Important Instructions on Use of Nematode Guidelines

Introduction

Plant-parasitic nematodes are small, microscopic, threadlike animals that possess a stylet which allows them to puncture and feed from plant cells. All cultivated soils contain some plant-parasitic nematodes. They may feed on roots, in roots, and in and on foliage. All are found in the soil at some stage of their life cycle. Eggs are deposited in the areas where they feed either separately or grouped in an old body wall or sticky mass. The nematode life cycle is typically completed in about 30 days when weather conditions are good for nematode development. Most nematodes grow best in moderate temperature and moisture conditions. They may overwinter as eggs or as any one of the various stages of their life cycle. Often, newly hatched juveniles are the infective stage if the nematode feeds on the inside of the plant. The laboratory results that you will get from sending in a "nematode sample" are counts of the total number of all the life stages found in the soil. Nematode species are sensitive to soil type, moisture and temperature. Hence, there is a northern root-knot nematode and a southern root-knot nematode. Sting nematodes are found only in sandy soils and awl nematodes are found most often in wet soils. A few genera, like lesion nematodes, are found in most places where crops are grown. Plant-parasitic nematodes tend to colonize certain areas in fields, which results in an uneven distribution.

The number of plant-parasitic nematodes it takes to cause economic damage varies greatly with the different species. As an example, if you find one sting nematode in a sample, that means economic damage is likely to occur. However, it takes as many as 500 ring nematodes per 100 cubic centimeters of soil to do measurable damage to some turfgrasses. The concept of using nematode damage thresholds is based on knowing the nematode species present and the number of that species it will take to cause measurable damage to a particular host plant.

There are several ways to lessen the potentially damaging effects of plant-parasitic nematodes. Nonhost crops, host-plant resistance, host-plant tolerance, fallow, green manure crops, organic additives and nematicidal chemicals are all legitimate approaches to preventing unacceptable losses to nematodes. Combinations of control methods often work well and may be the best approach to avoiding economic losses. Very few chemicals are available for noncommercial crop situations. In such cases, other approaches are the only defense. For instance, if nematodes in a lawn are the problem, learning the best cultural practices to let you live with nematode infestations may be the only logical choice. If your problem involves cotton or commercial sod, then there may be nematicides that can be profitably applied. For these reasons, several kinds of controls may be suggested for a given nematode-crop situation.

Sampling for Nematodes

The number of nematodes recovered from soil can vary greatly, depending upon the time of year and the stage of crop or plant development at the time the samples are taken. Many other factors can be involved. The guidelines in this publication are based on samples taken near or at the time of maturity of annuals (row crops, plant beds, etc.) and during the summer and early fall for perennials (shrubs, fruit trees, turfgrasses, etc.). Samples taken during the winter and early spring are less reliable, and in some situations, certain nematodes, including root knot and sting, may be missed entirely. However, for some crops there will be notations that will help interpret numbers of nematodes recovered from samples taken at different times of the year. For instance, the number of ring nematodes recovered about peach roots may be higher in the spring than at other times of the year. Research has demonstrated that the number of root-knot nematodes recovered in late winter and early spring will be about one-twentieth of the number found at crop maturity. For a few species, there is not an important difference between numbers taken at crop maturity and in the spring. The Columbia lance nematode is an example.

Often a plant-parasitic nematode population is made up of two or more genera. When that happens, interpretation of counts is a little more complex. As a general rule, the effects are additive. If counts for each of two or more genera are close to economic threshold levels, then the total population should be considered damaging and controls considered. Chemical controls will usually be effective even if there is a mixed population. Caution should be exercised when rotations and resistance are considered for a mixed population because host status may be different for each nematode genus or species. More than one control method may need to be applied.

How to Use Nematode Assay Laboratory Results

Results of nematode counts can be used to make management decisions in at least the following ways.

1. To determine if nematode problems exist in fields and where in the fields control measures should be applied.

2. To help identify a possible cause of poor-growing crops or plants.

3. Thorough sampling well in advance of planting can reveal the plant-parasitic nematode numbers present and provide a guideline for selecting resistant or tolerant varieties, a nonhost crop, or a nematicidal treatment.

Sampling Procedures for Nematodes

The instructions given below are for field sampling for plant-parasitic nematodes. The principles involved are the same regardless of the crop and location. Some modifications may need to be made to accommodate such crops as potted plants, mixed plant species and perennial plants.

1. Most nematodes are in the “root zone” and samples should be taken to represent that area. Samples should be taken from both poor-growing and healthy plants. Root extractions for endoparasitic nematodes are available upon request. Please contact the Nematode Assay Laboratory for sampling guidelines.

2. The Nematode Assay Laboratory at Clemson University recommends that samples be taken when the soil is moist but not wet and be made up of 10 to 20 small samples from an area of no more than 10 acres in size. The composite sample should be one quart. A good procedure is to use a 1-inch core sampler. If that is not available, use a shovel to cut through the soil profile and then take a 1- to 2-inch slice from the edge of the opening to simulate a core. Include feeder roots.

3. For field crops, sample 6 to 8 inches deep in the root zone in a zig-zag pattern over the field; for turfgrass, sample 3 to 5 inches deep in a zig-zag pattern. If there are dead or dying areas, take the sample from the interface of the good and poor spots; for trees, shrubs and vines, sample 12 to 15 inches deep in a zig-zag pattern under the canopy at the drip line.

4. Place the mixed sample in a plastic bag supplied by the county Extension office and label with your name and field number. Label the outside of the bag with location information using a permanent marker.

5. Keep samples cool, below 80 °F if practical, and out of direct sunlight. Do not put samples in the back of trucks, trunks or noninsulated floorboards of trucks or cars. Take samples to the county Extension office or to the Nematode Assay Laboratory at the Agricultural Service Laboratory as soon as you can.

6. Fill out the submission form as completely as you can. Accurate information helps the diagnosticians do a better job for you. Any answers you may receive will be only as good as the sample that is processed. There is a fee for identifying and counting plant-parasitic nematodes.

Root-Knot and Other In-Root Nematodes

1. Live specimens are needed to determine species of root-knot and some other species of plant-parasitic nematodes that are located inside plant roots. Submit live plants with three or more roots showing nematode damage (galls or lesions), keeping the soil about the roots.

2. Mature root-knot females can be found only from mid-June through September in South Carolina.

3. Determining root-knot nematode species is especially valuable for soybean, tobacco and peanut. Please provide the name of the crop and the crop variety when submitting samples. There is a fee for root-knot nematode speciation.

Services

Laboratory technicians will identify to genus and count the number of each genus of plant-parasitic nematode recovered from the sample(s). These results will be matched with appropriate recommendations derived from the information supplied. Your county agent will be sent a copy of the information shortly after the sample is processed by the Nematode Assay Laboratory. Information on nematode control for South Carolina is presented in various Clemson University bulletins and leaflets prepared for growers. These are updated regularly and only the latest updated information should be used. The bulletins and leaflets are available in county Extension offices.

Acknowledgement

These plant-parasitic nematode action level guidelines for agent and grower use were developed from data and publications from the Southeastern region of the United States. Our thanks are expressed to the nematologists and plant pathologists of the region for their support.

This is the second revision of the nematode guidelines for South Carolina and includes several changes to take advantage of the new information available. The guidelines are meant to assist growers and advisors in making decisions about controlling plant-parasitic nematodes. The numbers given are not absolute. The level of management, potential yield for a given crop and the cost of treatment will determine in many cases whether control is profitable. Producers ultimately will have to make the decision.

Much credit is due to the late Dr. Fred Smith who originated the first edition of the guidelines and felt strongly that such information should be made available to all those who would be faced with dealing with the tiny pests called nematodes. His foresight is gratefully acknowledged. This latest version was prepared by the nematologists and plant pathologists of the Department of Plant Pathology and Physiology at Clemson University and the Nematode Assay Laboratory of the Clemson University Agricultural Service Laboratory. Dr. O. J. Dickerson, Mr. James H. Blake and Dr. Stephen A. Lewis served as editors.

This document can be found on the World Wide Web at http://pppweb.clemson.edu/nematodeguidelines.htm.

CROP TO BE PLANTED IS EITHER FIELD OR SWEET CORN

Nematode	ACTION LEVELS Nematodes per 100 cc of soil Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	Control options**
Columbia lance *Hoplolaimus columbus*	1-55 56-99 100+	1-149 150-199 200+	1-32 33-49 50+	A,E B,C B,C,D
Dagger *Xiphinema americanum*	1-199 200+	1-399 400+	1-79 80+	A,E B,C,D
Ring *Criconemella* spp.	1-199 200+	1-599 600+	1-199 200+	A,E B,C,D
Root knot *Meloidogyne* spp.	1-149 150-299 300+	1-199 200-399 400+	1-49 50-149 150+	A,E B,C B,C,D
Lesion *Pratylenchus* spp.	1-199 200-499 500+	1-199 200-499 500+	1-49 50-89 90+	A,E B,C B,C,D
Spiral *Helicotylenchus* spp.	1-499 500+	1-699 700+	1-199 200+	A,E B,C,D
Sting *Belonolaimus longicaudatus*	4+	NA	1+	B,D
Stubby root *Paratrichodorus minor*	1-9 10-39 40+	1-49 50-79 80+	1-3 4-13 14+	A,E B,C B,C,D
Stunt *Tylenchorhynchus* spp.	1-499 500+	1-999 1,000+	1-249 250+	A,E B,C,D

*When soil is prepared for planting, nematodes become scattered and will be fewer when compared to samples taken from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*****. D - An approved nematicide can be of value*******. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publications, *Diseases and Insects of Corn in South Carolina* (EC 601), and *Pest Management Handbook, Volume 1* (EC 670), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: All nematodes listed may cause economic losses, especially in sandy soils. When two or more genera are near the economic threshold, it is an indication that significant losses are occurring. The higher the yield potential, the greater the loss potential. Recommendations are based on populations taken at the end of a growing season. Samples taken in the winter will have lower populations. Some genera such as root-knot and sting nematodes overwinter as eggs which are not recovered in the routine soil processing procedures. Therefore, a zero count at that time of year does not necessarily mean that damaging populations will not occur. For root-knot nematodes, multiply samples taken in January or later by 20.

