Live Plant Parasitic Nematode Determination

March 16, 2018
Fee Schedule for Plant Parasitic Nematode Assay(s)

<table>
<thead>
<tr>
<th>Service Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>Live Plant Plant Parasitic Nematode Identification ID (Ag Soil)</td>
<td>$58.00</td>
</tr>
<tr>
<td>Live Plant Plant Parasitic Nematode Identification (Compost)</td>
<td>$68.00</td>
</tr>
<tr>
<td>Root Tissue Exam (Root-knot confirmation only)</td>
<td>$20.00</td>
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<tr>
<td>Cyst Nematode Egg Count (Ag Soil)</td>
<td>$28.00</td>
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<tr>
<td>Cyst Nematode Egg Count (Compost)</td>
<td>$38.00</td>
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Advantages

- Competitive Rates
- Approximately 3-5 working-day turnaround (7-10 business days for live plant parasitic nematode)
  
  *Special rushes can normally be accommodated, please inquire about our rush surcharges*
- Online Reporting
- Latest Equipment & Technique
- Meets USDA/APHIS 526 Requirement for Interstate Movement of Live Pests
- Meets USDA/APHIS 526 Requirements for Importation of live pests, noxious weeds, and soil (International)
- Meets State of Nebraska Plant Protection Regulations
- Consulting available

Visit our website for a complete listing of our fee schedule and online reporting options at [www.midwestlabs.com](http://www.midwestlabs.com).
Live Plant Parasitic Nematode ID

Plant Parasitic nematodes are microscopic organisms that must have living host plant tissue to feed upon in order to grow and reproduce. Every production crop, garden plants, and turf grass has at least one plant parasitic nematode that infects it, most of them being root feeders. About 95% of plant-parasitic nematodes live in the soil and feed in or on the plant root systems. Damage caused by parasitic nematode infection is often mistaken for other environmental factors, including nutritional and soil moisture problems. Common external characteristics are yellowing, reduced plant vigor and yield loss.

Length of the life cycle of plant parasitic nematodes, their seasonal changes, over winter survival rates and distribution patterns in the soil are important considerations for sampling. Under favorable soil and moisture condition, more plant parasitic nematodes typically complete their life cycles (from egg to egg laying adult) within 30-days. The duration of this life cycle for some species, especially when they are feeding on a poor or moderate host, will take up to 60 days. Very few species take longer than 60 days, but those that do may take one year to develop from egg to egg laying adult. The life span from birth to death may be as little as 60 days for some nematodes and many years for individuals of other species. These birth and death rates, along with the number of eggs produced by females, are important factors in the population dynamics of nematodes and must be considered in sampling.

Sampling for Parasitic Plant Nematodes

Proper sampling of fields and sample submittal are crucial for reliable determination of nematode populations. The following information will aid in determining the proper sampling location, how to best sample an area and how to submit samples to assure obtaining the most accurate information regarding possible parasitic nematode problems. The results will, in turn, enable the grower to make sound nematode management decisions.

Time of the year: Timing of the sampling relates to the purpose for the assay: prediction, crop loss assessment, or diagnosis. Sampling done in the fall, soon after the previous crop has been harvested is called Predictive Sampling: This type of sampling will determine if a nematode(s) will be a problem for the next growing season. Predictive sampling can be done any time after the previous crop is harvested and before the next crop is planted, when soil conditions allow for proper sampling. The action levels provided in this brochure are useful guidelines to help growers decide on the need for action to control the nematode or nematodes of concern.
Samples taken during the summer months, when plants are actively growing, are generally used for Diagnostic purposes. The results may help determine growth problems that are outwardly evident on the plants. Action levels listed for individual crop types are not relevant for diagnosis. Diagnostic samples should be collected from “healthy appearing” plants at the margin of the problem area(s). If diagnostic sampling is being performed for planning long-term nematode management strategy, collect samples mid growing season. This is a period when numbers of nematodes are likely to be highest. This would also be a good time to map the field for areas where plants are growing poorly to determine if nematodes or other causes are responsible for the poor growth. This type of information is especially useful for growers employing precision agriculture technology. Nematode sampling during the growing season can also be done for Crop Loss Assessment. If there is a need for such information, the grower is encouraged to contact Midwest Laboratories, Inc. before sampling in order to establish the purpose for determining the loss. With this purpose as a guide, the best design for sampling can then be developed.

