



Major Plant Parasitic Nematodes and Their Symptoms

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Nematodes are roundworms that resembles like a thread and can live in soil as well as fresh and salt water. There are several nematode species that parasitize plants, fungi, bacteria, protozoans, and other nematodes. Insects, humans, and other animals can also be parasitized by them. Plant parasitic nematodes (PPN), which feed on plant parts, are prevalent in agricultural soils. A nematode can overwinter at any stage of its life cycle eggs, juveniles, and adults. The environment, initial nematode populations at planting, the pathogenicity of the nematode species, and the plant's tolerance for nematode feeding all contribute to crop damage. Majority of PPNs feeds by stylet resembling like needle. They pierce and kill root cells. Lesion, lance, needle, sting, stunt, and sting are such nematodes that feeds in this way. The root knot nematode (RKN) and the cyst nematode, two of the most destructive nematodes in the economy, enter roots and establish permanent feeding sites where they complete their life cycles without harming the surrounding cells. Nematode infection has symptoms that are similar to those caused by impaired root function and growth, so they may look like abiotic stress like drought and nutritional deficiencies or biotic stress like stem and root rots. General symptoms of nematodes are incorporate yellowing, hindering, withering and yield decline. Infections can go unnoticed until populations have reached economic thresholds, and above-ground symptoms are not always obvious. Root galling is caused by the RKN, but the degree of galling may be affected by how the plant and the RKN species interact.

Economic Importance of Major Plant Parasitic Nematodes

The significance of nematodes in world agriculture and horticulture can be decided by climate or not their harm is disastrous to significant harvests. The following are some important ones:

- Nematology is a relatively new field of study in comparison to its more established counterparts, Entomology and Plant Pathology. Therefore, despite the significant role that nematodes play in agriculture.
- Nematodes are found in every ecological niche that is moist to watery, including cold oceans, hot springs, mountain peaks, soil ecosystems, plants, and animals. About 15% of all nematode species that can be found in a variety of habitats and engage in a variety of feeding strategies are Phyto-parasitic.
- Phyto-nematodes parasitize all kinds of plants, from lower thallophytes (algae) to highly developed angiosperms (all plants and trees) and cause billions of dollars' worth of damage to food crops, tree crops, turf, and ornamentals around the world.

- Phyto-parasitic nematodes are found in 197 genera and have approximately 6000 known species. Since they are obligate parasites, they must eat their hosts' plants and weaken them in the process. Hundreds of plant parasitic nematodes from at least four genera can be found in a handful of soil collected around a plant's roots.

Major plant parasitic nematodes

1. *Meloidogyne* (Root-knot nematodes):

Major species: *M. incognita*, *M. javanica*, *M. arenaria*, *M. hapla*, *M. chitwoodi*. Female parasitize in root tissue, globose, 0.5-0.8 mm in measurement with thin neck and male vermiform with a length of 1-2mm and a free life in soil. Vermiform juveniles about 450um long. A large portion of the females are inside the roots. distribution across the globe.

2. *Heterodera* (Cyst nematodes):

Major species: *H. avenae*, *H. schachtii*, *H. glycines*, *H. trifolii*, *H. gottingiana*, *H. cajani*, and *H. zaeae*. Females are enlarged or stout, lemon shaped, 300-600um in width with an unmistakable neck. After dying, the female cuticle forms a protective cyst, and several hundred eggs are produced by the female. Eggs that are still inside the cyst. Cysts are partially enclosed in the soil or root tissue. It is known as a "cyst stage" because the adult female is extremely swollen and filled with eggs. Soil-dwelling male vermiform, also known as a worm. Vermiform juveniles are 450-600 um long. The genus is found all over the world, but there are no specific species.

3. *Globodera* (Golden nematodes):

Major species: *G. rostochiensis*, *G. pallida*, *G. tabacum*. Resembles like *Heterodera* however, the gall is globuse. Species restricted to cooler regions.

4. *Anguina* (Seed gall nematodes):

Major species: *A. tritici*, *A. agropyri*, *A. spermophaga*, *A. balsamphila*, *A. agrostis*, *Afrina/Anguina wevelli*. Typical gall forming endoparasites of seeds, stems and leaves of cereals, grasses and other plants. Adult stages are found only in plant galls, juveniles are found in galls, plant tissues or soil. As the galls matures and dies, the infective juveniles can survive many years in a quiescent state.