CROP TO BE PLANTED IS COTTON

Nematode	ACTION LEVELS Nematodes per 100 cc of soil			Control options**
	Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	
Columbia lance *Hoplolaimus columbus*	1-49 50-99 100+	1-99 100-149 150+	1-16 17-33 34+	A,E B,C B,C,D
Lance *Hoplolaimus galeatus*	1-199 200-249	1-249 250-349 250+	1-69 70-89 350+	A,E B,C 90+ B,C,D
Reniform *Rotylenchulus reniformis*	1-49 50-749 750+	1-49 50-749 750+	1-15 16-149 150+	A,E B,C B,C,D
Ring *Criconemella* spp.	1-399 400+	1-599 600+	1-139 140+	A,E B,C,D
Root knot *Meloidogyne incognita*	1-49 50-99 100+	1-99 100-129 130+	1-16 17-39 40+	A,E B,C B,C,D
Lesion *Pratylenchus* spp.	1-49 50-99 100+	1-79 80-149 150+	1-16 17-32 33+	A,E B,C B,C,D
Spiral *Scutellonema* spp. & *Helicotylenchus* spp.	1-799 800+	1-999 1,000+	1-264 265+	A,E B,C,D
Sting *Belonolaimus longicaudatus*	10+	NA	1+	B,D
Stunt *Tylenchorhynchus* spp.	1-599 600+	1-799 800+	1-199 200+	A,E B,C,D

*When soil is prepared for planting, nematodes become scattered and will be fewer when compared to samples taken from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*****. D - An approved nematicide can be of value*******. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publications, *South Carolina Cotton Growers Guide* (EC 589), and *Pest Management Handbook, Volume 1* (EC 670), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: Cotton varieties recommended for South Carolina will have varying levels of root knot tolerance. Always use in-furrow subsoiling. About 50 percent of the cotton acreage is infested with damaging levels of plant-parasitic nematodes. *H. columbus*, the Columbia lance nematode, is the most common, existing in about 40 percent of all fields and is found over the entire cotton-growing regions of the state. Root knot is more common in the Savannah Valley area and reniform nematodes are more prevalent in the Pee Dee area.

Numbers of nematodes are for samples taken at the end of a growing season. For samples taken in late winter, multiply the numbers returned by 20 for root-knot nematodes, 5 for reniform nematodes and use as they are for Columbia lance nematodes.

CROP TO BE PLANTED IS COMMERCIAL PEANUTS

Nematode	ACTION LEVELS Nematodes per 100 cc of soil			Control options**
	Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	
Dagger *Xiphinema americanum*	1-49 50+	1-79 80+	1-16 17+	A,E B,C
Ring *Criconemella* spp.	1-49 50+	1-79 80+	1-16 17+	A,E B,C,D
Lesion *Pratylenchus brachyurus*	1-7 8-24 25+	1-11 12-39 40+	1-2 3-7 8+	A,E B,C B,C,D
Root knot *Meloidogyne arenaria*	1-49 50+	1-99 100+	1-16 17+	A,E B,C,D
Spiral *Helicotylenchus* spp. & *Scutellonema* spp.	1-199 200+	1-249 250+	1-64 65+	A,E B,C
Sting *Belonolaimus longicaudatus*	1-7 8+	NA	1-3 4+	A,E B,C,D
Stubby root *Paratrichodorus minor*	1-49 50+	1-79 80+	1-16 17+	A,E B,C

*When soil is prepared for planting, nematodes become scattered and will be fewer when compared to samples taken from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*****. D - An approved nematicide can be of value*******. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publications, *Peanut Production Guide for South Carolina* (EC 588), and *Pest Management Handbook, Volume 1* (EC 670), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: Peanuts are a nonhost for the Southern root-knot nematode, *Meloidogyne incognita*, and for race 2 of *Meloidogyne arenaria.* Race 1 of *Meloidogyne arenaria* is damaging to peanut. Cotton is a good rotation crop because it is a nonhost for *Meloidogyne arenaria*. Of the nematodes listed, root knot can be the most serious although it is not in most South Carolina peanut fields. Ring and lesion nematodes are common and often cause economic losses. Fields to be planted in peanuts should be sampled for plant-parasitic nematodes at the end of the growing season for the crop now in the field. If sampling is delayed until winter, it is likely that some populations large enough to cause economic damage will be missed. Root knot counts from samples taken in late winter should be multiplied by 20, ring populations by 5 and lesion populations by 5.

CROP TO BE PLANTED IS SORGHUM

Nematode	ACTION LEVELS Nematodes per 100 cc of soil			Control options**
	Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	
Columbia lance *Hoplolaimus columbus*	1-49 50+	1-149 150+	1-32 33+	A,E B,C
Dagger *Xiphinema americanum*	1-199 200+	1-399 400+	1-79 80+	A,E B,C
Ring *Criconemella* spp.	1-199 200+	1-599 600+	1-199 200	A,E B,C
Root knot *Meloidogyne* spp.	1-149 150-299 300+	1-199 200-399 400+	1-49 50-149 150+	A,E B,C B,C,D
Lesion *Pratylenchus* spp.	1-29 30-79 80+	1-99 100-149 150+	1-16 17-39 40+	A,E B,C B,C,D
Spiral *Helicotylenchus* spp. & *Scutellonema* spp.	1-499 500+	1-699 700+	1-199 200+	A,E B,C
Sting *Belonolaimus longicaudatus*	1-3 4+	NA	1+	A,E B,D
Stubby root *Paratrichodorus minor*	1-9 10-39 40+	1-49 50-79 80+	1-3 4-13 14+	A,E B,C B,C,D
Stunt *Tylenchorhynchus* spp.	1-499 500+	1-999 1,000+	1-249 250+	A,E B,C

*When soil is prepared for planting, nematodes become scattered and will be fewer when compared to samples taken from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*****. D - An approved nematicide can be of value*******. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publication, *Pest Management Handbook, Volume 1* (EC 670), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: The nematode genera most likely to be damaging are sting, stubby root and lesion. Sorghum usually results in lower populations of root knot and lance species but there may be damage to the current sorghum crop.

CROP TO BE PLANTED IS SOYBEAN

Nematode	ACTION LEVELS Nematodes per 100 cc of soil			Control options**
	Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	
Dagger *Xiphinema americanum*	1-249 250+	1-349 350+	1-79 80+	A,E B,C,D
Columbia lance *Hoplolaimus columbus*	1-49 50+	1-79 80+	1-16 17+	B,C B,C,D
Lesion *Pratylenchus* spp.	1-149 150+	1-199 200+	1-49 50+	A,C B,D
Reniform *Rotylenchulus reniformis*	1-99 100+	1-99 100+	1-49 50+	A,E B,C,D
Ring *Criconemella* spp.	1-199 200+	1-299 300+	1-59 60+	A,E B,C,D
Root knot *Meloidogyne arenaria*	1-39 40-79 80+	1-49 50-99 100+	1-13 14-26 27+	A,E B,C B,C,D
Root knot *Meloidogyne incognita*	1-99 100-199 200+	1-149 150-249 250+	1-29 30-69 70+	A,E B,C B,C,D
Soybean cyst *Heterodera glycines*	1-39 40-69 70+	1-39 40-69 70+	1-16 17-39 40+	A,E B,C B,C,D
Spiral *Helicotylenchus* spp. & *Scutellonema* spp.	1-599 600+	1-799 800+	1-199 200+	A,E B,C,D
Sting *Belonolaimus longicaudatus*	1-3 4+	NA	1+	A,E B,C,D
Stubby root *Paratrichodorus* spp.	1-49 50+	1-99 100+	1-16 17+	A,E B,C,D
Stunt *Tylenchorhynchus* spp.	1-699 700+	1-799 800+	1-229 230+	B,C,E B,C,D

*When soil is prepared for planting, nematodes become scattered and will be fewer when compared to samples taken from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*****. D - An approved nematicide can be of value*******. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publications, *Soybean Nematode Control* (SL 2); *Soybean Insects, Nematodes, and Diseases* (EC 504); and *Pest Management Handbook, Volume 1* (EC 670), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: The major nematodes are root knot, cyst, lance and sting. Root knot and lance are best controlled by resistant or tolerant varieties, in-row subsoiling, and crop rotations. Soybean cyst nematodes are best controlled with a combination of rotations with nonhosts and judicious use of resistant and susceptible cultivars. Sting alone may be managed by nematicides combined with deep tillage. Consult SC Soybean Leaflet 2 for the latest list of recommended cultivars for South Carolina. It is necessary to know the species of root knot and the race of the soybean cyst nematode to make resistant varieties useful. Root knot species sometimes can be assumed by the previous crop. If cotton was the previous crop, the species is probably *M. incognita.* If the previous crop was peanut, then the species is probably *M. arenaria.* For samples taken in late winter, multiply the numbers returned by 20 for root knot and 5 for reniform. Use the rest as they are.

CROP TO BE PLANTED IS TOBACCO

Nematode	ACTION LEVELS Nematodes per 100 cc of soil Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	Control options**
Dagger *Xiphinema americanum*	1-399 400+	1-499 500+	1-129 130+	B,C B,C,D
Root knot *Meloidogyne arenaria &* *Meloidogyne javanica*	1-20 21+	1-29 30+	1-7 8+	B,C,E B,C,D
Root knot *Meloidogyne incognita*	1-99 100+	1-99 100+	1-33 34+	A,C B,C,D
Lesion *Pratylenchus brachyurus*	1-39 40-79 80+	1-59 60-99 100+	1-13 14-39 40+	A B,C B,D
Spiral *Scutellonema* spp. & *Helicotylenchus* spp.	1-399 400+	1-449 450+	1-129 130+	B,C B,C,D
Stubby root *Paratrichodorus minor*	1-799 800+	1-899 900+	1-264 265+	B,C B,C,D
Stunt *Tylenchorhynchus* spp.	1-249 250+	1-279 280+	1-79 80+	A B,D

*When soil is prepared for planting, nematodes become scattered and will be fewer when compared to samples taken from about living plant roots.