**Sampling Procedure**

Before taking a sample, insure that your equipment is clean and that there is no possibility of contamination from a previous sample.

The procedure for sampling a field depends on the purpose of the sample.

**Diagnostic:** Usually, symptoms of nematode damage are depressed, circular or oval areas of stunted and or yellowish plants in the field. These areas will usually be limited to specific areas of a field, but may include much larger areas. The highest nematode counts will usually be at the edges of the damaged area and not in the middle. Therefore, it would be advantageous to take the sample at the edge of the damaged area where plants still appear healthy. Collect several core or spades of soil to an 8” depth around the affected area, making sure that the sample is collected from the root zone where roots are most abundant. The highest probability of recovering large numbers of the nematodes would be to dig up several plants from the periphery of the affected area and shake the soil into a bucket. Mix the soil gently and place a pint of mixed soil into a plastic bag or a Midwest Laboratories sample bag for transport to Midwest Labs. Note: A plastic or plastic lined bag must be used to prevent nematode dehydration.

**Predictive:** The ideal sampling strategy for predictive purposes is to divide a field into several areas of no more than five acres each. Collect 20-40 soil cores or shovels of soil to a depth of 8” in a zig-zag pattern from each 5-acre area separately. Gently mix the soil. Remove approximately one pound of the soil and place it into a sample bag for transport to Midwest Laboratories.

**Regardless of purpose, it is best to sample soil when it is at the ideal moisture conditions for planting.**
Sample Shipment (Interstate)

If samples are to be held for more than one day, place them in a storage unit set at 45°F. For shipping, place the samples in a cooler or plastic lined box with frozen ice packs sealed in zip lock bags. However, keep in mind the shipping time and outside weather conditions before shipping your sample. Complete a pre-printed Midwest Laboratories plant parasitic nematode submittal sheet. This sheet can be obtained by contacting the laboratory or by downloading the forms at our website: https://48ktyk3qffqswttxc2dv5i-wpengine.netdna-ssl.com/wp-content/uploads/2016/11/Plant_Parasitic_Nematode_Sample_Submittal-2.pdf

Always fill out all information on the submittal sheet, including current and future crops, sample identification, and grower/billing information. In addition, please include a copy of the Midwest Laboratories USDA/APHIS permit to move live plants pests in soil. A copy of this permit can be obtained by contacting George Nelsen at Midwest Laboratories at (402) 829-9868 or go to this link: https://midwestlabs.com/resource/usda-aphis-nematodes-permit/

Shipping labels, ARS labels, bags and shipping boxes are available from Midwest Laboratories. For information call (402) 334-7770 or email us at getinfo@midwestlabs.com.

Sample Shipment (International)

Prior to shipping, contact Midwest Laboratories for shipping guidelines and proper shipping labels.

Sample Results

Results for plant parasitic nematode sample assays are usually completed within 7-10 working days after receipt of the samples. However, this time may be extended during the labs busy seasons, usually during planting and harvest seasons. Samples results will be reported by genus and numbers/100 cubic centimeters of soil. The results will also show numbers of all parasitic plant nematodes recovered. Included with this brochure are descriptive action sheets, which are grouped by crop types, action numbers and best time to sample.

Sample Results (Midwest Labs Web Site)

Plant Parasitic Nematode results can be viewed on our MyLab portal https://mylab.midwestlabs.com/documents/reports

1. Click on “View Report” under the header “REPORTS AND DOCUMENTS.”
2. Select your “Account”
3. There are two ways to find/filter your reports, by date range or by Report #/Sample ID.
Recommendations

Midwest Laboratories recommends multi-year rotations with resistant varieties or non-host crops to decrease plant parasitic nematode populations. Included on the individual crop sheets are possible non-host crops for use in a crop rotation program. However, other factors such as soil conditions and location need to be considered. Additional information on crop choices, or possible use of nematicides for plant parasitic nematode control can be obtained from your county extension office.

