

Plant parasitic nematodes are in every field (to some extent), ranging from no obvious crop impact to severe injury and tremendous yield loss. Above-ground symptoms of nematode damage to corn include:

1. General stunting resulting in uneven plant height.
2. General yellowing of leaf tissue.
3. Poor pollination.
4. Small ears.
5. Lodging later in the growing season.

The symptoms that occur below ground are quite variable depending on the nematode species and the environmental conditions present in the field, and can include:

1. Stunting of the root system.
2. Slight to general root discoloration.
3. Distinct, dark necrotic root lesions.
4. Proliferation of fibrous roots.

There are at least 120 different species of plant-parasitic nematodes known to feed on corn worldwide, and more than 60 species occur in North America. Of these, there are more than 12 species of corn nematodes with common names, such as:

1. Sting.
2. Needle.
3. Stubby-root.
4. Lance.
5. Root-lesion.
6. Stunt.
7. Dagger.
8. Spiral.

The degree of crop injury and yield loss in each field depends on which nematode species are present in the field, and their population densities.



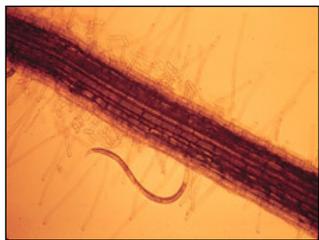
Corn damage as a result of corn nematodes

None of the symptoms are unique enough to provide a conclusive diagnosis of nematode damage in a field, and there are no reliable, definitive signs that will indicate nematodes are within a field.

The only way to determine whether nematodes are a potential risk factor, or causing damage is by collecting and submitting a sample(s) to a laboratory for plant parasitic nematode analysis.

Ectoparasites

Most species of plant-parasitic nematodes that feed on corn occur only in the soil and feed from outside of the roots. These nematodes are described as **ectoparasites**. To determine the population densities (or numbers of ectoparasitic nematodes), soil samples are collected and nematodes are extracted from the soil; identified and counted.



Ectoparasitic stunt nematode feeding on a corn root

Endoparasites

A few nematode species that feed on corn enter and feed completely within the root tissue. These nematodes, which complete their entire life cycle within the roots are described as **endoparasites**, and include lance nematode (*Hoplolaimus* spp.), root-knot nematode (*Meloidogyne* spp.), and root-lesion nematode (*Pratylenchus* spp.).

To assess population densities of endoparasitic lance and root-lesion nematodes, nematodes must be extracted from root tissue and then identified and counted. The numbers of lance and root-lesion nematodes in the soil during the growing season can be deceptively low, while several thousands of nematodes can be present in a single gram of root tissue.



Endoparasitic lance nematodes (stained red) feeding within root segments

It's important to collect, handle, and submit samples appropriately in order to avoid compromising the quality of the sample and reliability of the results of the analysis.

Corn nematode species are diverse and don't cause equal damage. For example, needle and sting nematodes are relatively large and uncommon, but often cause the worst visible injury. Because of their larger size, sting and needle nematodes are only present in fields with at least 80% sand. They can be hard to detect since they can move down several feet in the soil beneath the reach of traditional soil probes. For that reason, the best time to sample sandy corn fields for nematodes is while plants are small (up to approximately V6 growth stage).

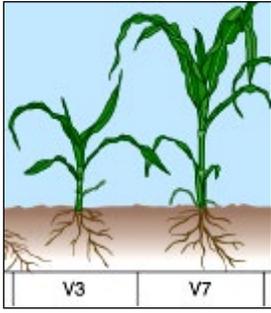
Early in the season, these nematodes are expected to be in shallow soil, feeding on shallow corn roots (still mainly in the upper 8-10 inches of the soil profile). Scouting early season will increase your chance of capturing them in a routine sample.

Most fields (whether sandy or not sandy) have a mixture of nematode species of varying population densities. Other nematode species affecting corn are not known to travel deeper in the soil and would be included in any late season soil samples. Fields with finer textured soils may be sampled for nematodes almost any time. In finer textured fields, sampling can be done early in the season when symptomatic areas are more obvious, or it can be delayed until after harvest when nematodes will be at their highest population densities. Often, waiting until after harvest may be more convenient if you're planning to collect soil samples for nutrient analysis, and can simply collect additional soil for nematode sampling. However, damage thresholds may not be helpful since most of them were developed based on early season sampling V3-V6.

Some nematodes, such as root-lesion (also called lesion nematodes), are much more common, regardless of soil texture. Lesion and other nematodes tend to cause less severe symptoms and injury on corn than sting or needle nematodes, but likely cause greater losses than any other nematodes due to their wide distribution.

When to sample:

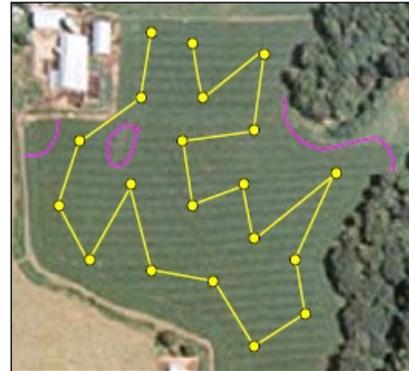
Take soil samples for corn nematode screening 4 to 6 weeks after planting (V3 – V6).



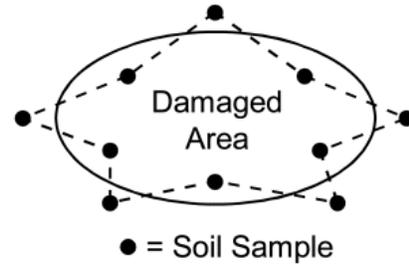
Three leaves with collars (V3) visible to six leaves with collars visible (V6)

Sampling later in the season can also be done, but many nematode threshold charts are based upon the V3-V6 growth stages.

