caused by cysts/galls (*Meloidogyne* spp.*).*

Swift detection of the presence of nematodes enables pepper plant producers to take timely decisions to reduce the level of infestation throughout the orchard.

▶ ***Penja pepper producers are advised to carry out this inspection using an observation and monitoring sheet provided in the appendix.***

GOOD FARMING PRACTICES TO COMBAT PROBLEM

- **Crop control:** to reduce nematode attacks in pepper plant orchards, producers should follow this advice:
  - Do not combine pepper crops with banana trees or maize.
  - Do not plant pepper crops near other nematode host plants.
  - Ensure the farm is suitably maintained (good plant nutrition, combating fungal diseases and other agents in the soil).
- **Organic control:** using natural predators against nematodes is not practical for Penja pepper producers due to the complexity involved and the difficulty in implementing such an approach.

  However, the following biological agents are recognised as being able to reduce the impact of nematodes on crops:
  - Predatory fungi, including ovicidal fungi (which kill eggs).
  - Sticky spore fungi; endomycorrhizae (living in symbiosis with the roots).
  - Natural enemy bacteria.

- **Control using plant protection products:** chemical treatment is the most common method used to combat nematodes. It is advisable to carry out this granulated nematicidal treatment on damp soil in April or May. It should be noted that no product is currently approved to combat nematodes on pepper plants (List of pesticides approved in Cameroon consulted on 4 March 2021). However, there are some commercially-available nematicidal solutions authorised for banana trees (see table below) that could be used on Penja pepper plants subject to prior authorisation from the competent authorities.

Solutions	Method of use	Status as per Regulation (EC) No 1107/2009	Crop-pest combination for which the active substance is approved in Cameroon	EU MRL for pepper
Ethoprophos 150g/kg	20g of cp/pruned plant	**Ethoprophos:** Not approved	Nematodes (*Radophulus similis*) on banana trees	**Ethoprophos:** 0.02*
Fosthiazate 100g/kg	20g cp/banana tree	**Fosthiazate:** Approved	Nematodes on banana trees	**Fosthiazate:** 0.05*
Terbufos 100g/kg	30g cp/banana tree	**Terbufos:** Not approved	Nematodes on banana trees	**Terbufos:** 0.01*
Fosthiazate 10%	15g cp/root	**Fosthiazate:** Approved	Nematodes on banana trees	**Fosthiazate:** 0.05*

(*) cp: Commercial product
(*) Indicates the lower limit of the analytical determination

APPENDIX: OBSERVATION AND MONITORING SHEET

Campaign: .....

Date: .....

Plot code: .....

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Vegetative stage: .....

Date of last treatment: .....

Product(s) used: .....

Observations: .....

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INFESTATION LEVEL

Nematodes: .....

Comments: .....

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Sources: Figure 1 - Nematoda Wikipédia.fr.wikipedia.org ¦ Figure 2 - Processus écologiques - Biologie / Physiologie supagro.fr ¦ Figure 3 - Parasitologie Médicale ikm2014.lescigales.org ¦ Figure 4 - Gestion des nématodes à Galles: Lutte Conventionnelle et Luttes Alternatives. L'Atout des Plantes Pièges. supagro.fr ¦ Figure 5 - Morphologie d'un nématode mâle et femelle (Moravec, 1994). researchgate.net ¦ Figure 6 - Nématodes à galles: biologie, systématique, cycle et dégâts bio-enligne.com ¦ Figure 7 - Survie et dissémination du nématode *Radopholus similis* (Cobb) Thorne dans les sols bruns-rouilles à halloysites (nitisols): agritrop.cirad.fr

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