Remember: Reduction of plant parasitic nematodes is only obtained by a continuous control program. Therefore, yearly sampling is needed to monitor its success.

For additional information, or to obtain a copy of the Midwest Laboratories USDA/APHIS Permit, please contact:

George Nelsen, Nematology Laboratory
Phone: (402) 829-9868
gnelsen@midwestlabs.com
**Information and Interpretation of Results Field-Corn Parasitic Nematodes**

**Lesion Nematodes (Pratylenchus)**

**Parasitic Habitat:** Endo-parasite, found within plant roots and soil. Migrates through the roots while feeding.

**Possible Symptoms:** Stunting of roots, lacking hair roots. Reduced root volumes and weights. Black discolored areas present on roots (lesions). Reduced yields may be present without any of the previously listed symptoms.

**Actions Levels:** 25-30/100cc

**Sampling:** Sample when plants are actively growing. Can be sampled year around, but populations may decrease as soil temperature cools.

**Management:** For lower populations, rotation with a non-host or poor host crop (ex. soybeans, winter wheat). For larger populations genetically modified corn or treated seed in conjunction with crop rotation. Chemical applications may also be an option.

**Lance Nematodes (Hoplolaimus)**

**Parasitic Habitat:** Endo-parasite, found within plant roots and soil. Migrates through the roots while feeding. More common in sandy soil.

**Possible Symptoms:** Stunted root systems, but galls are not present. Problem areas are generally clustered in a field.

**Action Levels:** 25-30/100cc

**Sampling:** Sample soil when crops are actively growing. Sample stunted areas separately from healthy areas. Can be sampled year around, but populations may decrease as soil temperature cools.

**Management:** Lance nematodes are widely distributed across the United States with a wide range of host crops. Usually, soybeans or winter wheat are common rotational crops. Using a genetically modified or treated seed corn, or chemical applications may be an option.
**Stunt Nematodes (Tylenchorhynchus)**

**Parasitic Habitat:** Ecto-parasite, found in soil and feeds on root surface. More common in sandy soil.

**Possible Symptoms:** Very common. Larger populations may cause stunting of plant root system, reduced yields.

**Action Levels:** 200/100cc

**Sampling:** Sample soil when crops are actively growing. Sample stunted areas separately from healthy areas. Can be sampled year around, but populations may decrease as soil temperature cools.

**Management:** Usually standard corn/soybean rotation will control the populations. However, with large populations chemical control in conjunction with crop rotation may be needed.

**Sting Nematode (Belonolaimus)**

**Parasitic Habitat:** Ecto-parasite, found in the soil. Because of its large size, a sandy soil (>80%) is usually needed for populations of Sting nematodes to survive.

**Possible Symptoms:** Root tip swelling, will stop root growth giving roots the appearance of being cut. Seedling plants may sprout and then cease growing completely in larger populations.

**Action Level:** Any detectable level.

**Sampling:** Sample soil when crops are actively growing. Sample stunted areas separately from healthy areas. Can be sampled year around, but populations may decrease as soil temperature cools.

**Management:** Sting nematodes do not have long term survival skills, therefore, a populations will decline quickly in the absence of food. Many crops are host for Sting nematodes. Possible options are genetically modified corn or treated seed corn. Chemical control may also be an option.

**Stubby Root Nematode (Trichodorus/Paratrichodorus)**

**Parasitic Habitat:** Ecto-parasites, found in soil and feed on the root surface. More common in sandy soil.
**Possible Symptoms:** Feeding causes growth and elongation of the roots to cease leading to a “stubby-root” appearance. Is also known to transmit plant viruses through feeding (ex. tobacco rattle virus).

