

CHAPTER 8

NEMATODE MANAGEMENT

LEARNING OBJECTIVES

After completely studying this chapter, you should:

- Know what a nematode is and how it develops.
- Know the three groups of control tactics specific to nematode management.
- Understand the life cycle and management options for soybean cyst nematode, sugar beet cyst nematode, corn needle nematode, the root-lesion nematode, and the northern root-knot nematode.

INTRODUCTION

Nematodes are very small roundworms. They live everywhere—in soil, plants, water, and animals, including humans. Nematodes feed on bacteria, fungi, algae, plants, and animals. A few thousand species attack plants; most nematodes feed on dead or decaying organic matter. Many nematode species are beneficial because they feed on bacteria, insects, fungi, and other soil pests.

The life cycle of a nematode is egg, four juvenile stages, and adult. Adult females lay eggs that hatch into young nematodes, **juveniles**. Juveniles look like small adults. First and second stage juveniles are usually found still inside the egg case. For most plant-parasitic nematodes, egg hatching takes place during the second juvenile stage. After a total of four molts (shedding of their skin), the juveniles become adults. If males and females are present, they mate and produce more eggs. Typically, the life cycle of a plant-parasitic nematode is completed within 20 to 60 days.

About 95 percent of plant-feeding nematodes live in the soil and feed in or on roots. Some consume above-ground plant parts. Plant-feeding nematodes feed by inserting a needlelike structure (**stylet**) into plant cells.

They inject an enzyme into the cell that dissolves the cell contents. The nematode then uses its stylet like a straw to remove the liquid cell contents.

Nematode root feeding directly interferes with a plant's ability to take up water and nutrients. Infected plants wilt and appear to be suffering from a lack of water or nutrients. These symptoms can easily be mistaken for damage caused by other conditions. High nematode populations result in plant stunting, yellowing, a general decline in plant health, and sometimes plant death. Nematode feeding can cause yield loss. The feeding sites also act as points of entry for other pathogens such as fungi and bacteria.

