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SOYBEAN NEMATODE MANAGEMENT GUIDE

Our soybean checkoff.

Effective. Efficient. Farmer-Driven.

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SOYBEAN
NEMATODE MANAGEMENT GUIDE

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INTRODUCTION

NEMATODES IN VIRGINIA

Nematodes, or unsegmented roundworms, feed in or on roots of plants. More than 100 species of plant-parasitic nematodes feed on soybean roots, but only a few are economically important. In Virginia, most nematode species can be found in the sandier Coastal Plain soils. However, some nematode species can also develop and reproduce on the heavier-textured soils of the Piedmont and Shenandoah Valley. This guide will focus on those that can cause damage to soybeans in Virginia.

Many soybean farmers do not realize that nematodes may be reducing yields by as much as 7 to 8 percent. Therefore management of these pests begins with sampling and determination of the species and number present. If nematodes have been determined to be a threat, certain management practices remain available to help prevent further spread and reduce the economic losses that they cause.

SURVEY OF PROBLEM FIELDS

In recent years, researchers took more than 1,000 soil samples in problematic soybean and corn fields in eastern Virginia and analyzed them for nematodes. They did not choose these fields at random, but selected them because of low productivity or because they showed symptoms that can be typical of nematode damage. **Of the "problem" soybean fields, 98 percent contained nematodes and 71 percent of the fields showed a moderate to high risk of nematodes causing significant yield loss.**

SURVEY OF PROBLEM FIELDS

		RISK LEVEL[a]		
		LOW %	MODERATE %	HIGH %
Percentage of 454 soybean fields surveyed in Virginia during 2007-2009 where nematodes were present at low, moderate or high risk.	Soybean cyst	5	9	22
	Lance	48	4	2
	Lesion	46	15	2
	Ring	1	0	0
	Root Knot	18	8	9
	Spiral	67	8	NA[c]
	Sting	0	0	<1
	Stubby Root	24	12	NA
	Stunt	57	12	3
	Field[b]	29	23	47

[a]**RISK LEVELS:**

Low = nematodes will not likely cause crop damage.

Moderate = borderline populations in which crop damage may occur if other factors stress the crop

High = populations likely to cause crop damage and significant yield loss

[b]**Field risk** level takes into account all nematode species present in that field. For instance, low to moderate populations of two or more nematode species may result in a high field risk level.

[c]**Spiral and stubby root nematodes** usually only cause crop damage when other factors are stressing the crop.

SAMPLING AND THRESHOLDS

VIRGINIA TECH'S NEMATODE ADVISORY PROGRAM depends on the cooperation of the agricultural community, extension agents and the Nematode Assay Laboratory. "Assay" means to test, examine, assess, analyze and evaluate. Proper sampling, completion of appropriate forms and careful laboratory analysis remain necessary to provide farmers with appropriate recommendations on nematode management. The nematode advisory program can help farmers avoid costly yield loss due to plant-parasitic nematodes if the steps outlined below are followed.

The Virginia Tech Nematode Assay Laboratory currently performs soil and other tests for two different purposes:

1. **Predictive:** The predictive assay determines if nematode populations will affect next year's crop. A fee exists for predictive samples. Routine assays cost $11 per soil sample, and a routine soil test plus the testing of cysts on soybean roots cost $19 per sample.
2. **Diagnostic:** The diagnostic assay determines if poor growth in the current year's crop is caused by nematodes. Diagnostic samples can be conducted at no cost.

SAMPLING AND THRESHOLDS

When to Sample: The most appropriate time to sample depends on the purpose of the sample.

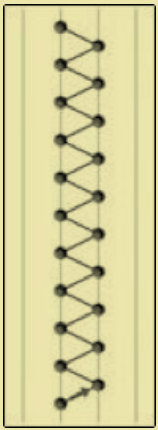
Predictive Assays: Fall sampling provides the most reliable information for predicting nematode problems for a future crop. Nematode populations can be highest at the end of the growing season and decline as the soil temperatures drop. Sample at or immediately after harvest of previous crop, Sept. 15 to Nov. 15.