**A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem.
C - Apply cultural controls. See crop recommendations*******. D - An approved nematicide can be of value*******.
E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publications, *South Carolina Tobacco Growers Guide* (EC 569), and *Pest Management Handbook, Volume 1* (EC 670), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: The most common nematode on tobacco is the Southern root-knot nematode, *Meloidogyne incognita.* Another species, *M. arenaria*, the peanut root-knot nematode is prevalent and is more damaging. Varieties resistant to *M. incognita* probably will not be resistant to *M. arenaria.* It takes fewer *M. arenaria* to cause economic damage. *M. javanica* is not common but is very damaging when present. It is important to know the species of root-knot nematode present in fields to be planted in tobacco. There is a good chance that fields will have a mixture of species. This is the reason galls may be present on "resistant" varieties. See county Extension offices for details on getting a species identification. Rotation is effective for both root knot species and should provide the basis for management of nematode populations. A lesion nematode, *Pratylenchus brachyurus*, does not increase in numbers on tobacco but relatively low populations will cause severe stunting at the beginning of the season. Numbers of root knot in samples taken in the winter should be multiplied by 20. Use numbers for other species as they are.

CROP TO BE PLANTED IS WHEAT

Nematode	ACTION LEVELS Nematodes per 100 cc soil			Control options**
	Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	
Lesion *Pratylenchus* spp.	1-499 500+	1-499 500+	1-249 250+	A,E B,C
Ring *Criconemella* spp.	1-299 300+	1-299 300+	1-129 130+	A,E B,C
Stunt *Tylenchorhynchus* spp.	1-99 100+	1-99 100+	1-79 80+	A,E B,C

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A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*****. D - An approved nematicide can be of value*******. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publication, *Pest Management Handbook, Volume 1* (EC 670), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: All nematodes listed may cause economic losses, especially in sandy soils. When two or more genera are near the economic threshold, it is an indication that significant losses may occur. The higher the yield potential, the greater the loss potential. Recommendations are based on populations taken at the end of a growing season. Samples taken at other times of the year may not give a true reflection of the damage potential because some nematodes survive over the noncrop season as eggs and, as such, would not be picked up in routine sampling.

CROP TO BE PLANTED IS COMMERCIAL BEANS OR COWPEAS

Nematode	ACTION LEVELS Nematodes per 100 cc of soil			Control options**
	Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	
Awl *Dolichodorus* spp.	1-99 100+	NA	1-3 4+	A,E B,C,D
Columbia lance *Hoplolaimus columbus*	1-99 100+	1-149 150+	1-32 33+	A,E B,C,D
Ring *Criconemella* spp.	1-199 200+	1-299 300+	1-39 40+	A,E B,C,D
Root knot *Meloidogyne incognita*	1-11 12+	1-11 12+	1-5 6+	A,E B,C,D
Lesion *Pratylenchus* spp.	1-49 50+	1-99 100+	1-16 17+	A,E B,C,D
Spiral *Helicotylenchus* spp. & *Scutellonema* spp.	1-199 200+	1-299 300+	1-69 70+	A,E B,C,D
Sting *Belonolaimus longicaudatus*	1-7 8+	NA	1+	B,C,D B,C,D
Stubby root *Paratrichodorus minor*	1-99 100+	1-199 200+	1-79 80+	A,E B,C,D
Stunt *Tylenchorhynchus* spp.	1-199 200+	1-299 300+	1-79 80+	A,E B,C,D

*When soil is prepared for planting, nematodes become scattered and will be fewer when compared to samples taken from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*****. D - An approved nematicide can be of value*******. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publication, *Pest Management Handbook, Volume 1* (EC 670), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: When two or more genera are near threshold level, significant damage may occur. There is resistance to root-knot nematodes in cowpea and a few varieties of beans. The most damaging nematodes will be root knot and sting species. Threshold numbers are based on end of the season counts. Counts taken in midwinter should be multiplied by 20 for root knot. Because these nematodes overwinter as eggs, zero counts from samples taken in winter do not mean damage will not occur.

CROP TO BE PLANTED IS COMMERCIAL CANTALOUPES

Nematode	ACTION LEVELS Nematodes per 100 cc of soil			Control options**
	Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	
Dagger *Xiphinema americanum*	1-199 200+	1-249 250+	1-69 70+	A,B,E B,C,D
Ring *Criconemella* spp.	1-199 200+	1-239 240+	1-69 70+	A,E B,C
Root knot *Meloidogyne incognita*	1-9 10-19 20+	1-13 14-24 25+	1-3 4-8 9+	A,E B,C B,C,D
Lesion *Pratylenchus* spp.	1-49 50-119 120+	1-89 90-199 200+	1-16 17-39 40+	A,E B,C B,C,D
Spiral *Helicotylenchus* spp. & *Scutellonema* spp.	1-199 200+	1-224 225+	1-69 70+	A,E B,C
Sting *Belonolaimus longicaudatus*	1+	NA	1+	B,D
Stunt *Tylenchorhynchus* spp.	1-249 250+	1-299 300+	1-79 80+	B,C B,C,D

*When soil is prepared for planting, nematodes become scattered and will be fewer when compared to samples taken from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*. D - An approved nematicide can be of value***.
E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publication, *Pest Management Handbook, Volume 1* (EC 670), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: The major nematode will be root knot and there is no resistance in commercial cantaloupes. Sampling for plant-parasitic nematodes before planting is especially advisable for crops such as cantaloupes because the kinds of crops grown the preceding season make a difference in the kinds of plant-parasitic nematodes present as well as their population level. Recommendations are based on populations taken at the end of a growing season in late summer or early fall. Samples taken in the winter will probably have lower populations. Genera such as sting and root knot may not be recovered. These nematodes overwinter as eggs which are not recovered in the routine soil processing procedures. Therefore, a zero count at that time of year does not necessarily mean that damaging populations will not occur. If specimens of sting or root-knot nematodes are recovered at any level in the winter or spring, there is a good chance that economic damage will occur.

CROP TO BE PLANTED IS COMMERCIAL COLE CROPS (BROCCOLI, TURNIPS, CABBAGE, COLLARDS)

Nematode	ACTION LEVELS Nematodes per 100 cc of soil			Control options**
	Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	
Columbia lance *Hoplolaimus columbus*	1-99 100+	1-149 150+	1-32 33+	A,E B,C,D
Ring *Criconemella* spp.	1-99 100+	1-149 150+	1-32 33+	A,E B,C
Root knot *Meloidogyne incognita*	1-16 17+	1-16 17+	1-16 17+	A,C,E B,C,D
Lesion *Pratylenchus* spp.	1-99 100+	1-129 130+	32 33+	A,E B,C
Spiral *Helicotylenchus* spp. & *Scutellonema* spp.	1-199 200+	1-249 250+	1-99 100+	A,E B,C
Sting *Belonolaimus longicaudatus*	1-29 30+	NA	1-9 10+	B,C, B,D
Stubby root *Paratrichodorus minor*	1-99 100+	1-119 120+	1-32 33+	A,E B,C
Stunt *Tylenchorhynchus* spp.	1-149 150+	1-199 200+	1-49 50+	A,E B,C

*When soil is prepared for planting, nematodes become scattered and will be fewer when compared to samples taken from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*. D - An approved nematicide can be of value***. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publication, *Pest Management Handbook, Volume 1* (EC 670), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: Because of the cool temperatures, cole crops grown as winter and early-spring crops should not be greatly damaged unless the previous season's crop was heavily infested. Crops planted in late summer may be severely damaged since the temperatures are ideal for nematode development. Sampling before planting for a fall crop should be routine. When two or more genera are near threshold level, significant damage probably will occur.

CROP TO BE PLANTED IS COMMERCIAL IRISH POTATO

Nematode	ACTION LEVELS Nematodes per 100 cc soil			Control options**
	Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	
Columbia lance *Hoplolaimus columbus*	1-49 50+	1-79 80+	1-19 20+	A,E B,C,D
Dagger *Xiphinema americanum*	1-199 200+	1-249 250+	1-69 70+	A,E B,C,D
Ring *Criconemella* spp.	1-249 250+	1-299 300+	1-79 80+	A,E B,C,D
Root knot *Meloidogyne incognita* & *Meloidogyne arenaria*	1-9 10-19 20+	1-14 15-39 40+	1-5 6-9 10+	A,E B,C B,C,D
Lesion *Pratylenchus brachyurus*	1-99 100+	1-149 150+	1-32 33+	A,E B,C,D
Spiral *Helicotylenchus* spp. & *Scutellonema* spp.	1-249 250+	1-399 400	1-89 90+	A,E B,C
Sting *Belonolaimus longicaudatus*	1-7 8+	NA	1-3 4+	B,C,D B,C,D
Stubby root *Paratrichodorus minor*	1-199 200+	1-229 230	1-64 65+	A,E B,C,D
Stunt *Tylenchorhynchus* spp.	1-249 250+	1-299 300	1-64 65+	A,E B,C,D

*When soil is prepared for planting, nematodes become scattered and will be fewer when compared to samples taken from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*****. D - An approved nematicide can be of value*******. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publication, *Pest Management Handbook, Volume 1* (EC 670), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: When two or more genera are near threshold level, significant damage probably will occur. The most damaging nematodes will be root knot, sting and lesion species. Threshold numbers are based on end of the season counts. Counts taken in midwinter or later should be multiplied by 20 for root knot. Because these nematodes overwinter as eggs, zero counts from samples taken in winter does not mean damage will not occur.