**Action Levels:** 20/100cc

**Sampling:** Sample soil when crops are actively growing. Sample stunted areas separately from healthy areas. Can be sampled year around, but populations may decrease as soil temperature cools.

**Management:** Stubby-root nematodes have a wide host crop range, so rotation in larger populations may be ineffective without the addition of chemical control.

**Root-knot Nematode (Meloidogyne)**

**Parasitic Habitat:** Endo-parasite, found within the root tissue. Adults are infrequently found in soil.
*Presence of suspected juveniles in soil does not confirm presence of Root-knot nematodes, root tissue examination is required.

**Possible Symptoms:** Swelling of infected root tissue (galls). Leaves on infected plants may wilt at midday more readily than healthy plants.

**Action Levels:** Any detectable number (with root tissue confirmation).

**Sampling:** Sample soil when crops are actively growing. Sample stunted areas separately from healthy areas. Can be sampled year around, but populations may decrease as soil temperature cools. Include root tissue sample with soil.

**Management:** Rotation with resistant varieties or not-host crops for lower populations. Chemical control, in conjunction with crop rotation, may be necessary for larger populations.

**Needle Nematodes (Longidorus)**

**Parasitic Habitat:** Ecto-parasite, not found in roots, remains in soil as it feeds. Extremely large nematode. Because of its large size, a sandy soil (>80%) is usually needed for populations of Needle nematodes to survive.

**Possible Symptoms:** Root-tip swelling. Patches of stunted plants may be observed early in the season. Severely reduced yields.

**Action Levels:** Any detectable level.
**Sampling:** Sample soil when crops are actively growing. Sample stunted areas separately from healthy areas. Can be sampled year round, but populations may decrease as soil temperature cools.

**Management:** Nematode is not commonly found in large numbers. Rotation to a non-host or poor host crop is recommended (ex. soybeans, alfalfa).

**Dagger Nematodes (Xiphinema)**

**Parasitic Habitat:** Ecto-parasite, not found in roots, remains in soil as it feeds. Large nematode, able to penetrate deep in to the fibrous tissue when feeding.

**Possible Symptoms:** Root-tip swelling. Patches of stunted plants may be observed early in the season. Severely reduced yields.

**Action Levels:** 100/100cc

**Sampling:** Sample soil when crops are actively growing. Sample stunted areas separately from healthy areas. Can be sampled year round, but populations may decrease as soil temperature cools.

**Management:** Rotation with a non-host or poor host crop (ex: soybeans, winter wheat, and alfalfa)
**Information and Interpretation of Results-Soybean Parasitic Nematodes**

**Soybean Cyst Nematode (Heterodera)**

**Parasitic Habitat:** Cysts, adults, and juveniles found in soil. Once nematode enters the plant roots it will remain sedentary while feeding. Dead females (cysts) can remain in the soil for 12+ years and still produce eggs when soybean plants are introduced.

**Possible Symptoms:** Females are small, yellow, and lemon shaped and can be observed on the roots of infected plants. Symptoms may not appear at the time of first introduction to a field. Damage may only be slight drops in yields. Significant populations may take several years to appear. Above ground damage is often attributed to other problems (ex. nutrient deficiency, compaction, iron, dry conditions). Some HG types will reduce root nodulation.

**Action Levels:** 10/100cc

**Sampling:** Reproduces rapidly. Parasitic and cyst forms can be sampled year around.

**Management:** Soybean Cyst Nematodes have a limited plant host list. Rotation with a resistant soybean variety or non-host crop (ex. corn, alfalfa, wheat) is also recommended.

**Root-knot Nematode (Meloidogyne)**

**Parasitic Habitat:** Endo-parasite, found within root tissue. Adults are infrequently found in soil. *Presence of suspected juveniles in soil does not confirm presence of Root-knot nematodes, root tissue examination is required.

**Possible Symptoms:** Swelling of infected root tissue (galls). Leaves on infected plants may wilt at midday more readily than healthy plants.