5. *Ditylenchus* (Stem and bulb nematode):

Major species: *D. destructor*, *D. dipsaci*, *D. angustus*. Potato rot nematode (*D. destructor*) is one of the most important nematodes. Slender vermiform nematodes. Ectoparasites of plant stems, leaves and within the tissues.

6. *Pratylenchus* (Lesion nematodes):

Major species: *P. penetrans*, *P. brachyurus*, *P. coffeae*, *P. zaeae*, *P. goodeyi*, *P. thornei*, *P. vulnus*. A significant class of ectoparasites and endoparasites of roots that migrate. They are tiny nematodes, measuring less than 1 mm in length.

7. *Radopholus* (Burrowing nematodes):

Major species: *R. similis* with two host races that differ in parasitism of citrus. It is a significant group of endo-parasitic nematodes of plant roots and tubers that are less than 1 millimeter long.

8. *Hirschmanniella* (Root nematodes):

Major species: *H. oryzae*, *H. mucronata*, *H. spinicauda*. *H. oryzae* is a major pest of rice in several countries. Medium size to long, slender migratory endoparasites, many on roots (1-4 mm).

9. *Hoplolaimus* (Lance nematodes):

Major species: *H. columbus*, *H. seinhorsti*, *H. indicus*. It is an important group of basically migratory ectoparasites which feed on roots of many kinds of fruits and other economic plants world-wide. Medium length (1-2mm).

10. *Rotylenchulus* (Reniform nematodes):

Major species: *R. reniformis* which found in both tropical and warm temperate soils. Immature females establish permanent feeding sites in roots, become semi-swollen, and protrude from roots. They are 0.23-0.64 mm long and have a kidney shaped body. Males are vermiform. Eggs are laid in gelatinous matrix.

11. *Tylenchulus* (Citrus nematode):

Major species: *T. semipenetrans*, which is found everywhere in citrus growing areas. It has vermiform, immature females that live in the soil. The mature female's posterior, slender portion protrudes from the roots and is swollen, while the anterior portion is embedded in root tissues. Vermiform and slender, both males and juveniles.

12. *Helicotylenchus* (Spiral nematodes):

Major species: *H. multicinctus*, *H. mucronatus*, *H. dihystra*, *H. pseudorobustus*. The most damaging species is *H. multicinctus*. Small to medium sized nematodes (0.4-1.2mm), usually in spiral shape. Ectoparasitic, semi-endoparasitic or endo-parasitic nematodes of roots.

13. *Criconebella* (Ring nematodes):

Major species: *C. xenoplax*, *C. axestis*, *C. sphaerocephalum*. Migratory ectoparasites. Females are 0.2-1mm long, stout with prominent retrorse annules. Males are slender and short; juveniles are like females with annules.

14. *Xiphinema*, *Longidorus*, *Trichodorus* and *Paratrichodorus* (Dagger, needle and stubby root nematodes):

Major species: *X. americanum*, *X. elongatum*, *X. index*, *L. africanus*, *T. obtusus*, *P. minor*. Slender, virus transmitting nematodes 0.8-5mm long. Ectoparasites on roots of Perennial and woody plants. World-wide distribution.

15. *Aphelenchus* (Bud, Leaf, and Pine Wood Nematodes): These are found all over the world. Strawberry plants are the prey of *A. fragariae* and *A. besseyi*, which also harm rice. Necrose develops on the leaves of chrysanthemums and other ornamentals caused by *A. ritzemabosi*.

16. Pine wood nematode (*Bursaphelenchus xylophilus*) has been embroiled in a serious sickness of pine trees (pine wither).

Symptoms Caused by Plant Parasitic Nematodes

The majority of the plant parasitic nematodes influence the root piece of plants aside from *Anguina* spp., *Aphelenchus* spp., *Aphelenchoides* spp., *Ditylenchus* spp., *Rhadinaphelenchus cocophilus* and *Bursaphelenchus xylophilus*. With the assistance of a stylet, nematodes suck the plants' sap, resulting in wilting, galls, reduced root system, leaf discoloration, stunted growth, and smaller fruits. Side effects of nematode illnesses can be delegated over the ground taking care of nematodes side effects and subterranean taking care of nematodes side effects.