CROP TO BE PLANTED IS COMMERCIAL CUCUMBER OR SQUASH

Nematode	ACTION LEVELS Nematodes per 100 cc of soil			Control options**
	Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	
Columbia lance *Hoplolaimus columbus*	1-49 50+	1-99 100+	1-16 17+	A,E B,C,D
Dagger *Xiphinema americanum*	1-199 200+	1-249 250+	1-59 60+	B,C B,C,D
Ring *Criconemella* spp.	1-199 200+	1-224 225+	1-69 70+	A,E B,C
Root knot *Meloidogyne incognita*	1-9 10+	1-12 13+	1-3 4+	A,E B,C,D
Lesion *Pratylenchus* spp.	1-49 50-129 130+	1-79 80-149 150+	1-8 9-16 17+	A,E B,C B,C,D
Spiral *Helicotylenchus* spp. & *Scutellonema* spp.	1-199 200+	1-225 226+	1-64 65+	A,E B,C
Sting *Belonolaimus longicaudatus*	1-7 8+	NA	1-3 4+	B,C B,D
Stunt *Tylenchorhynchus* spp.	1-79 80+	1-99 100+	1-19 20+	A,E B,C

*When soil is prepared for planting, nematodes become scattered and will be fewer when compared to samples taken from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*****. D - An approved nematicide can be of value*******. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publication, *Pest Management Handbook, Volume 1* (EC 670), available from county Extension offices or the Clemson Extension Bulletin Room (864-656- 3261).

NOTES: The major nematode will be root knot, and there is no resistance in commercial cucumbers or squash. The kinds of crops grown the preceding season make a difference in both the kinds and population levels of plant-parasitic nematodes. Recommendations are based on populations taken at the end of a growing season in late summer or fall. Samples taken in the winter will have lower counts. Genera such as root knot and sting may not be recovered. These nematodes overwinter as eggs which are not recovered in the routine soil processing procedures. Therefore, a zero count at that time of year does not necessarily mean that damaging populations will not be present. If specimens of sting or root-knot nematodes are recovered at any level, there is a good chance that economic damage will occur.

CROP TO BE PLANTED IS COMMERCIAL SWEET POTATO

Nematode	ACTION LEVELS Nematodes per 100 cc of soil Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	Control options**
Columbia lance *Hoplolaimus galeatus*	1-599 600+	1-799 800+	1-199 200+	A,E B,C
Reniform *Rotylenchulus reniformis*	1-4 5+	1-9 10+	1-2 3+	A,E B,C,D
Root knot *Meloidogyne* spp.	1-9 10-49 50+	1-19 20-79 80+	1-3 3-5 6+	A,E B,C B,C,D
Lesion *Pratylenchus* spp.	1-49 50-99 100+	1-79 80-129 130+	1-16 17-32 33+	A,E B,C B,C,D
Spiral *Helicotylenchus* spp. & *Scutellonema* spp.	1-249 250+	1-179 180+	1-79 80+	A,E B,C
Sting *Belonolaimus longicaudatus*	1-9 10+	NA	1-3 4+	A B,D
Stunt *Tylenchorhynchus* spp.	1-149 150+	1-179 180+	1-49 50+	A,E B,D

*When soil is prepared for planting, nematodes become scattered and will be fewer when compared to samples taken from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*****. D - An approved nematicide can be of value*******. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publication, *Pest Management Handbook, Volume 1* (EC 670), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: Usually nematode control for sweet potato production is a multi-step process. Crop rotation is the first step. Root knot and reniform are most likely to cause problems. Both nematodes have wide host ranges. As a general rule, corn is the best of the vegetable crops for rotation. Never follow sweet potatoes with sweet potatoes. The next step is to use resistant varieties where practical. Several varieties have resistance to *Meloidogyne incognita*. Transplants should be from nematode-free "seed" stock grown in beds treated with an all-purpose pesticide. If it is suspected that the "seed" or soil is infested, either use root cuttings in sterilized soil or unrooted cuttings to avoid taking more problems to the field. Several nematicides can be used to help control plant-parasitic nematodes. Generally, fumigants have performed better than nonfumigants.

CROP TO BE PLANTED IS TOMATOES, PEPPERS, EGGPLANT, OKRA

Nematode	ACTION LEVELS Nematodes per 100 cc of soil Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	Control options**
Dagger *Xiphinema americanum*	1-199 200+	1-249 250+	1-64 65+	B,C B,C,D
Ring *Criconemella* spp.	1-199 200+	1-249 250+	1-64 65+	A,E B,C,D
Root knot *Meloidogyne incognita* & *Meloidogyne arenaria*	1-9 10-19 20+	1-19 20-29 30+	1-3 4-10 11+	A,E B,C B,C,D
Lesion *Pratylenchus* spp.	1-99 100+	1-149 150+	1-79 80+	B,C B,C,D
Spiral *Helicotylenchus* spp. & *Scutellonema* spp.	1-279 280+	1-299 300+	1-89 90+	B,C B,C,D
Sting *Belonolaimus longicaudatus*	1-3 4+	NA	1+	B,C B,C,D
Stubby root *Paratrichodorus minor*	1-199 200+	1-225 226+	1-32 33+	B,C B,C,D
Stunt *Tylenchorhynchus* spp.	1-249 250+	1-299 300+	1-79 80+	B,C B,C,D

*When soil is prepared for planting, nematodes become scattered and will be fewer compared to samples taken from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*****. D - An approved nematicide can be of value*******. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publication, *Pest Management Handbook, Volume 1* (EC 670), available from county Extension offices or the Clemson Extension Bulletin Room (864-656- 3261).

NOTES: The major nematodes will be root knot, sting and sometimes stubby root. Root knot will be in sand and many of the coastal soils with high organic matter. Sting will be found in the more sandy soils. Stubby root may be in both soil types. Recommendations are based on populations at the end of the growing season. Samples taken in winter or early spring will probably have lower populations. Root-knot and sting nematodes overwinter as eggs and the eggs will not be recovered by normal soil processing. Therefore, a zero count at that time of year does not necessarily mean little or no damage. If specimens of sting or root-knot nematodes are recovered at any level in the spring, there is a good chance economic damage will occur.

CROP TO BE PLANTED IS WATERMELON

Nematode	ACTION LEVELS Nematodes per 100 cc of soil Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	Control options**
Dagger *Xiphinema americanum*	1-299 300+	1-349 350+	1-89 90+	A,E B,C
Columbia lance *Hoplolaimus columbus*	1-89 90+	1-149 150+	1-32 33+	A,E B,C,D
Ring *Criconemella* spp.	1-299 300+	1-299 300+	1-69 70+	A,E B,C
Root knot *Meloidogyne* spp.	1-9 10-19 20+	1-16 17-32 33	1-3 4-5 6+	A,E B,C B,C,D
Lesion *Pratylenchus* spp.	1-49 50-119 120+	1-79 80-199 200+	1-16 17-32 33+	A,E B,C B,C,D
Stubby root *Paratrichodorus minor*	1-99 100+	1-149 150+	1-32 33+	B,C B,C,D
Stunt *Tylenchorhynchus* spp.	1-249 250+	1-299 300+	1-79 80+	B,C B,C

*When soil is prepared for planting, nematodes become scattered and will be fewer compared to samples taken from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*****. D - An approved nematicide can be of value*******. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publication, *Pest Management Handbook, Volume 1* (EC 670), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: The major nematode will be root knot and there is no resistance in commercial varieties. The kinds of crops grown the preceding season make a difference in the kinds of plant-parasitic nematodes present as well as their population level. Recommendations for the next crop are based on populations at the end of the growing season of the previous crop. Samples taken in winter or early spring will probably have lower populations. Root-knot nematodes overwinter as eggs and the eggs will not be recovered by normal soil processing. Therefore, a zero count at that time of year does not mean little or no damage. If specimens of root-knot nematodes are recovered at any level in the spring, there is a good chance economic damage will occur.

CROP TO BE PLANTED IS HOME GARDEN

Nematode	ACTION LEVELS Nematodes per 100 cc soil Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	Control options**
Dagger *Xiphinema americanum*	1-199 200+	1-249 250+	1-69 70+	B,C B,C
Ring *Criconemella* spp.	1-199 200+	1-249 250+	1-69 70+	A,E B,C
Root knot *Meloidogyne incognita* & *Meloidogyne arenaria*	1-9 10-32 33+	1-19 20-49 50+	1-4 5-10 11+	A,E B,C B,C,D
Lesion *Pratylenchus* spp.	1-99 100+	1-149 150+	1-32 33+	B,C B,C
Spiral *Helicotylenchus* spp. & *Scutellonema* spp.	1-499 500+	1-799 800+	1-199 200+	B,C B,C
Sting *Belonolaimus longicaudatus*	1-3 4+	NA	1+	B,C B,C
Stubby root *Paratrichodorus minor*	1-199 200+	1-224 225+	1-32 33+	B,C B,C
Stunt *Tylenchorhynchus* spp.	1-249 250+	1-299 300+‘	1-79 80+	B,C B,C

*When soil is prepared for planting, nematodes become scattered and will be fewer compared to samples taken from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*****. D - An approved nematicide can be of value*******. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publications, *Home Vegetable Gardening* (EC 570), and *Pest Management Handbook, Volume 1* (EC 670), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: The major nematodes will be root knot, sting and sometimes stubby root. Root knot will be in sand and many of the coastal soils with high organic matter. Sting will be found in the more sandy soils. Stubby root may be in both soil types. Recommendations are based on populations at the end of the growing season. Samples taken in winter or early spring will probably have lower populations. Root-knot and sting nematodes overwinter as eggs and the eggs will not be recovered by normal soil processing. Therefore, a zero count at that time of year does not mean little or no damage. If specimens of sting or root-knot nematodes are recovered at any level in the spring, there is a good chance economic damage will occur. Generally it is good to rotate corn with the more nematode-susceptible crops, such as tomatoes and okra. Look for resistant varieties that have desired horticultural characteristics. Solarization by covering an infested garden spot in the summer with plastic for one month to raise soil temperature sometimes helps reduce nematode populations. Working in organic matter in the form of manures and compost can help overcome the nematode damage. A spring garden probably will be less affected by nematodes than will summer crops and fall plantings.