**Action Levels:** 100/100cc

**Sampling:** Sample soil when crops are actively growing. Sample stunted areas separately from healthy areas. Can be sampled year around, but populations may decrease as soil temperature cools. Include root tissue with soil sample.

**Management:** Rotation with resistant varieties (corn) or non-host crops. Chemical control may be necessary in large populations.
**Sting Nematodes (Belonolaimus)**

**Parasitic Habitat:** Ecto-parasite, found in the soil. Because of its large size, a sandy soil (>80%) is usually needed for populations of Sting nematodes to survive.

**Possible Symptoms:** Root tip swelling, highly branched appearance. Will stop root growth giving roots the appearance of being cut. Seedling plants may sprout and then cease growing completely in larger populations.

**Action Levels:** Any detectable number.

**Sampling:** Sample soil when crops are actively growing. Sample stunted areas separately from healthy areas. Can be sampled year around, but populations may decrease as soil temperature cools.

**Management:** Sting nematodes do not have long term survival skills, therefore, a population will decline quickly in the absence of food. Many crops are host for Sting nematodes. Possible options are resistant varieties. Chemical control may also be an option.

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**Information and Interpretation of Results - Alfalfa-Hay Nematodes**

**Stem Nematode (Ditylenchus)**

**NOTE:** One species is predominantly predatory on Alfalfa the Stem and Bulb Nematode (Ditylenchus dipsaci). Presence of Stem nematode does not necessarily indicate a problem unless species is confirmed.

**Parasitic Habitat:** Migratory Endo-parasite. Found within crowns, buds, and leaves. Migrate through the plant tissue as they feed.

**Possible Symptoms:** Patches of stunted plants and deformed leaves. Crowns of infected plants may become swollen and discolored. Also, presence of white leaf tissue (flagging).

**Action Levels:** Any detectable level.

**Sampling:** Difficult to detect in soil. Leaf and stem tissue need to be collected and included with soil to confirm presence of species.
Management: Use of resistant alfalfa varieties. Rotation of 2-4 years with a non-host or poor host crop (ex. sorghum, small grains, beans, corn).

**Root-knot Nematodes (Meloidogyne)**

Parasitic Habitat: Endo-parasite, found within root tissue. Adults are infrequently found in soil. *Presence of suspected juveniles in soil does not confirm presence of Root-knot nematodes, root tissue examination is required.

Possible Symptoms: Swelling of infected roots (galls). Leaves on infected plants may wilt at midday more readily than healthy plants.

Action Levels: 50/100cc

Sampling: Sample soil when crops are actively growing. Sample stunted areas separately from healthy areas. Can be sampled year around, but populations may decrease as soil temperature cools. Include root tissue with sample.

Management: Rotation with resistant varieties or non-host crops. Chemical treatments may be needed for larger populations.

**Sting Nematode (Belonolaimus)**

Parasitic Habitat: Ecto-parasite, found in the soil. Because of its large size, a sandy soil (>80%) is usually needed for populations of Sting nematodes to survive.

Possible Symptoms: Root tip swelling, highly branched appearance. Will stop root growth giving the roots the appearance of being cut.

Action Levels: Any detectable level.

Sampling: Sample soil when crops are actively growing. Sample stunted areas separately from healthy areas. Can be sampled year around, but populations may decrease as soil temperature cools.

Management: Sting nematodes do not have long term survival skills, therefore, populations will decline quickly in the absence of food. Plant resistant varieties if possible. however, because of the commitment involved with alfalfa, chemical control may be necessary.
Information and Interpretation of Results-Cotton Nematodes

Root-Knot Nematode (Meloidogyne)

Parasitic Habitat: Endo-parasite, found within the root tissue. Adults are infrequently found in soil. *Presence of suspected juveniles in soil does not confirm presence of Root-knot nematodes, root tissue examination is required.

Possible Symptoms: Swelling of infected root tissue (Galls). Leaves on infected plants may wilt at midday more readily than healthy plants.

Action Levels: Any detectable number (with root tissue confirmation).

