Understanding Soil Nematodes

Nematodes are microscopic, worm-like organisms with over 4,000 species known to be parasitic to plants. There are also beneficial nematodes that feed on bacteria and fungi the soil. Parasitic nematodes typically feed on the exterior (ectoparasites) or interior (endoparasites) of plant roots. Crop damage typically results from root damage from feeding and the reallocation of resources from plant tissues to the nematode. In addition, nematodes can also provide openings for other pathogens to enter and cause disease. Early detection and preventative management are the cornerstones to limit the spread of nematodes and to reduce the economic losses caused by nematode infestations.

Life Cycle

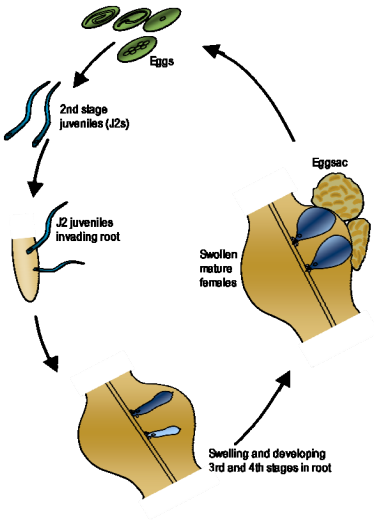

Figure 1. Nematode lifecycle recreated from Bridge, J. and Starr, J. Plant Nematodes of Agricultural Importance.

Nematodes life cycles have multiple stages, beginning with an egg stage, then four juvenile stages (J1-J4), followed by the adult stages (Figure 1). Nematodes begin to feed on plant roots during the second juvenile stage (J2). Both juveniles and adults feed on the roots of host plants. Depending on the species and the environmental conditions, the life cycle of a nematode can be completed in 3 to 4 weeks and several generations in a year. The length of time required to complete a life cycle varies widely among species, from several days up to a year.

Distribution of nematodes is dependent on several factors. Nematodes require the presence of a susceptible host to survive. Nematodes move in the water film in soil pore space. They are capable of traveling minute distances in the soil and moving up and down in the soil profile as conditions change. Mobility in the soil is limited and influenced by soil temperature and moisture and soil texture. Nematodes are also moved around by tillage equipment, movement of soil by water and wind, and on plant material. There are several sources for more in-depth information on nematodes.[1,2]

Multiple species are capable of infesting row crops (Table 1).[3,4] Nematodes are typically soil-borne and feed on plant roots. The presence of certain nematode species can vary according to environmental conditions, soil types, and plant growth.

Nematodes feeding on root cells can reduce the plant's ability to absorb water and nutrients. Damage caused by root feeding can further predispose the plant to fungal and bacterial pathogens cause disease complexes.

Table 1. Important Nematode Species in Corn, Cotton, and Soybean.

Corn	Lesion, Needle, Lance, Dagger, Root-knot, Sting, Stubby-root, Spiral, Stunt, Pin, Sheath, Ring, Stem
Cotton	Root-knot, Reniform, Columbia lance
Soybean	Soybean cyst, Columbia lance, Root-knot, Sting, Lesion, Reniform

Symptoms

Common above-ground plant symptoms include wilting, yellowing, and stunting. Often, there are no visible above-ground symptoms unless nematode populations are extremely high. Common below-ground symptoms include swollen roots, galls on roots, lack of fine roots, minimal root branching, and necrotic lesions. Nematode damage is rarely uniform in a field. In many cases, crop injury is the result of several nematode species interacting with other pathogens (Figures 2 and 3).

Symptoms are often non-descript and can be confused with other stresses. Symptoms of nematode feeding are most noticeable when environmental conditions cause plant stress.

Figure 2. Soybean cyst nematodes devastate susceptible soybean plants (Left) while resistant plants thrive (Right).

Figure 3. Below-ground RKN damage to cotton roots.

Soil Sampling

To confirm the presence of nematodes, samples of soil, plants, and roots can be submitted to a nematode testing laboratory. Nematode distribution can be very irregular within a field, therefore it is important to collect several composite samples to provide an accurate population estimate. Since nematode treatment thresholds vary by soil type, fields should be divided into zones by soil texture, and separate samples should be collected for each zone. If no symptoms of nematode damage are apparent, take a general field survey to determine the nematode species and populations present to help assess risk potential to a crop. If nematodes are a current or suspected problem, samples should be collected around the edges of symptomatic areas, and samples should include roots of the crop. Sampling should occur while the crop is growing and when soils are not overly wet or dry. Nematode numbers will be higher and easier to detect later in the growing season. Plant pathologists also caution that weeds can allow nematode numbers to increase even after crop harvest.

Follow lab instructions for collecting, handling, and shipping all nematode samples to avoid killing nematodes before they reach the lab. A good sample will provide a reliable diagnosis and management strategy.

Nematode Management

Management options are determined by nematode species, host, soil type, population density, and action thresholds. Fall is typically the recommended time to soil sample for nematodes. Consult a local university for scouting and soil sampling recommendations and procedures for nematodes in crops.

Timely identification is an important first step in the integrated management of nematodes.[5] Scouting and soil sampling are essential because plant damage may not be noticeable in above ground symptoms and damage can be confused with other stresses such as nutrient deficiency, compaction, herbicide injury, and others pathogens.

Three approaches to scouting and soil sampling can be considered depending on the situation:

- Scouting for nematode infestations. A necessity for soybean cyst nematode and it may also be important for other nematodes. Collect a sample for field areas where nematode introduction is likely to have occurred. Fall sampling after harvest may be the easiest time to soil sample.
- Diagnose damage from specific nematodes. Collect samples when plants exhibit symptoms. Take samples near plants showing damage such as yellowing or stunting, and swelling root tissue. Take 10 or more samples from areas with a range of symptoms. Take an equal number of samples from healthy areas of the field for comparison.
- Predicting nematode damage. Sampling can be used to estimate population densities and damage potential. The information can help determine management strategies, such as the use of non-host or resistant host crop products. Collect soil cores from 15 or more places within an area no larger than 20 acres. Sample the area in a systematic zigzag or M-shaped pattern.

For all three sampling strategies, a soil probe works best for collection, but a hand trowel or garden shovel also can be used. Place soil cores in a bucket and mix thoroughly. Put the soil in a properly labeled soil sample bag and send to the lab.

An integrated nematode management plan should consider:

- Scout and soil sample to determine the extent and intensity of nematode infestations.
- A crop rotation plan that utilizes non-host crops and the appropriate interval between susceptible crops.
- Host plant resistance to help suppress nematode populations and protect susceptible crop yield potential.
- A weed management plan to eliminate weed hosts for various nematode species.
- Fertility and pest management to help reduce crop stress and keep the crop as healthy as possible to withstand nematode damage.
- Tillage management to help suppress nematode infestations and prevent moving nematodes to uninfested fields.
- Use seed-applied and soil-applied nematicides to help suppress nematode populations.

Sources: [1] Lambert, K. and Bekal, S. 2002. Introduction to plant-parasitic nematodes. The Plant Health Instructor. [2] Plant and insect parasitic nematodes home page. University of Nebraska. [3] Mueller, J., Kirkpatrick, T., Overstreet, C., Koenning, S., Kemerait, B., and Nichols, B. 2012. Managing nematodes in cotton-based cropping systems. Cotton Incorporated. [4] Niblack, T. 2016. Nematodes, Chapter 15, Illinois Agronomy Handbook. University of Illinois. [5] Soil sampling strategies for plant-parasitic nematodes. Iowa State University Integrated crop Management. Web sources verified 01/06/2017.