CROP OR CROP TO BE PLANTED IS BENTGRASS

Nematode	ACTION LEVELS Nematodes per 100 cc Soil Sand to sandy loam	Control options**
Awl *Dolichodorus* spp.	1-32 33+	A,E B,C,D
Lance *Hoplolaimus galeatus*	1-149 150+	A,E B,C,D
Ring *Criconemella ornata*	1-499 500+	A,E B,C,D
Root knot *Meloidogyne* spp.	1-79 80+	A,E B,C,D
Sheath *Hemicycliophora* spp.	1-199 200+	A,E B,C,D
Spiral *Helicotylenchus* spp.	1-599 600+	A,E B,C,D
Sting *Belonolaimus longicaudatus*	1-19 20+	B,D B,D
Stubby root *Paratrichodorus minor*	1-99 100+	A,E B,C,D
Stunt *Tylenchorhynchus* spp.	1-149 150+	A,E B,C,D

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*. D - An approved nematicide can be of value***. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publications, *Diseases of Turfgrasses in the Southeast* (EB 146), and *Pest Management Handbook, Volume 2* (EC 695), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: When soil is prepared for sodding or seeding, nematodes become scattered and will be fewer when compared to samples from about living plant roots of established sod. Sampling should be done regularly until nematode distribution and population levels are known for each site. Mixed populations of two or more genera near economic threshold levels indicate that damage is occurring. Treat only where counts indicate that there is an economic problem. For soil to be planted to bentgrass, the site may be treated with an all-purpose fumigant to reduce nematodes, disease-causing microorganisms and weeds (preplant only). Care should be taken to prevent contamination with sod, sprigs, or movement of water and soil. There are nematicides (restricted chemicals) for nematode control on commercial turfgrass. These treatments will only suppress populations. Horticultural practices such as pH adjustment, good fertility, and drainage and proper mowing should be implemented in addition to pesticide applications.

CROP OR CROP TO BE PLANTED IS BERMUDAGRASS

Nematode	ACTION LEVELS Nematodes per 100 cc of soil			Control options**
	Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	
Awl *Dolichodorus* spp.	1-79 80+	NA	1-26 27+	A,E B,D
Dagger *Xiphinema americanum*	1-299 300+	1-349 350+	1-99 100+	A,E B,C,D
Lance *Hoplolaimus galeatus*	1-49 50+	1-49 50+	1-16 17+	A,E B,C,D
Ring *Criconemella ornata*	1-999 1,000+	1-999 1,000+	1-299 300+	A,E B,C,D
Root knot *Meloidogyne* spp.	1-299 300+	1-349 350+	1-99 100+	A,E B,C,D
Lesion *Pratylenchus* spp.	1-149 150+	1-149 150+	1-29 30+	A,E B,C,D
Sheath *Hemicycliophora* spp.	1-199 200+	1-199 200+	1-69 70+	A,E B,C,D
Spiral *Helicotylenchus* spp.	1-999 1,000+	1-999 1,000+	1-599 600+	A,E B,C,D
Sting *Belonolaimus longicaudatus*	1-16 17+	NA	1-6 7+	A,E B,C,D
Stubby root *Paratrichodorus minor*	1-99 100+	1-99 100+	1-26 27+	A,E B,C,D

*Where soil is prepared for sodding, sprigging or seeding, nematodes become scattered and counts will be lower when compared to samples taken from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*****. D - An approved nematicide can be of value*******. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publications, *Diseases of Turfgrasses in the Southeast* (EB 146), and *Pest Management Handbook, Volume 2* (EC 695), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: Often nematode populations are mixed. Two or more genera near threshold levels indicate that economic damage is occurring. Sampling should be done regularly until the nematode distribution and population levels become known. Turfgrass sites often reflect many environments, and nematode populations will vary from place to place within a site. Horticultural practices such as pH adjustment, good fertility and drainage, and proper mowing should be utilized to increase tolerance to pests before resorting to pesticide applications.

CROP OR CROP TO BE PLANTED IS CENTIPEDEGRASS

Nematode	ACTION LEVELS Nematodes per 100 cc of soil			Control options**
	Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	
Awl *Dolichodorus* spp.	1-79 80+	NA	1-25 26+	A,E B,D
Dagger *Xiphinema americanum*	1-299 300+	1-349 350+	1-99 100+	A,E B,C,D
Lance *Hoplolaimus galeatus*	1-49 50+	1-49 50+	1-16 17+	A,E B,C,D
Ring *Criconemella ornata*	1-499 500+	1-499 500+	1-299 300+	A,E B,C,D
Root knot *Meloidogyne* spp.	1-299 300+	1-349 350+	1-99 100+	A,E B,C,D
Lesion *Pratylenchus* spp.	1-149 150+	1-149 150+	1-25 26+	A,E B,C,D
Sheath *Hemicycliophora* spp.	1-149 150+	1-149 150+	1-64 65+	A,E B,C,D
Spiral *Helicotylenchus* spp.	1-999 1,000+	1-999 1,000+	1-999 1,000	A,E B,C,D
Sting *Belonolaimus longicaudatus*	1-19 20+	NA	1+	A,E B,C,D
Stubby root *Paratrichodorus minor*	1-99 100+	1-99 100+	1-24 25+	A,E B,C,D

*Where soil is prepared for sodding or planting, nematodes become scattered and will be fewer when compared to samples taken from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*****. D - An approved nematicide can be of value*******. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publications, *Diseases of Turfgrasses in the Southeast* (EB 146), and *Pest Management Handbook, Volume 2* (EC 695), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: Often nematode populations are mixed. Two or more genera near threshold levels indicate that economic damage is occurring. Sampling should be done regularly until the nematode distribution and population levels become known. Turfgrass sites often reflect many environments, and nematode populations will vary from place to place within a site. Horticultural practices such as pH adjustment, good fertility and drainage, and proper mowing should be utilized to increase tolerance to pests before resorting to pesticide applications.

CROP OR CROP TO BE PLANTED IS TALL FESCUE

Nematode	ACTION LEVELS Nematodes per 100 cc of soil			Control options**
	Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	
Awl *Dolichodorus* spp.	1-49 50+	NA	1-3 4+	A,E B,C,D
Dagger *Xiphinema americanum*	1-149 150+	1-149 150+	1-79 80+	A,E B,C,D
Lance *Hoplolaimus galeatus*	1-99 100+	1-99 100+	1-49 50+	A,E B,C,D
Ring *Criconemella ornata*	1-499 500+	1-499 500+	1-79 80+	A,E B,C,D
Root knot *Meloidogyne* spp.	1-199 200+	1-199 200+	1-79 80+	A,E B,C,D
Lesion *Pratylenchus* spp.	1-149 150+	1-149 150+	1-79 80+	A.E B,C,D
Sheath *Hemicycliophora* spp.	1-79 80+	1-79 80+	1-33 34+	A,E B,C,D
Spiral *Helicotylenchus* spp.	1-999 1,000+	1,999 1,000+	1-399 400+	A,E B,C,D
Sting *Belonolaimus longicaudatus*	1-19 20+	NA	1-6 7+	A,E B,C,D
Stubby root *Paratrichodorus minor*	1-149 150+	1-199 200+	1-79 80+	A,E B,C,D
Stunt *Tylenchorhynchus* spp.	1-99 100+	1-99 100+	1-49 50+	A,E B,C,D

*Where soil has been tilled, nematodes become scattered and will be fewer when compared to samples taken from sod.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*. D - An approved nematicide can be of value***. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publications, *Diseases of Turfgrasses in the Southeast* (EB 146), and *Pest Management Handbook, Volume 2* (EC 695), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: Nematode populations are often mixed. Two or more genera near threshold levels indicate that damage is occurring. Sampling should be done regularly until the nematode distribution and population levels become known. Turfgrass sites often reflect many environments, and nematode populations will vary from place to place within a site. Horticultural practices such as pH adjustment, good fertility, aeration, adequate drainage and proper mowing should be utilized to increase tolerance to pests before resorting to pesticide applications.

CROP OR CROP TO BE PLANTED IS PERENNIAL RYEGRASS
TO BE USED FOR TURFGRASS

Nematode	ACTION LEVELS Nematodes per 100 cc of soil			Control options**
	Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	
Awl *Dolichodorus* spp.	1-49 50+	NA	1-4 5+	A,E B,C,D
Dagger *Xiphinema americanum*	1-149 150+	1-149 150+	1-79 80+	A,E B,C,D
Lance *Hoplolaimus galeatus*	1-99 100+	1-99 100+	1-49 50+	A,E B,C,D
Ring *Criconemella ornata*	1-149 150+	1-149 150+	1-69 70+	A,E B,C,D
Root knot *Meloidogyne* spp.	1-199 200+	1-199 200+	1-69 70+	A,E B,C,D
Lesion *Pratylenchus* spp.	1-159 160+	1-159 160+	1-79 80+	A,E B,C,D
Sheath *Hemicycliophora* spp.	1-79 80+	1-79 80+	1-39 40+	A,E B,C,D
Spiral *Helicotylenchus* spp.	1-989 990+	1-989 990+	1-399 400+	A,E B,C,D
Sting *Belonolaimus longicaudatus*	1-19 20+	NA	1-3 4+	A,E B,C,D
Stubby root *Paratrichodorus minor*	1-149 150+	NA	1-69 70+	A,E B,C,D
Stunt *Tylenchorhynchus* spp.	1-99 100+	1-99 100+	1-49 50+	A,E B,C,D

*When soils are prepared for sodding, sprigging or seeding, nematodes become scattered and will be fewer when compared to samples from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*****. D - An approved nematicide can be of value*******. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publications, *Diseases of Turfgrasses in the Southeast* (EB 146), and *Pest Management Handbook, Volume 2* (EC 695), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: Often nematode populations are mixed. Two or more genera near threshold levels indicate that economic damage is occurring. Sampling should be done regularly until the nematode distribution and population levels become known. Turfgrass sites often reflect many environments, and nematode populations will vary from place to place within a site. Horticultural practices such as pH adjustment, good fertility and drainage, and proper mowing should be tried before, and even in addition to, pesticide applications.