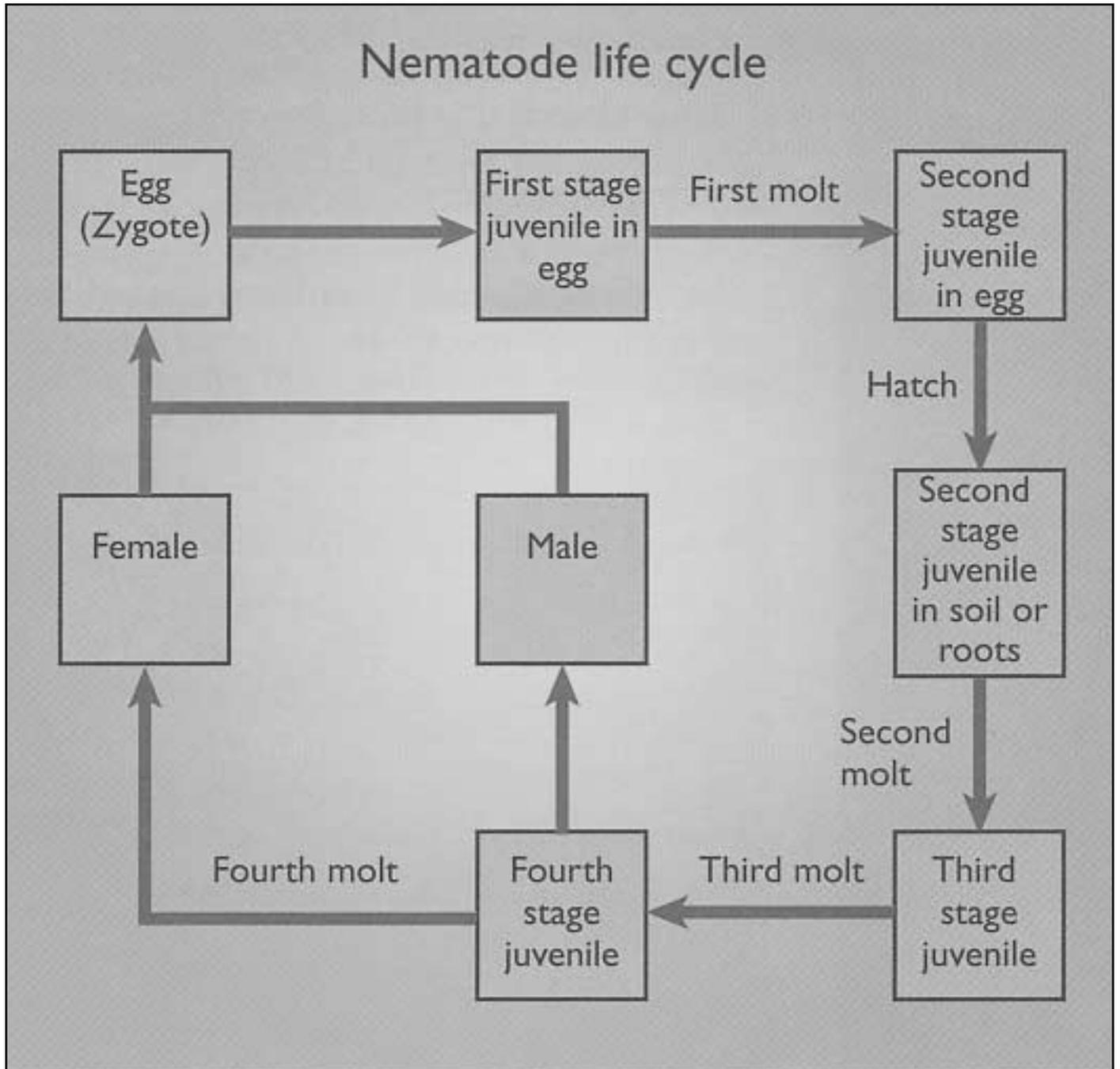
Though nematodes are small, they can easily disperse over long and short distances. In the soil, nematodes move approximately 1 inch per year. However, they can be transported from field to field or within a field by flood waters, dust storms, contaminated machinery, and nursery stock or transplants.

Nematode populations are identified and located from field soil samples. Soil and root samples can be submitted to MSU Diagnostic Services for identification. After proper identification, a site-specific nematode management program can be developed. Details on how to collect and submit a proper soil sample are found in current MSU Extension bulletins.

NEMATODE MANAGEMENT

Nematode management tactics can be grouped into three types: prevention, containment, and chemical control.

- **Prevention tactics** are intended to prevent nematode problems. Some are: practicing crop rotation, using nematode-free seeds and transplants, planting nematode-resistant or -tolerant varieties, keeping farm equipment nematode free, and maintaining good farm sanitation.



Nematode life cycle.

- **Containment tactics** keep a nematode population from spreading to other fields or other areas in the same field. It is nearly impossible to completely remove a nematode population from a field after it has become established. Prevention tactics such as crop rotation and planting nematode-free seeds and transplants can reduce the nematode population, however.
- **Chemical control tactics** are not often recommended for nematode control. However, both fumigant and non-fumigant nematicides (nematode-specific pesticides) are available. Chemical control of nematodes should always be used in conjunction with other nematode management strategies. For pesticide recommendations, refer to current MSU Extension bulletins.

SOYBEAN CYST NEMATODE

Host plants: Soybeans, dry beans, and other legume crops (green beans, green peas) and weeds (henbit, field pennycress, shepherd's purse).

First detection in Michigan: 1987.