Diagnostic Assays: Sample at the onset of symptoms, during the growing season. Nematodes feed only on living plants; therefore, sample soil around live plants showing symptoms. Some nematodes spend part of their life cycle inside the roots, and a more accurate diagnosis of nematode damage can be made from samples including roots. Also, send another sample from a healthy plant to compare population densities.

How to Sample: Always sample within the feeder-root zone– this varies for each crop. Avoid collecting samples when the soil is extremely dry or extremely wet. DO NOT add water to the soil after sampling. Take soil samples in areas of common crop history. For example, if one-half of the field is planted to soybeans and the other half to corn, sample each area separately.

SAMPLING AND THRESHOLDS

1. Collect vertical core subsamples of soil with a soil sampling core or shovel within the feeder-root zone (see figure at right). A 6-inch depth should be adequate. Nematodes do not occur uniformly throughout a field; thus, more than one subsample must be taken from the same field. The number of subsamples needed depends on the size of the field:



   – For small fields (fewer than 4 acres), collect at least 20 subsamples.
   – For large fields (more than 4 acres), divide the field into 4-acre sections. If the field consists of several soil types, divide the field into as many sections as there are soil types. Collect at least 20 subsamples from each section.

2. Mix the subsamples in a clean bucket.
3. Place at least 1 pint (500 cc) of the soil mixture into a nematode soil-sample bag or plastic bag. **LABEL COMPLETELY with the farmer's name, address, county, agent, crop information, and field or sample number.**

SAMPLING AND THRESHOLDS

4. **Check with your county extension agent for a sample form.** Complete the form to send with the samples. Send forms to your nearest Virginia Cooperative Extension offices at no charge. Soil sample bags may be available at these offices, as well; however, quart-size, sealable, plastic bags will also be suitable.
5. **Store samples in a cooler or refrigerator until shipping.** It is best to ship samples on Monday or Tuesday to avoid them sitting in a hot U.S. mail room or truck.
6. Mail samples with the appropriate form, and a check for predictive assays, immediately to the **Nematode Assay Laboratory, 115 Price Hall, Virginia Tech, Blacksburg, VA 24061-0331.**

Interpreting Predictive Assays: Predictive nematode sampling use nematode risk thresholds to determine whether to take action against nematodes. **These thresholds have been based on results of on-farm tests over several locations and years.**

SAMPLING AND THRESHOLDS

The table below lists three levels of risk for yield loss according to population densities in a 500-cc sample of soil.

Risk thresholds apply only to soil samples collected in late summer or early fall. Soil samples that are collected during winter or spring always contain reduced levels of nematodes due to unfavorable temperatures and the absence of a host crop.

Note: If more than one nematode has been found at the borderline level, the likelihood of a profitable response to a control measure increases.

Risk Thresholds for Soybeans (per 500 cm^3 soil)		RISK LEVEL[a] LOW	MODERATE	HIGH
Soybean cyst	larvae	0-20	20-60	>60
	cysts	0	-	>1
Lance		0-300	300-1,000	>1,000
Lesion		0-100	100-500	>1,000
Ring		0-200	200-700	>700
Root-Knot		0-50	50-170	>170
Spiral		0-1000	>1,000	-
Sting		0-10	10-20	>20
Stubby Root		0-90	>90	-
Stunt		0-300	300-1,000	>1,000

Low = nematodes will not likely cause crop damage.
Moderate = borderline populations in which crop damage may occur if other factors stress the crop
High = populations likely to cause crop damage and significant yield loss

MANAGEMENT OPTIONS

Prevention and Sanitation: The best management tactics can be those that prevent the spread of nematodes. **Equipment, especially tillage equipment, will spread nematodes from one field to another. Reducing tillage has been an effective means of control.** All equipment should be cleaned thoroughly after coming out of a field known to be infected with nematodes.

Rotation: Crop rotation is the best option for reducing nematodes. However, many nematodes can survive, reproduce and/or increase in numbers in other crops. For rotation to work, the rotational crop must not be a host to that particular nematode. **Unfortunately, soybeans host nearly all damaging species.** Use the table below to help choose good rotational crops.