Ryegrass used as an overseeded crop should be viewed as a winter annual. Root-knot nematodes in moderate numbers should not be a serious threat since most *Meloidogyne* spp. are warm-season nematodes and they develop slowly during cool weather. Awl and sting nematodes will be most prevalent in the fall and late spring. Ring nematodes will reproduce well during the winter months and could be a problem in the spring.

CROP IS ST. AUGUSTINEGRASS

Nematode	ACTION LEVELS Nematodes per 100 cc of soil			Control options**
	Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	
Awl *Dolichodorus* spp.	1-79 80+	NA	1-8 9+	A,E B,C,D
Dagger *Xiphinema americanum*	1-189 190+	1-249 250+	1-69 70+	A,E B,C,D
Lance *Hoplolaimus galeatus*	1-49 50+	1-69 70+	1-16 17+	A,E B,C,D
Ring *Criconemella ornata*	1-499 500+	1-499 500+	1-199 200+	A,E B,C,D
Root knot *Meloidogyne* spp.	1-79 80+	1-79 80+	1-39 40+	A,E B,C,D
Lesion *Pratylenchus* spp.	1-149 150+	1-149 150+	1-69 70+	A,E B,C,D
Sheath *Hemicycliophora* spp.	1-79 80+	1-79 80+	1-8 9+	A,E B,C,D
Spiral *Helicotylenchus* spp.	1-999 1,000+	1-999 1,000	1-399 400+	A,E B,C,D
Sting *Belonolaimus longicaudatus*	1-19 20+	NA	1-4 5+	A,E B,C,D
Stubby root *Paratrichodorus minor*	1-149 150+	1-149 150+	1-26 27+	A,E B,C,D
Stunt *Tylenchorhynchus* spp.	1-199 200+	1-199 200+	1-99 100+	A,E B,C,D

*When soil is prepared for sodding, sprigging or seeding, nematodes become scattered and will be fewer when compared to samples taken from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*****. D - An approved nematicide can be of value*******. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publications, *Diseases of Turfgrasses in the Southeast* (EB 146), and *Pest Management Handbook, Volume 2* (EC 695), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: St. Augustinegrass is particularly sensitive to lance nematode, *Hoplolaimus galeatus*. Nematode populations are often mixed. Numbers of two or more genera near threshold levels indicate that serious damage is occurring. Sampling should be done regularly until the nematode distribution and population levels become known. Turfgrass sites often reflect many environments and nematode populations will vary from place to place within a site. Horticultural practices such as pH adjustment, good fertility, proper drainage, and proper mowing should be tried before, and even in addition to, pesticide applications.

CROP OR CROP TO BE PLANTED IS ZOYSIAGRASS

Nematode	ACTION LEVELS Nematodes per 100 cc of soil Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	Control options**
Awl *Dolichodorus* spp.	1-16 17+	NA	1+	A,E B,D
Dagger *Xiphinema americanum*	1-299 300+	1-349 350+	1-99 100+	A,E B,C,D
Lance *Hoplolaimus galeatus*	1-49 50+	1-49 50+	1-16 17+	A,E B,C,D
Ring *Criconemella ornata*	1-499 500+	1-499 500+	1-299 300+	A,E B,C,D
Root knot *Meloidogyne* spp.	1-299 300+	1-349 350+	1-99 100+	A,E B,C,D
Lesion *Pratylenchus* spp.	1-149 150+	1-149 150+	1-29 30+	A,E B,C,D
Sheath *Hemicycliophora* spp.	1-199 200+	1-199 200+	1-69 70+	A,E B,C,D
Spiral *Helicotylenchus* spp.	1-999 1,000+	1-999 1,000+	1-599 600+	A,E B,C,D
Sting *Belonolaimus longicaudatus*	1-16 17+	NA	1+	A,E B,C,D
Stubby root *Paratrichodorus minor*	1-149 150+	1-149 150+	1-24 25+	A,E B,C,D

*When soil is prepared for sodding or sprigging, nematodes become scattered and will be fewer when compared to samples taken from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*****. D - An approved nematicide can be of value*******. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publications, *Diseases of Turfgrasses in the Southeast* (EB 146), and *Pest Management Handbook, Volume 2* (EC 695), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: Often nematode populations are mixed. Two or more genera near threshold levels indicate that economic damage is occurring. Sampling should be done regularly until the nematode distribution and population levels become known. Turfgrass sites often reflect many environments, and nematode populations will vary from place to place within a site. Horticultural practices such as pH adjustment, good fertility and drainage, and proper mowing should be utilized to increase tolerance to pests before resorting to pesticide applications. Alternative turfgrass varieties may be available.

CROP TO BE PLANTED IS APPLE

Nematode	ACTION LEVELS Nematodes per 100 cc of soil Sand to sandy loam	 Clay loam to clay	Control options**
Dagger *Xiphinema americanum*	1-29 30-79 80+	1-39 40-89 90+	A,E B,C B,C,D
Root knot *Meloidogyne incognita, Meloidogyne arenaria,* & *Meloidogyne javanica*	1-16 17-99 100+	1-49 50-149 150+	A,E B,C B,C,D
Lesion *Pratylenchus* spp.	1-49 50-79 80+	1-69 70-99 100+	A,E B,C B,C,D

**A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem.
C - Apply cultural controls. See crop recommendations*******. D - An approved nematicide can be of value*******.
E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publication, *Pest Management Handbook, Volume 1* (EC 670), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: When soil is prepared for planting, nematodes become scattered and will be fewer when compared to samples taken from about living plant roots. For preplant fumigation, a broadcast treatment would be preferable. Rates will vary with soil type; generally heavier soils require higher rates. For postplant treatments, application in strips under the canopy up to about 50 percent of the land surface area is satisfactory. It is best to use preventative treatments when nematode problems are expected rather than try to control an above-economic-threshold population level.

The dagger nematode may vector certain virus diseases of apple. Lesion nematodes cause lesions that are first light brown, then darken. The lesions enlarge and coalesce, often girdling the root. Generally there are fewer secondary roots. Root-knot nematodes usually cause some swelling of roots and the number of secondary roots are much reduced.

CROP TO BE PLANTED IS GRAPE

Nematode	ACTION LEVELS Nematodes per 100 cc of soil Sand to sandy loam	 Clay loam to clay	Control options**
Dagger *Xiphinema americanum*	1-29 30-49 50+	1-39 40-69 70+	A,E B,C,D B,C,D
Ring *Criconemella xenoplax*	1-49 50-99 100+	1-49 50-99 100+	A,E B,C B,C,D
Root knot *Meloidogyne incognita*, *Meloidogyne arenaria*, & *Meloidogyne javanica*	 1-9 10-99 100+	 1-9 10-99 100+	 A,E B,C B,C,D
Lesion *Pratylenchus vulnus*	1-39 40-79 80+	1-59 60-99 100+	A,E B,C B,C,D
Stubby root *Paratrichodorus minor*	1-29 30-159 160+	1-69 70-199 200+	A,E B,C B,C,D

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*. D - An approved nematicide can be of value***. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publication, *Pest Management Handbook, Volume 1* (EC 670), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: When soil is prepared for planting, nematodes become scattered and will be fewer compared to samples taken from about living plant roots. For preplant fumigation, a broadcast treatment would be preferable. Rates will vary with soil type; generally heavier soils require higher rates. For postplant treatments, application in strips on both sides of the row up to about 50 percent of the land surface area is satisfactory. It is best to use preventative treatments when nematode problems are expected rather than try to control an above-economic-threshold population level. When two or more genera are near threshold level, it is probable that significant damage is occurring.

The dagger nematode may vector certain virus diseases of grape. Roots that have been fed on by the dagger nematode have swollen root tips, many secondary roots that appear enlarged, and collapsed epidermal and sub-epidermal cells. Lesion nematodes cause lesions that are first light brown, then darken. The lesions enlarge and coalesce, often girdling the root. Generally there are fewer secondary roots. Root-knot nematodes usually cause some swelling of roots and the number of secondary roots are much reduced. Stubby-root nematodes cause roots to cease growing and the root system will appear stubby and will be dark in color.

CROP TO BE PLANTED IS PEACHES

Nematode	ACTION LEVELS Nematodes per 100 cc of soil		Control options**
	Sand to sandy loam	Clay loam to clay	
Dagger *Xiphinema americanum*	1-49 50-149 150+	1-49 50-149 150+	A,E B,C B,C,D
Ring *Criconemella xenoplax*	1-19 20-49 50+	1-39 40-79 80+	A,E B,C,E B,C,D
Root knot *Meloidogyne* spp.	1-49 50-99 100+	1-99 100-149 150+	A,E B,C B,C,D

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*. D - An approved nematicide can be of value***.
E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publications, *Managing Peach Tree Short Life in the Southeast* (EC 585), and *Pest Management Handbook, Volume 1* (EC 670), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: When soil is prepared for planting, nematodes become scattered and will be fewer compared to samples taken from about living plant roots. When two or more genera are near threshold level, it is probable that significant damage is occurring. For preplant fumigation, a broadcast treatment would be preferable. Rates will vary with soil type; generally heavier soils require higher rates. For postplant treatments, application in strips under the canopy up to about 50 percent of the land surface area is satisfactory. It is best to use preventative treatments when nematode problems are expected rather than try to control an above-economic-threshold population level. There is tolerance to the ring nematode and resistance to root-knot nematodes in some root-stock varieties. Sample the area to be planted to be sure of the nematode species present, if any. The biggest danger from dagger nematodes is that they transmit stem-pitting virus.