Life cycle: The adult female soybean cyst nematode mates with a male and produces 150 to 500 eggs. Shortly after mating, she dies. But first she deposits a few eggs on the outside of her body. The other eggs remain in her dead body, which is called a **cyst**. In the cyst the eggs are protected from predators and environmental factors that would kill them. The eggs in the cyst hatch over the next eight years. Soybean cyst nematode eggs survive best



Soybean cyst nematodes on soybean roots (G. Tylka, Iowa State University).

under cool, moist conditions. The juveniles emerge from the eggs and immediately begin searching for food -- soybean roots. Once the juveniles find a soybean root, they enter the root and begin to feed. A juvenile soybean cyst nematode molts four times before becoming an adult nematode. Under moderate soil conditions, it takes 21 to 24 days for a soybean cyst nematode to complete its life cycle.



Soybean field infected with soybean cyst nematodes.

Damage and symptoms: The most common above-ground symptoms of soybean cyst nematode damage are stunted and yellowed plants. Plant symptoms are usually not evenly distributed in a field. In early July, white female soybean cyst nematodes are found attached to plant roots. As the nematodes age, they become yellow. The attached females are the only visible sign of a soybean cyst nematode infestation. Soybean cyst nematode infestations can reduce soybean yields by 30 percent without plants showing symptoms. Severe infestations can reduce soybean yields as much as 80 percent.

Management options: To prevent soybean cyst nematode infestations, practice crop rotation, plant nematode-free seed, and maintain clean machinery. Nematode-resistant and -tolerant soybean varieties are available. Fields with low to moderate soybean cyst nematode populations can be managed by practicing a three-year crop rotation. Longer rotations may be necessary for fields

with large soybean cyst nematode populations. Soil fumigants are available but very expensive. Non-fumigant nematicides applied at planting may reduce soybean cyst nematode populations. In many situations, they, too, are very costly.

SUGAR BEET CYST NEMATODE



A sugar beet infected with sugar beet cyst nematode.

Host plants: Sugar beets, cabbage, mustard, cauliflower, and many weeds.

First detection in Michigan: 1949.

Life cycle: All cyst nematodes develop in the same manner. Therefore, the sugar beet cyst nematode is very

similar to the soybean cyst nematode. After hatching, the second stage juvenile (J2) nematodes enter the sugar beet roots to feed. As the nematode grows, it bursts from the root. The white to yellow adult females are exposed on the root surface. With ideal soil conditions, the sugar beet cyst nematode completes its life cycle in 25 days.



Plant symptoms of a sugar beet cyst nematode infestation.

Damage and symptoms: Typically, the sugarbeet cyst nematode is found in the fibrous roots, but it can also feed on the storage root. Infected sugar beet plants are stunted, have yellow foliage, and wilt in warm weather. The wilting can be persistent even in soil with high moisture levels. You can see female sugar beet cyst nematodes on the plants roots without a hand lens. Severe nematode infestations may reduce yields.

Management options: Sugar beets are the only major host of sugarbeet cyst nematodes in Michigan, so crop rotation provides sufficient control. Typically, at least a three-year rotation out of sugar beets is recommended. However, in heavily infested fields a longer rotation (five to eight years) may be necessary. Currently, there are no sugar beet varieties that are resistant to the sugar beet cyst nematode.

CORN NEEDLE NEMATODE



A corn needle nematode infestation can stunt a plant's growth.

Host plants: Corn and other grass plants

First detection in Michigan: 1980.

Life cycle: Female corn needle nematodes produce roughly one egg per day over several months. In the spring after the eggs hatch, the juvenile nematode feeds on young corn roots. As the soil temperature increases, the corn needle nematode migrates deeper into the soil and may stop feeding. In Michigan, it completes approximately one generation per year. The corn needle nematode is typically found in sandy fields with long histories of corn production and poor crop rotation. Unlike cyst nematodes, the corn needle nematode will not survive long without its host plant.