MANAGEMENT OPTIONS

Acceptable rotations using common crops grown in Virginia for several nematode species *(note that an "X" indicates that the crop is not a good rotational crop).*

Nematode	Corn	Cotton	Peanut	Soybean	Perennial Grass Forage
Soybean Cyst				X	
Dagger			X	X	
Lance	X	X		X	X
Lesion	X	X	X	X	
Ring	X		X	X	X
Northern Root-Knot (RKN)			X	X	
Southern (RKN)	X	X		X	
Spiral				X	
Sting	X	X	X	X	
Stubby Root	X	X	X	X	X
Stunt				X	

MANAGEMENT OPTIONS

Resistant Varieties: Variety selection ranks close to rotation as an effective strategy for managing nematodes. One year of a rotation to a non-host crop may not always be enough for lasting control. Depending on the nematode species and one's crop rotation, variety selection may be the only option. Integrating a resistant variety with effective rotation will result in a greater response than just one tactic.

For instance, a rotation of corn rotated with a resistant soybean variety then rotated back to corn means that the nematode has nothing to feed on (excluding weed hosts) for three years. Before purchasing seed, farmers should review local reports of cultivar performance and characteristics for their region. Most soybean varieties have soybean cyst nematode resistance and a few have root-knot nematode resistance. Check seed-company guides or contact your seed provider for a list a nematode resistance and other traits.

MANAGEMENT OPTIONS

Nematicides: The need for a nematicide should be based on the previous site history and on the results of a soil test for the presence and level of plant pathogenic nematodes.

Nematicides Registered for Use on U.S. Soybeans:

Nematode	Nematicide Common Name	Nematicide Trade Name	Rate	Remarks
Root-knot, lesion, stubby root	abamectin + thiamethoxam + fungicide mixtures	Avicta Complete Beans	0.15 mg ai/seed	Only for use as a seed treatment in Syngenta-certified treatment facilities.
	clothianidin + *Bacillus firmus* (systemic insecticide + biological seed treatment)	Poncho/Votivo (protects seed and seedlings against early-season insect and nematode damage)	0.13 mg ai/seed	Apply only as a seed treatment according to label directions. Not for use as a hopper box or other treatment in on-farm applications
	aldicarb	Temik 15G	5.5 oz/ 1,000 ft. of row	Apply to seed furrow at planting. Maximum use rate is 7 pounds per acre. See label instructions to protect groundwater and wells.

Soybean cyst nematode remarks: Use of nematicides alone for control of soybean cyst nematode has not been recommended. A four-year rotation that alternates resistant and susceptible varieties with nonhost crops is needed. Application of Temik® 15G at 3 to 5 ounces per 1,000 feet of row in furrow may suppress nematode damage.

SOYBEAN CYST NEMATODE

LIGHT MICROGRAPH OF FEMALES AND CYSTS OF THE SOYBEAN CYST NEMATODE, **Heterodera spp.**

OVERVIEW

SOYBEAN CYST NEMATODE (SCN), the most common soybean nematode in Virginia, can be most problematic in continuous soybeans. Several types or races have been identified. Farmers need to know the race of the nematode infecting their fields in order for control measures to be effective. Although resistance to race 3 of this nematode has been placed into most soybean varieties, fewer have resistance for races 1 and 2. Additionally, several fields in Virginia have been identified as containing race 4 SCN. Only one commercial variety available has been identified as providing resistance to this race.

SOYBEAN CYST NEMATODE

SYMPTOMS

Above-ground symptoms can include stunting and yellowing, but 15 to 20 percent yield losses can occur even when there can be no above-ground symptoms. Stunting and yellowing actually reveal a long-term problem that has affected yield over several seasons. Yellowing resembles the symptom associated with Mn deficiency in soybean. Below ground, nodule formation and the nitrogen fixation in these nodules can be reduced with substantial populations. Because symptoms can be nondescript, diagnosis must be based on the white or yellow females attached to the roots.

MANAGEMENT

Rotation and the use of resistant varieties are the only effective management strategies for SCN. Although an aldicarb insecticide will reduce damage to roots early in the season and reduce yield loss, it does not reduce end-of-season populations. Furthermore, the newer seed treatments have not proven to be a replacement for aldicarb.