CROP TO BE PLANTED IS STRAWBERRY

Nematode	ACTION LEVELS Nematodes per 100 cc of soil			Control options**
	Sand to sandy loam	Clay loam to clay	Preplant: turned/ disced*	
Dagger *Xiphinema americanum*	1-9 10+	1-9 10-49 50+	 1+	A,E B,D B,D
Foliar *Aphelenchoides* spp.	NA NA	NA NA	1-3 (in tissue) 4+ (in tissue)	A,E B,C,D
Ring *Criconemella* spp.	1-299 300+	1-299 300+	1-99 100+	A,E B,C,D
Lesion *Pratylenchus* spp.	1-24 25-49 50+	1-99 100-199 200+	1-99 100-299 300+	A,E B,C B,D,
Root knot *Meloidogyne hapla*	1-2 3-9 10+	1-49 50-99 100+	1-2 3-49 50+	A,E B,C B,D
Spiral *Helicotylenchus* spp.	1-999 1,000+	1-999 1,000+	1-499 500+	A,E B,C,D
Sting *Belonolaimus longicaudatus*	0 1-2 3+	1-4 5-19' 20+	0 1-2 3+	A,E B,C B,D
Stunt *Tylenchorhynchus* spp.	1-99 100+	1-99 100+	1-49 50+	A,E B,C,D

*When soil is prepared for planting, nematodes become scattered and will be fewer when compared to samples taken from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*****. D - An approved nematicide can be of value*******. E - Continue to monitor populations periodically.

*** For management options, see the Clemson Extension publication, *Pest Management Handbook, Volume 1* (EC 670), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

NOTES: Root knot may not be a problem. *Meloidogyne hapla* is rarely found in South Carolina and strawberry is resistant to most races of *M. incognita*, *M. arenaria* and *M. javanica*. *M. hapla* may be found on transplants. Soil sampling before planting is recommended. Preplant soil fumigation should sufficiently control plant-parasitic nematodes in the soil. Insist on nematode-free transplants. Foliar nematodes, *Aphelenchoides* spp., infest the leaves and buds and cause spring and summer dwarf of strawberry. An interaction between foliar nematodes in the genus *Aphelenchoides* and *Corynebacterium fascians* (a bacterium) produce “cauliflower disease” of strawberry. The dagger nematode can vector soil-borne viruses damaging to strawberry plants.

ORNAMENTAL PLANTS

Plant-parasitic nematodes inhabit all soils in South Carolina. Most home and business grounds are planted with some ornamental plants that will be fed on by these pests. Deciding when the nematodes will cause enough damage to warrant control measures often is not an easy decision. There are hundreds of ornamental plants. Only a few of them have been tested against the 13 most common genera of nematodes. To help with decision making, three pieces of information are provided here. First is a matrix with plants that have been associated with specific nematodes. As information becomes available, you may wish to write in additional associations. Second, there is a chart which lists some typical populations of the nematodes likely to be found with an estimation of how different-sized populations may be considered in relation to control measures. Third, there is a brief life history of the most common nematodes that are likely to be reported from samples tested for nematodes. These three pieces of information will provide information to assist with formulating plant-parasitic nematode control plans under several sets of conditions.

NOTES - It is recommended that soil be tested for nematodes before plants are transplanted. All pre-plant fumigants are restricted pesticides. If a commercial applicator is not retained, consider using resistant or nonhosts, if known. Consult the Clemson Extension publication EC 695, *Pest Management Handbook, Volume 2,* for a list of resistant plants and other management options.

Threshold numbers of plant-parasitic nematodes will be different for perennials and annuals. If the plant is expected to grow several years, even very low numbers of nematodes will eventually increase to a damaging population. If there is more than one genus near threshold level, then it is likely that significant damage may occur. This sometimes makes it difficult to use resistant plants since the same plant may not be resistant to all genera.

Generally winter annuals are not damaged as severely by plant-parasitic nematodes as are summer annuals. A moderate to low number of root-knot nematodes would not be expected to severely hamper growth of pansies set in the fall whereas the same number of nematodes would noticeably damage petunias planted in the spring.

Potted plants and transplants in soilless mixes should be free of soil-borne nematodes. If they are not, consider returning the plants to the seller. If symptoms of plant-parasitic nematodes are showing, it is highly likely that there is a severe infection.

The only chemical controls for living plants in a home ground setting are biological controls. This organization has not tested these formulations enough to make specific recommendations. Try small areas before investing significant quantities of resources.

Symptoms of nematode damage include lack of good foliar growth, small and uneven flushes of foliage, unresponsiveness to good horticultural practices such as regular watering and fertilizing, poor root growth, and galls and lesions on roots. The root-knot nematodes will be the most common and certainly the most visible nematode found on ornamental plants in the landscape.

In plant beds, rotations with resistant plants can be considered; root-knot-resistant plants include begonia, marigold, vinca, salvia and zinnia.

NEMATODES KNOWN TO BE ASSOCIATED WITH ORNAMENTAL PLANTS*

Nematode**

Plant	Awl	Dagger	Foliar	Lance	Pin	Ring	Root knot	Lesion	Sheath	Spiral	Sting	Stubby root	Stunt
Azalea	✓			✓	✓	✓	✓✓	✓	✓	✓	✓	✓✓	✓✓
Aucuba							✓✓						
Begonia			✓✓				✓✓						
Boxwood		✓		✓✓		✓✓	✓✓	✓✓		✓✓	✓✓		
Calendula		✓✓					✓✓						
Camellia	✓	✓		✓	✓	✓✓	✓✓	✓	✓	✓		✓	✓
Carnation				✓	✓	✓				✓			
Chrysanthemum			✓✓				✓						✓
Daffodil								✓✓					
Dahlia										✓		✓	✓
Daphne				✓		✓	✓			✓			
Dogwood		✓		✓		✓	✓	✓		✓		✓	✓
Firethorn		✓					✓	✓		✓		✓	✓
Gardenia		✓		✓		✓	✓✓	✓		✓		✓	✓
Gladiolus		✓				✓	✓			✓			
Gloxinia			✓										
Holly		✓		✓	✓	✓✓	✓✓	✓	✓	✓✓	✓	✓	✓✓
Hosta			✓✓										
Hydrangea						✓	✓✓						
Impatiens							✓✓	✓✓					
Juniper								✓✓					
Liriope						✓				✓		✓	
Mountain Laurel							✓						
Phlox					✓✓								
Photinia										✓			
Pittosporum						✓				✓			✓
Privet			✓✓		✓	✓✓							✓
Rose		✓✓		✓			✓✓		✓	✓		✓	✓
Snapdragon							✓						
Vinca		✓✓					✓✓						

* See the table on the following page for threshold levels.

** (✓✓) = Known to cause damage. (✓) = Associated with plants only.

CROP TO BE PLANTED IS ORNAMENTAL PLANTS

Nematode	ACTION LEVELS Nematodes per 100 cc of soil			Control options**
	Sand to sandy loam	Clay loam to clay	Preplant: turned/disced*	
Awl *Dolichodorus* spp.	1-5 6+	NA	1-3 4+	B,C B,C
Dagger *Xiphinema* spp.	1-2 3-39 40+	1-39 40-79 80+	1-3 4-25 26+	A,E B,C B,C,D
Foliar *Aphelenchoides* spp.	1+ (in tissue)	1+ (in tissue)	1+ (in tissue)	B,C
Lance *Hoplolaimus galeatus*	1-9 10-79 80+	1-99 100-149 150+	1-9 10-39 40+	A,E B,C B,C,D
Pin *Paratylenchus* spp.	1-49 50+	1-69 70+	1-49 50+	A,E B,C
Ring *Criconemella* spp.	1-49 50+	1-249 250+	1-32 33+	A,E B,C
Root knot *Meloidogyne* spp.	1-24 25-99 100+	1-99 100-199 200+	1-9 10-39 40+	A,E B,C B,C,D
Lesion *Pratylenchus* spp.	1-39 40+	1-99 100+	1-16 17+	A,E B,C,D
Sheath *Hemicycliophora* spp.	1-39 40+	1-39 40+	1-29 30+	A,E B,C,D
Spiral *Helicotylenchus* spp.	1-99 100+	1-199 200+	1-39 40+	A,E B,C
Spiral *Scutellonema* spp.	1-79 80+	1-99 100+	1-16 17+	A,E B,C
Sting *Belonolaimus longicaudatus*	1-9 10-32 33+	NA	1-4 5-10 11+	B,C B,C B,C,D
Stunt *Tylenchorhynchus* spp.	1-16 17+	1-24 25+	1-9 10+	A,E B,C

*When soil is prepared for planting, nematodes become scattered and will be fewer when compared to samples taken from about living plant roots.

A - Nematodes at this level are not likely to cause a problem. B - Nematodes at this level are likely to cause a problem. C - Apply cultural controls. See crop recommendations*****. D - An approved nematicide can be of value*******. E - Continue to monitor populations periodically.

***For management options, see the Clemson Extension publication, *Pest Management Handbook, Volume 2* (EC 695), available from county Extension offices or the Clemson Extension Bulletin Room (864-656-3261).

PLANT-PARASITIC NEMATODES ASSOCIATED WITH ORNAMENTAL PLANTS

AWL - *Dolichodorus heterocephalus* is the most common species and is typically found in wet, sandy soils. They are at times found in and about golf greens that have been built near wet areas. Ornamental plants in such settings can suffer damage by awl nematodes. Awl nematodes feed from the outside of the root and often cause short, stubby roots and root lesions.