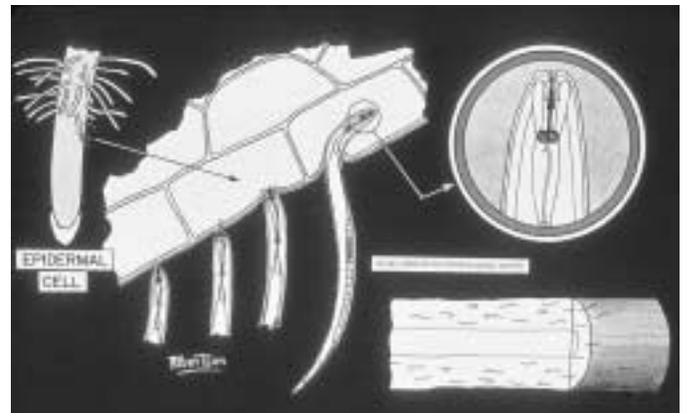
Damage and symptoms: Corn needle nematodes do not enter the root but feed close to the root tip, preventing the root from developing normally. The damage includes root tip swelling, stunted plants, small and barren ears at harvest, and a reduction (10 to 75 percent) in grain yields. The corn needle nematode prefers to live in coarse-textured or sandy soils. As the soil moisture decreases and temperature increases, the corn needle nematode moves deeper into the soil. During the summer, the corn needle nematode can be found 18 to 36 inches below the soil surface.

Management options: Soil sampling should be done in spring or fall, when the corn needle nematode is close to the soil surface. Sampling in the root zone during the summer will not detect it. Crop rotation, especially with soybeans or alfalfa, will reduce corn needle nematode populations. It is also important to maintain soil quality. Non-fumigant nematicides do not provide control of corn needle nematode.

ROOT-LESION NEMATODE

Host plants: More than 350 recorded host plants, including corn and sugar beets

First detection in Michigan: Unknown



Root lesion nematode.

Life cycle: After mating, females lay single eggs in roots or soil. Second stage juveniles (J2) hatch from the eggs. Like all nematodes, the root-lesion nematode goes through four molts before reaching the adult stage. Adults and the last three juvenile stages can enter the roots to feed at any time. Root-lesion nematode may take from 30 to 86 days to complete its life cycle.

Damage and symptoms: Root-lesion nematodes usually feed on the smaller plant roots, killing them. The feeding sites allow other pathogens such as fungi and bacteria to enter the root system. Root-lesion nematode infestations cause plants to grow poorly and have yellow leaves that may wilt in hot weather, and can reduce crop yields. Infested seedlings are often stunted.

Management options: Root-lesion nematodes can attack a wide number plants. Therefore, crop rotation will usually not sufficiently reduce their populations. Nematicides are available but should always be used on a field-by-field basis and with a nematode management program.