Long-term management of SCN depends on:

1. Early-season soybean vigor
2. Reducing SCN levels in the soil
3. Preserving resistant varieties

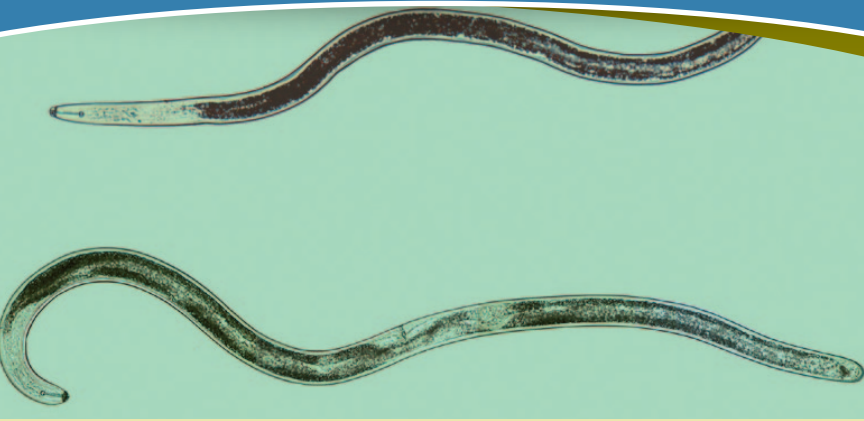
SOYBEAN CYST NEMATODE

To meet these goals, the following four-year rotation must be put into place:

1. **Year 1 – non-host crop**
2. **Year 2 – resistant soybean variety**
3. **Year 3 – non-host crop**
4. **Year 4 – susceptible soybean variety**

A 3-year rotation can be used in areas with low to moderate risk of crop damage: Year 1 – non-host crop; Year 2 – resistant soybean variety; and Year 3 – susceptible soybean variety.

LANCE NEMATODE

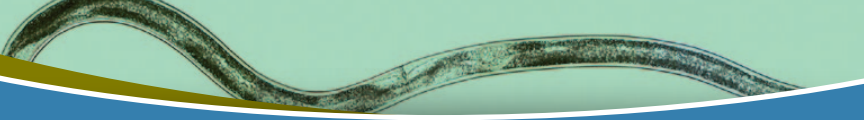


LIGHT MICROGRAPH OF A MALE AND FEMALE LANCE NEMATODE, **Hoplolaimus app.**

OVERVIEW

LANCE NEMATODE has been found throughout Virginia in many soils, but has been rarely found in great enough numbers to cause yield reductions. Still, lance nematode has been identified as the reason for poor growth in several fields surveyed in Virginia during 2007 to 2010.

It must be noted that three species of lance nematode have been identified, one of which (the Columbia lance nematode) can cause severe injury. The Columbia lance nematode has **not** been reported in Virginia.



LANCE NEMATODE

SYMPTOMS

Stunted plants will be the primary symptom of lance nematode. Under damaging infestations and where subsurface compaction has been present, great numbers of secondary and tertiary roots are produced and coincide with taproot necrosis.

MANAGEMENT

Planting early (mid-April/early-May) may help avoid optimal temperatures for infection and reproduction of the nematode. Aldicarb can help prevent yield loss. Subsoiling will be advised to alleviate hardpans.

LESION NEMATODE

LIGHT MICROGRAPH OF A FEMALE LESION NEMATODE, Pratylenchus spp.

OVERVIEW

LESION NEMATODES HAVE BEEN FOUND THROUGHOUT VIRGINIA AND ATTACK A NUMBER OF CROPS AND WEEDS. Lesion nematodes can be identified as small nematodes occurring on a wide range of soil types. Occasionally these nematodes can be found in great-enough numbers to cause a yield reduction in Virginia fields.

LESION NEMATODE

SYMPTOMS

Under heavy infestations, stunting and yellowing of plants will occur; however, crop losses from lesion nematode can occur without any observable symptoms above ground. Feeding from lesion nematodes causes dark lesions and an overall browning of the roots. Roots may appear short and stubby on the tips. The outer two layers of cells (epidermis and cortex) can slough away from the roots on severely infected plants. Nutrient and soil moisture stress intensifies yield loss.

