Educational Material Series # 3 **Soil Nematodes**

Introduction

Nematodes are microscopic, non-segmented worms, and make up four out of every five animals on the planet. About 90% of soil nematodes live in the top 6 inches of the soil. They live near topsoil and plant roots where they have access to food sources and occupy all soil types but generally soil moisture, soil temperature and soil texture influence the ability of nematodes to move and reproduce. Most nematodes are beneficial to plant and soil health and some are harmful to plants. Therefore, nematodes are classified into non-plant parasitic (free living) and plant parasitic nematodes (Fig. 1). This fact sheet explains what nematodes are, what types of nematodes live in the soil, and what management practices improve beneficial and reduce plant parasitic nematode populations.

Fig. 1. A root lesion nematode seen under a microscope. Notice the syringe-like stylet at the head. This nematode is < 1 mm long. Photo by Sean Kelly, DAFWA, Nematology.

Free-living (Non-Plant Parasitic) Nematodes

The majority of nematode species are non-plant parasite nematodes, commonly known as "free-living" nematodes. These nematodes live in the soil water and feed on organisms including bacteria, fungi, algae, insects, and other nematodes as well as organic debris. They have a beneficial role in the soil by maintaining a diversified soil food web. These nematodes can control pests by attacking and killing harmful bacteria and fungus, as well as plant parasitic nematodes. Free-living nematodes can be divided into four principal groups based on their feeding abilities:

- ***Bacterivores*** consume both beneficial and plant pathogenic bacteria.
- ***Fungivores*** consume both beneficial and plant pathogenic fungus. The stylet punctures the cell wall of fungal hyphae and allows the release of plant available nutrients (including N).
- ***Predatory nematodes*** feed on all type of nematodes, including themselves, and protozoa (single-celled eukaryotes, either free-living or parasitic).
- ***Omnivores*** feed on a variety of bacteria, fungi, algae, and other nematodes.

Benefits of Free-living Nematodes

Nutrient cycling: Nematodes mineralize, or release, nutrients to plant-available forms.

Grazing: Nematodes control the balance of soil fauna in the soil food web by grazing on bacteria, fungi, and the species composition of the microbial community.

Dispersal of microbes: Nematodes aid in distributing bacteria and fungi through the soil and along roots by moving live and dormant microbes on their body surfaces and in their digestive systems.

Disease suppression: Some nematodes consume disease-causing organisms, such as plant parasitic nematodes, or prevent their access to roots. They have the potential to be biocontrol agents.

Plant Parasitic Nematodes

Plant parasitic nematodes feed on living roots through piercing a root cell with its stylet, injecting enzymes into the host's cell to partially digest the cell contents, then drawing back through the stylet into the nematode. Afterword, the nematode moves to the next root cell. Plant parasitic infestation symptoms are often ambiguous and hard to diagnose due to the visual similarity to some nutrient deficiency symptoms.

Visible symptoms include yellowing, stunting, and wilting, followed by yield decline. The most well-known plant parasitic nematodes are:

- ***Soybean Cyst Nematode*** attacks the roots of soybeans leaving lemon-shaped cysts full of eggs. The cysts are attached to the roots and visible to the naked eye. Aboveground symptoms are similar looking to iron deficiency chlorosis, and nutrient deficiencies.
- ***Sugar Beet Cyst Nematode*** is a parasite of cole crops including sugar beets, cabbage, broccoli, and radish. Symptoms are stunted growth, wilting, pale yellow leaves, and can appear in an oval pattern. This nematode also leaves lemon-shaped cysts attached to the root.
- ***Root-knot Nematode*** attacks the roots of various trees, shrubs and herbaceous plants. The nematodes embed inside the roots, causing the roots to become distorted, developing irregular shaped galls.
- ***Lesion Nematode*** feeds on roots and tubers. Early infection symptoms show brown root discoloration, with fewer, and shorter root branches. Aboveground symptoms appear patchy and yellowed, similar to water or nitrogen deficiency.
- ***Dagger Nematode*** can cause economic damage and plant death with a relatively low population, by repetitive feeding on roots and transmission of viruses such as ringspot and mosaic. Symptoms are highly variable due to their wide range of hosts.
- ***Needle Nematode*** feeds on corn roots as a preferred host, but also feeds on other grasses. Needle nematodes can lower corn yield by 50 bu/A or more. Due to their large size, they only live in sandy soils with large pore spaces. Aboveground symptoms are stunting and yellowing while below-ground symptoms are pruned, discolored roots.

Plant Parasitic Diagnosis

To identify if a soil is infested with plant parasitic nematodes, soil samples can be collected before and after each growing season. Root samples can also be sent to a nematode testing laboratory for nematode identification.

Management Practices to Decrease Plant Parasitic Nematodes

Management practices that decrease plant parasitic nematodes are most helpful when using preventative care, and include:

- ***Use of a nematode resistant or tolerant variety:*** Choose a hybrid that disrupts nematode reproduction or a hybrid that can withstand some damage caused by nematodes without significant yield loss.
- ***Rootstock:*** Resistant and tolerant rootstocks (base of the trunk to the roots) can be grafted onto the scion (base of the trunk to the leaves) of a very productive variety, imparting resistance or tolerance to nematode pressure.
- ***Brassica family:*** Plants in the mustard family release natural root exudates that act as a fumigant, and decrease plant parasitic populations.
- ***Leaving the ground fallow:*** By keeping the ground fallow, growers can eliminate hosts for nematodes and keep the nematodes populations low especially if weeds are controlled during the fallow period.
- ***Soil Solarization prior to planting:*** Transparent plastic sheets heat the soil to a temperature lethal to nematodes. This practice decreases nematode populations, weed seeds, and other harmful organisms, but also kills beneficial organisms.
- ***Crop rotation:*** Selecting a non-host crop in rotation with cash crops will decrease plant parasitic nematode populations, decreasing pressure on the next cash crop.
- ***Clean Equipment:*** Washing all soil and root debris off of equipment when moving from and infected field to a non-infected field will reduce transmission.

Management Practices to Increase Beneficial Nematodes

- ***No-till:*** Tilling the soil exposes nematodes to the soil surface, causing the majority to dry out and die. Most of those nematodes are beneficial including fungivores that are specialized in N mineralization.
- ***Irrigation:*** Nematodes travel through the soil water. Irrigation or practices that maintain soil water provide suitable environment for increasing beneficial nematode populations.
- ***Addition of high-quality organic materials:*** Adding high quality (low C:N ratio) residue or organic materials will increase beneficial bacterivores, which increases N mineralization.

Summary

Nematodes can benefit crops and soil or decrease crop production. Education and prevention are key in maintaining the right balance of soil nematodes and to promote soil and plant health. The applicable practices to reduce plant parasitic nematodes are using resistant varieties, crop rotation, using brassica cover crops, and cleaning the farm equipment. The practices that improve beneficial nematode populations are no-till, adding high-quality organic materials, and irrigation.

Additional Information

Benefits of Nematodes in Healthy Soil Ecosystems http://nwdistrict.ifas.ufl.edu/phag/2018/11/09/benefits-of-nematodes-in-healthy-soil-ecosystems/

Niblack, T. 2016. Nematodes. Chapter 15, Illinois Agronomy Handbook. University of Illinois. http://extension.cropsciences.illinois.edu/handbook/pdfs/chapter15.pdf

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