DAGGER - *Xiphinema americanum* is the most common species, although several other species could be present. The dagger nematodes are found in many habitats and seem to be particularly damaging to perennials. The roots of roses being fed on by these nematodes, for instance, become short, slightly swollen and darkened. Plants have an unthrifty appearance and do not respond well to good horticultural practices. Dagger nematodes feed from the outside of the root. Nematodes in this group transmit plant viruses.

FOLIAR - *Aphelenchoides* spp. There are several foliar nematodes that have been associated with mums, ferns, lilies and hostas. The most common species are *A. fragariae* and *A. ritzema-bosi*. General symptoms range from leaf necrosis to deformed buds, shortened leaf and flower stems, and imperfect flowers. In South Carolina, the nematodes probably overwinter in dormant buds and growing points in stems and become active after new growth begins. They enter the leaves through stomata and feed, resulting in dead cells which are seen as dead spots on the leaves. Foliar nematodes are found in native plants. Plantings outside can become infested. Continuously moist conditions such as commercial greenhouses favor development of foliar nematodes.

LANCE - *Hoplolaimus galeatus* and *H. columbus* are species common to South Carolina. Lance nematodes feed from both the outside and inside of roots. When they are inside the root, the body lies parallel with the root three to four cells deep, with the head curved toward the central part of the root. They generally feed on the conducting tissues of the root. Lance nematodes are fairly large plant-parasitic nematodes and their feeding does considerable damage to roots. Dark lesions and reduced root growth are common symptoms of lance nematode feeding.

PIN - *Paratylenchus hamatus* is the most common, but not the only, pin nematode found in the Southeastern United States. Pin nematodes feed from the outside of the root by inserting their relatively long stylet several cells deep. They may feed on root tips and if so, the tips may become enlarged and cease to elongate. The nematodes sometimes appear attached to the roots. Pin nematodes are relatively small and may be undetected if present in low numbers. Populations reach large numbers on some hosts. *Paratylenchus* spp. are not common in the Southeastern states, but they do occasionally occur in large enough numbers to cause noticeable symptoms.

RING - *Criconemella xenoplax* is the most common species of ring nematode associated with ornamentals, although other species are present. Ring nematodes are small nematodes with a heavy cuticle and deep annules. They feed on roots from the outside by inserting their stylet. The cells from which the nematode feeds are transformed and damaged. There may be several hundred individuals in a few grams of soil. When feeding becomes heavy, symptoms appear in the form of unhealthy foliage, reduced growth, and "hairy," darkened roots.

ROOT KNOT - *Meloidogyne incognita*, races 1 and 3, *M. arenaria*, races 1 and 2, and *M. javanica* are the root-knot nematodes most likely found in South Carolina. Other species may occur in fields or on plants shipped from other locations. As a group they are the most damaging nematodes of ornamental plants. They enter the roots as young larvae and then enlarge as they become adults. Each female can produce 300

to 500 eggs. The most common symptoms are enlarged roots because the nematode has stimulated the root tissue cells to enlarge and divide. In a few cases there are no galls produced but the nematode is damaging the plant and reproducing well. Root-knot nematodes are hard to control because they are mostly inside the roots and reproduce rapidly, and the eggs are well-protected in a gelatinlike material. They can be carried either as live nematodes or as eggs in roots and soil. They do well in greenhouses and the field.

LESION - *Pratylenchus* spp. are common in most soils in South Carolina. They spend most of their life inside roots. They remain vermiform and as roots deteriorate for any reason they move into the soil. Feeding on susceptible ornamental plant roots results in darkened spots and heavy infestations result in reduced and discolored root systems. Because they are inside the roots, they are easily transported with live plants. It is difficult to control lesion nematodes because both the nematode and the eggs are inside roots.

SHEATH - *Hemicycliophora gracilis* is the most common sheath nematode in South Carolina. It is not common in all sites with ornamental plants. It is most often found in soil with a high pH and which tends to be wet. They feed from outside the roots on root tips resulting in swollen, knoblike structures. Any damage probably will be limited to a small geographical area.

SPIRAL - Spiral nematodes include *Helicotylenchus* spp. and *Scutellonema* spp. Species of both genera are common to South Carolina. These nematodes generally feed from outside the root. Often their heads will penetrate the root tissues for several cells. Occasionally they will be found inside the root, especially fleshy roots. They will increase to relatively large populations when feeding on suitable hosts. Foliage will be unthrifty and the roots reduced in size and often discolored. It generally takes a relatively large population to cause serious damage.

STING - *Belonolaimus longicaudatus,* along with other related sting nematode species, are common in the sandy areas of South Carolina. They are very damaging to root systems. Sting nematodes are ectoparasites and feed on root tips, causing the roots to stop elongating. The result is a short, stubby root system with a reduced number of fibrous roots. It takes only a few of these nematodes to cause economic damage. For some crops, only one nematode per 100 cubic centimeters of soil will cause economic damage.

STUBBY ROOT - *Paratrichodorus minor* is the most common of several genera and species that belong to the stubby root group of plant-parasitic nematodes. This group of nematodes transmit plant viruses as they feed. Their life is spent in the soil about plant roots with the eggs being deposited near the roots. They destroy the cells on which they feed and, in most situations, cause the roots to cease to grow. The result is stunted plants with much reduced and, as the name implies, stubby root systems. The population can become quite large if a favorable host is present.

STUNT - *Tylenchorhynchus* spp. are very common throughout the Carolinas. *T. claytoni* is perhaps the best-known. It has a wide host range and inhabits several soil types. Under favorable conditions, the populations become large. Plants are stunted with a reduced root system which is discolored and somewhat shriveled. Stunt nematodes spend their life cycle in the soil and feed from the outside of the root.

EC 703

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Clemson University Cooperating with U.S. Department of Agriculture, South Carolina Counties, Extension Service, Clemson, South Carolina.
Issued in Furtherance of Cooperative Extension Work in Agriculture and Home Economics, Acts of May 8 and June 30, 1914
Public Service Activities

7074

January 2000 EC 703

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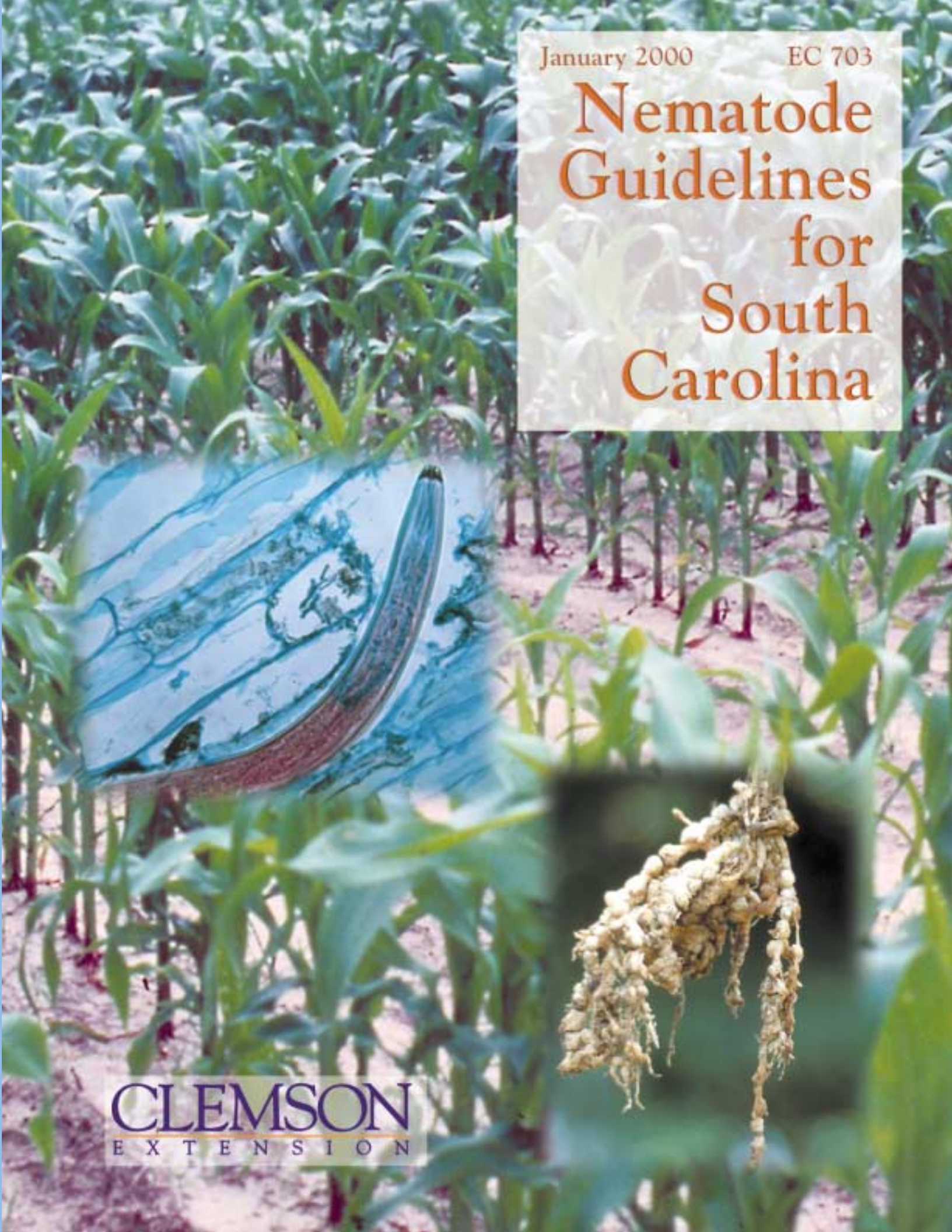

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