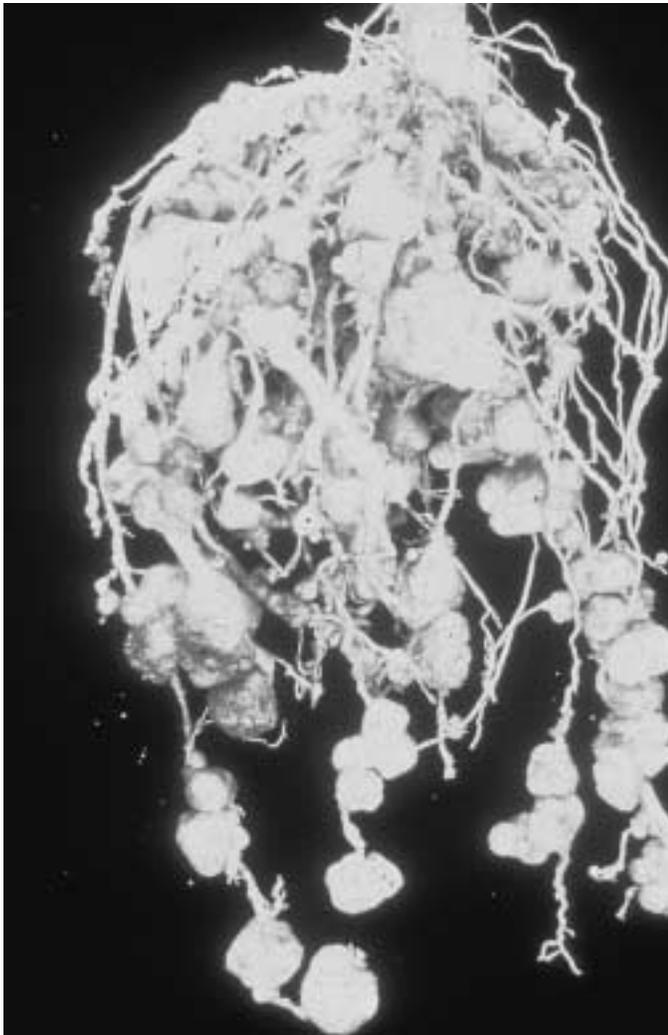
NORTHERN ROOT-KNOT NEMATODE

Host plants: More than 300 recorded plants, including dry beans, soybeans, sugarbeets and forage legumes

begin to feed on roots. Their feeding causes the roots to swell. The northern root-knot nematode completes its life cycle in one to two months. There are at least two generations per year in Michigan.

Damage and symptoms: Northern root-knot nematode feeding produces small root swellings called galls. Nematode-infested plants do not compete well for water and soil nutrients. These plants often appear to be water stressed even though there is sufficient soil moisture.

Management options: Crop rotation is the most effective way to manage the northern root-knot worm. Usually a one-year rotation out of the host crop is necessary to reduce nematode populations. Soil fumigants effectively control northern root-knot nematodes and may be necessary when populations are high.



Root-knot nematode.

First detection in Michigan: Early 1900s

Life cycle: The female northern root-knot nematode produces as many as 500 eggs. She carries these eggs in a slime like mass on the outside of her body. In early spring, second stage juveniles hatch from the eggs and

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Review Questions

Chapter 8: Nematode Management

Write the answers to the following questions and then check your answers with those in the back of the manual.

- Nematodes are small roundworms.
 - True
 - False
- Plant-parasitic nematodes usually cause crop damage by feeding on the plant's:
 - Leaves
 - Stems
 - Flowers
 - Roots
- A young nematode is called a:
 - Nymph
 - Juvenile
 - Larva
 - None of the above
- Nematodes can move across a field or from one field to another by:
 - Dust storms
 - Contaminated machinery
 - Floodwater
 - All of the above
- What type of mouthparts does a nematode have?
 - Chewing
 - Sucking
 - Piercing/sucking
 - Rasping
- List three types of management tactics used to control nematodes. Give an example of each type.
- Nematicides are applied to plant leaves to control root-feeding nematodes.
 - True
 - False
- 8-11. Match the following characteristics with the appropriate nematode.**
 - Soybean cyst nematode
 - Corn needle nematode
 - Root-lesion nematode
 - Northern root-knot nematode
- ___ Cannot be detected by sampling in the crop's root zone during the summer.
- ___ Feeding results in the production of root galls.
- ___ Usually managed by practicing crop rotation and planting resistant varieties.
- ___ Extremely difficult to control with crop rotation.
- The eggs of a soybean cyst nematode can continue to hatch over a period of:
 - 1 week
 - 10 hours
 - 8 years
 - 12 days

13. Which of the following nematodes does NOT enter the root to feed?
- A. Soybean cyst nematode
 - B. Corn needle nematode
 - C. Sugar beet cyst nematode
 - D. Root-lesion nematode
14. Using crop rotation to stop a nematode population from growing and moving to other areas of a field is an example of which type of management system?
- A. Chemical.
 - B. Prevention.
 - C. Containment.
 - D. Biological.
15. What is a cyst?