Sampling: Sample when plants are actively growing. Include root tissue with soil sample. Sample problem areas separately from areas with healthy plants. Populations will be reduced after harvest when soil temperature cools.

Management: Rotation with resistant varieties or non-host crops (ex. Sorghum, resistant soybeans) for lower populations. Chemical control, in conjunction with crop rotation, may be necessary for higher populations.

Reniform Nematode (Rotylenchulus)

Habitat: Ecto-parasite, found in soil and on surface of root tissue. Feed on the surface of the roots. Populations are more likely to be distributed evenly across the field making observations of damage areas difficult.

Possible Symptoms: Very similar to nutritional deficiencies, plant stunting and discoloration may be present in higher populations (flagging).

Action Levels: 75/100cc

Sampling: Composite sampling, make sure that individual samples do not represent more than 15-20 acres. Sample early season when plants are actively growing. Can be sampled year around. Populations will be reduced after harvest when soil temperature cools.

Management: Reniform nematodes can reproduce, to some extent, on many different crops. For lower populations rotation from cotton to a poor host crop is recommended (ex. soybeans, sorghum or other grass type crop, corn, millet). Chemical control in addition to crop rotation may be needed for larger populations.
**Sting Nematode (Belonolaimus)**

**Habitat:** Ecto-parasite, found in the soil. Because of its large size, a sandy soil (>80%) is usually needed for populations of Sting nematodes to survive.

**Possible Symptoms:** Root tip swelling, will stop root growth giving roots the appearance of being cut. Seedling plants may sprout and then cease growing completely in larger populations.

**Action Levels:** Any detectable level.

**Sampling:** It is important to sample when plants are actively growing. Sample problem areas separately from healthy areas. Populations will be significantly reduced after harvest when soil temperature cools.

**Management:** Sting nematodes do not have long term survival skills, therefore a population will decline quickly in the absence of food. Many crops are host for Sting nematodes, examples of non-host, or poor host, crops are tobacco, peanuts, and alfalfa, this may vary according to climate and region. Chemical control is recommended for most populations if non-host crops are not possible.

**Lance Nematodes (Hoplolaimus)**

**Habitat:** Migratory endo-parasite. Found in the soil and roots, migrates through the roots while feeding. More common in sandy soil (>80%).

**Symptoms:** Stunted root systems, but galls are not present. Distribution in the cotton belt is very limited. Problem areas are usually very clustered across a field. Oval areas in the direction of cultivation are indicative of damage.

**Action Levels:** 25/100cc

**Sampling:** Sample soil when crops are actively growing. Sample stunted areas separately from healthy areas. Can be sampled year around.

**Management:** Even though Lance nematodes are widely distributed across the United States, with a broad range of host crops, only one species appears to seriously damage Cotton plants. Because of the limited distribution of the species, occurrence is infrequent. For lower populations, crop rotation with a non-host or poor host crop is recommended (ex. peanut, alfalfa, and rye grains). For larger populations crop rotation in conjunction with chemical control is recommended.
Information and Interpretation of Results Other Crops

Dry Beans:

*Root-knot Nematode (Meloidogyne)*

**Parasitic Habitat:** Endo-parasite found within root tissue. Presence of juveniles in the soil does not confirm presence. Root tissue examination is needed to confirm presence.

**Possible Symptoms:** Galls on root tissue, Reduced yields.

**Action Levels:** Any detectable number (Root tissue examination)

**Management:** Rotation of resistant varieties with non-host or poor host crops. Use of small grains in conjunction with cover crops may also be effective. Use of nematicides may be needed for larger populations.

**NOTE:** Other nematodes may maintain populations on dry beans (lesion, soybean cyst nematodes) but would only cause damage in high populations (>1500-2000).

Small Grains:

*Root-knot Nematode (Meloidogyne)*

**Parasitic Habitat:** Endo-parasite found within root tissue. Presence of juveniles in the soil does not confirm presence. Root tissue examination is needed to confirm presence.