Where to sample: To determine if nematodes are present in your field, sample the fields in a manner similar to taking non-gridded soil samples (zig-zag pattern).



If sampling to confirm and evaluate corn nematode populations/damage, sample around the perimeter of the suspected damaged area, not in the middle of the area.



Collect 20, 12” inch deep soil cores through the root zone with a soil probe. Include corn root tissue to determine presence and population densities of plant-parasitic nematodes



Collect 2 or 3 root balls from plants with symptoms of damage and package them in plastic bags to maintain moisture while transporting. The stalks can be discarded.





How to take corn nematode samples:

1. Using a 1-inch-diameter (2.5-cm-diameter) soil probe, collect up to 20 soil cores 12” inches deep from each area being sampled. Angle the soil probe in down through the seed row corn roots, collecting the soil from within the root zone of growing corn plants.
2. Treat the samples gently while they're being taken and afterward because some corn nematodes are very sensitive to manipulation. You want to avoid killing them before they reach the lab so that you get accurate, reliable results. In other words, don't break up the cores or drop the samples. Handle them with care.
3. Double bag the sample in a zip-lock type plastic bag (not a paper bag) to help preserve moisture during transport. Label the outside of each sample bag with a permanent marker. Store the sealed plastic bags in a cooler and protect the samples from temperatures above 80 degrees F from time of sampling to delivery to the lab! **DO NOT FREEZE** the samples!
4. Package corn root samples similarly to soil samples, but in separate plastic bags.
5. It is imperative for the nematodes to be alive in these samples, because they must crawl out of root material during one of the extraction procedures. For this reason, it takes several days longer to process corn nematode samples than it does other types of samples.
6. “Ideally”, include the GPS coordinates for the sample location along with your contact information when you submit samples.
7. Samples should represent less than 20 acres; even fewer acres if there is variability in soil type/textures or terrain.
8. Deliver or send the samples to our lab for processing as quickly as possible. Avoid sending samples on Thursdays and Fridays so they do not sit in delivery trucks over the weekend.
9. **Thoroughly complete the USI Corn Nematode Soil Sample Submission** and include with samples.
10. Include an additional sample from a non-affected area to analyze (to compare nematode numbers).

University of Illinois' current (June 2012) Corn Nematode Interpretation Thresholds:

GENERALIZED POPULATION THRESHOLDS FOR DAMAGE BY PLANT-PARASITIC NEMATODES IN ILLINOIS¹

Threshold numbers per 100cc of soil
for degrees of problem severity²

Nematode, common and generic names	Insignificant ³	Minor ⁴	Moderate ⁵	Severe ⁶	Very Severe ⁷
Cyst (<i>Heterodera</i>), cysts, soybeans only	---	---	1-5	6-25	>25
Foliar (<i>Aphelenchoides</i>), per g fresh wt	---	---	1-5	6-25	>25
Stem (<i>Ditylenchus</i>), per g fresh wt	---	---	1-5	6-25	>25
Sting (<i>Belonolaimus</i>)	---	1-5	6-20	21-50	>50
Needle (<i>Longidorus</i>), corn only	---	1-5	6-20	21-75	>75
Stubby-root (<i>Paratrichodorus</i>)	1-5	6-20	21-50	51-100	>100
Root-knot (<i>Meloidogyne</i>), larvae	1-10	11-40	41-80	81-150	>150
Root-knot (<i>Meloidogyne</i>), galls per root system	1-5	6-10	11-20	21-50	>50
Root-lesion (<i>Pratylenchus</i>), preplant only	1-10	11-25	26-50	51-100	>100
Root-lesion (<i>Pratylenchus</i>), per g dry roots	1-50	51-200	201-500	501-1000	>1000
Dagger (<i>Xiphinema</i>)	1-10	11-25	26-50	51-100	>100
Lance (<i>Hoplolaimus</i>)	1-10	11-40	41-75	76-150	>150
Stunt (<i>Tylenchorhynchus</i>)	1-10	11-50	51-100	101-200	>200
Spiral (<i>Helicotylenchus</i>)	1-75	76-150	151-300	301-500	>500
Ring (<i>Criconemoides</i>)	1-75	76-150	151-300	301-600	>600
Pin (<i>Paratylenchus</i>)	1-50	51-100	101-500	501-1000	>1000

Revised: 2003, Dr. Dale Edwards

- Figures are guidelines only; thresholds often must be increased or decreased substantially, depending on plant species and cultivar, age of plant, season of sampling, soil texture, cultural practices, expected general weather conditions, sampling and extraction methods, and other biotic and abiotic factors.
- Based on soil analysis unless otherwise indicated; figures in each column subjectively correspond to trace, low, moderate, heavy, and very heavy nematode population levels, respectively.
- Population of no consequence during present growing season; potential for increase to damaging level remote in subsequent years.
- Population of little consequence at present; potential for increase to damaging level remote during present growing season but good on highly susceptible, monocultured hosts in subsequent years.
- Borderline situation with soil nematodes; measurable damage from nematodes alone highly dependent on present and future weather conditions and fertility level; nematodes possibly a contributing factor in a disease complex with fungi, bacteria, viruses, and/or other nematodes; control measures may not be economically practical; strip test recommended; continued monoculture may result in severe problem. Eventual mortality of parts or all of plant can be expected with foliar and stem nematodes; treatment or destruction of plant recommended.
- Population sufficiently high to cause economic damage; degree of production loss dependent on future weather conditions; control measures recommended.
- Population sufficiently high to cause severe economic damage and some plant mortality; established planting may not be salvageable; control measures mandatory.