1. Above ground symptoms

a. Dead or devitalized buds: When *A. fragariae* infects straw berry plants, the nematodes attack the plant's growing point, resulting in a blind plant. Seed galls are formed when the larva of *Anguina tritici* enter the flower primordium of wheat and grow into a gall. Within the cockled wheat grain, the nematodes can survive for up to 28 years.

b. Twisting of the stem and basal leaves: When *D. angustus* is present, onion's basal leaves twist. The wheat seed gall nematode is responsible for the crinkled or distorted stem and foliage. *A. tritici* pervades the developing point thus bends in stem and leaves occur.

c. Necrosis and discoloration: The red ring disease on coconut caused by *Rhadinaphelenchus cocophilus*. Due to the infestation, red colored circular area appears in the trunk of the infested palm.

- d. **Lesions on the stem and leaves:** *D. dipsaci* causes small, yellow spots on the onion stem and leaves, and *A. ritzemabosi* causes a leaf lesion on Chrysanthemum.
- e. **Hindering:** Decreased plant development, and the plants can not ready to endure unfavorable circumstances. The potato, gingelly, and wheat all suffer from stunted plants caused by *Globodera rostochiensis*, *Heterodera cajani*, and *Heterodera avenae*, respectively.
- f. **Leaf discoloration:** *Pratylenchus coffeae* causes coffee to appear patchy yellow, and potato plants infected with *G. rostochiensis* have light green leaves. On the leaves of citrus and orange trees, *Tylenchulus semipenetrans* produce fine mottling.
- g. Day wilting occurs when nematode infestation causes severe damage to the plant's root system (*Meloidogyne* spp.).

2. Below ground symptoms

Nematodes that feed below ground infest and feed on the root portion of plants, causing symptoms on both above-ground and below-ground plant parts. These nematodes are categorized as symptoms above ground and signs below ground.

- a. **Root lesion:** The penetration and movement of nematodes in the root causes typical root lesions e.g. Necrotic lesions induced by *Pratylenchus* spp. on crossandra; the burrowing nematode, *Radopholus similis* in banana. Similarly, *Pratylenchus coffeae* and *Helicotylenchus multicinctus* cause reddish brown lesion on banana root and corm. The rice root nematode also causes brown lesions on rice root.
- b. **Root galls or knots:** The root-knot nematode *Meloidogyne* spp. produces the characteristic root galls; *Nacobbus batatiformis* produces the false root galls on sugar beet and tomato. On lemon roots, *Hemicycliophora arenaria* produces small galls. On wheat and oats, *Ditylenchus radicum* causes root galls. *Xiphinema diversicaudatum* cause nerves on rose roots.
- c. **Root rot:** The nematodes eat the fleshy structure, causing tissues to rot (e.g.) Sweet potato nematode *Scutellonema bradys* and in potato *Ditylenchus destructor* cause root decay.
- d. **Reduced root system:** Nematode feeding stops the growth of the root tip and causes the root to produce branches. This could be a variety of things, like a curly tip, stubby root, or coarse root.
- e. **Coarse root:** Infestations of *Paratrichodorus* spp. stop lateral roots from growing, resulting in an open root system with only main roots and no lateral roots.
- f. **Stubby roots:** The lateral roots (such as *P. christei*) produce an excessively rootless plant.
- g. **Curly tip:** The "Fish Book" symptom is the injury caused by *Xiphinema* spp., a nematode that retards the elongation of roots and causes curling of roots.
- h. **Root proliferation:** Nematode infestation causes an increase in root growth or excessive branching. At the point of nematode infestation, the infested plant root produced excessive root hair, for example. *Heterodera* spp., *Nacobbus* spp., and *Trichodorus christii* *Pratylenchus* spp., *Meloidogyne hapla*, and other species.
- i. **Root surface necrosis:** Root necrosis occurs when the severe damage caused by *T. semipenetrans* on citrus causes complete decortications of the roots. The infestation of *D. dipsaci* in many tuber plants results in the formation of clusters of short, swollen sprouts on the tubers.

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