**Possible Symptoms:** Galls on root tissue, Reduced yields.

**Action Levels:** >25-50/100cc

**Management:** Use of resistant cultivars.

**NOTE:** Other nematodes may maintain populations on small grain crops (cereal cyst nematodes, lesion) but damage is much less common, and populations would need to be large.
**Information and Interpretation of Results-Turfgrass Parasitic Nematodes**

Crop rotation is usually not an option for management of turf-grass nematodes, therefore chemical control is generally recommended. Sampling for turf-grass is generally recommended from mid-spring to early fall (mid-west region)

Recommended action levels for each genus of nematode are general and do not account for soil and climate variations.

**Awl (Dolichodorus)**

*Parasitic Habitat:* Very large ectoparasite, not found in roots. Remains in soil as it feeds.

*Possible Symptoms:* Brown lesions on root tips. Root curvature, dead or dying root tips.

*Action Levels:* Bentgrass, Fescue, Rye, Zoysia: 30 numbers/100cc  
Bermuda, Centipede, St. Augustine: 80 numbers/100cc

**Dagger (Xiphinema)**

*Parasitic Habitat:* Ectoparasite, not found in roots, remains in soil as it feeds.

*Possible Symptoms:* Yellowing and stunting of top growth. Stunted root system with reddish to black lesions.

*Action Levels:* Bermuda, Centipede, Zoysia: 300 numbers/100cc  
Fescue, Rye, St. Augustine: 120 numbers/100cc

**Lance (Hopolaimus)**

*Parasitic Habitat:* Endoparasite, found within plant roots and soil. Migrates through roots while feeding. Found primarily on greens and tee’s.

*Possible Symptoms:* Stunting of top growth. Swelling of roots at feeding site. Increased chance for fungal disease.

*Action Levels:* Bentgrass, Fescue, Rye: 100 numbers/100cc  
Bermuda, Centipede, St. Augustine, Zoysia: 50 numbers/100cc
**Root-Knot (Meloidogyne)**

**Parasitic Habitat:** Endoparasite, found within plant roots and soil. Penetrates root tips and sets up a permanent feeding site at point of infection.

**Possible Symptoms:** General swelling and galls, roots distorted.

**Action Levels:** Bentgrass, St. Augustine: 80 numbers/100cc  
Bermuda, Centipede, Fescue, Rye, Zoysia: 250 numbers/100cc

**Sheath (Hemicycliophora)**

**Parasitic Habitat:** Ectoparasite, not found in roots. Remains in soil as it feeds.

**Possible Symptoms:** Varied depending on climate.

**Action Levels:** Bentgrass, Bermuda, Centipede, Zoysia: 150 numbers/100cc  
Fescue, Rye, St. Augustine: 80 numbers/100cc

**Sting (Belonolaimus)**

**Parasitic Habitat:** Ectoparasite, not found in roots. Remains in soil as it feeds.

**Possible Symptoms:** Stubby roots with large knob like appearances at root tips. Lesions apparent on roots, yellowing and stunted growth.

**Action Levels:** Any detectable number all types of grass.

**Stubby-Root (Paratrichodorus/Trichodorus)**

**Parasitic Habitat:** Ectoparasite, not found in roots. Remains in soil as it feeds.

**Possible Symptoms:** Large brown lesions near root tips. Short stubby roots with swollen tips.

**Action Levels:** Bentgrass, Bermuda, Centipede, Rye, St. Augustine, Fescue, Zoysia: 150 numbers/100cc

**Stunt (Tylenchlorhynchus)**

**Parasitic Habitat:** Ectoparasite, not found in roots. Remains in soil as it feeds.

**Possible Symptoms:** Roots shriveled; short and sparse
**Action Levels:** Bentgrass, Fescue, Rye: 100 numbers/100cc  
St. Augustine: 200 numbers/100cc

*Ring (Criconemella)*

Very little damage unless found at high levels: 500 numbers/100cc

*Non-parasitic (Benign)*

Not harmful to crops, found in most soil.