MANAGEMENT

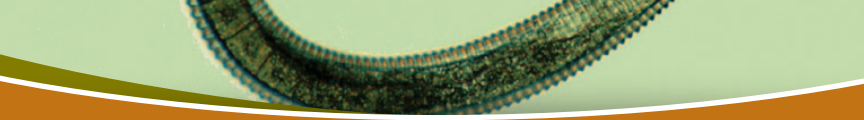
Varieties vary in their susceptibility to lesion nematode, but **few companies list (or know) this trait in publications**. The wide host range of this nematode makes rotation less effective, but rotating to perennial grass crops may be beneficial. Nematicides may reduce early-season injury.

RING NEMATODE

LIGHT MICROGRAPH OF A FEMALE RING NEMATODE, Mesocriconema spp.

OVERVIEW

RING NEMATODE has been the least common nematode in Virginia Tech surveys. Relatively high numbers must be found to cause yield reductions.



RING NEMATODE

SYMPTOMS

Symptoms caused by ring nematodes are nondescript. **Generally they may cause some stunting of the plants**, but their major effect is on overall yield, especially in seasons that include long periods of drought.

MANAGEMENT

Management of ring nematodes can be best achieved by crop rotation and other cultural practices because they are not very pathogenic and have minimal economic impact. Sources of resistance remain unknown, and nematicides can be too costly to provide a good return on the investment.

ROOT-KNOT NEMATODE (RKN)

GALLING CAUSED BY SOUTHERN ROOT-KNOT NEMATODE

OVERVIEW

RKN has been identified as one of the most problematic nematodes in Virginia and attacks a number of commonly grown crops. Four species of this nematode are commonly found in Virginia: southern RKN, northern RKN, Javanese RKN, and peanut RKN. Northern and peanut RKN can be usually found in our peanut-growing regions, whereas southern and Javanese RKN is most common in our traditional corn, small-grain and soybean regions. Southern RKN has become more established where cotton has been rotated with soybeans. Some fields contain mixtures of more than one species of RKN.

ROOT-KNOT NEMATODE (RKN)

SYMPTOMS

The main symptom of RKN includes the presence of galls, or swelling on the infected roots. Water and nutrient movement through the plant can be greatly disrupted or even inhibited. As a result of this disruption, infected plants will become yellow and stunted, and wilt during the hot parts of the day. On moderately and heavily infested fields, plants may mature one to two weeks earlier than normal. Spread of RKN can be generally in the direction of tillage; therefore, oval patches that run parallel to the row are common.

MANAGEMENT

Effective crop rotation for root-knot nematodes can be dependent upon identification of the species that are present in the field. The Virginia Tech Nematode Diagnostic Lab provides this service. This can only be done on special request. Rotation options have not been identified. Varieties with resistance to southern RKN can be available and remain a crucial management tactic. *Note that this resistance is not always complete and the addition of an in-furrow or seed treatment nematicide will usually increase yields over either tactic alone.* Double-cropping soybeans, due to a lack of food source for RKN during May and early June, may reduce RKN numbers.

SPIRAL NEMATODE

LIGHT MICROGRAPH OF A FEMALE SPIRAL NEMATODE, Helicotylenchus spp.

OVERVIEW

Spiral nematode will only cause yield reductions in soybeans when very high numbers have been present and the crop has been stressed with environmental or other conditions. Still, this nematode can be very common in surveyed fields. Very high numbers have been found in some fields, which, in combination with other nematodes present, resulted in control recommendations.

SPIRAL NEMATODE

SYMPTOMS

The symptoms caused by spiral nematode have been minimal and may only show as a reduction in yield potential, especially during growing seasons with long periods of drought.

MANAGEMENT

Management of spiral nematodes can be difficult to achieve and usually not profitable because their impact has been minimal.

STING NEMATODE

LIGHT MICROGRAPH OF A FEMALE AND MALE STING NEMATODE, BELONOLAIMUS SPP.

OVERVIEW

Sting nematode, one of the least common and problematic of the nematodes, has been found in Virginia. Still, relatively low numbers of these nematodes can cause substantial damage to soybeans. They have larger bodies than other nematodes, have a wide host range and generally occur on very sandy soils.

STING NEMATODE

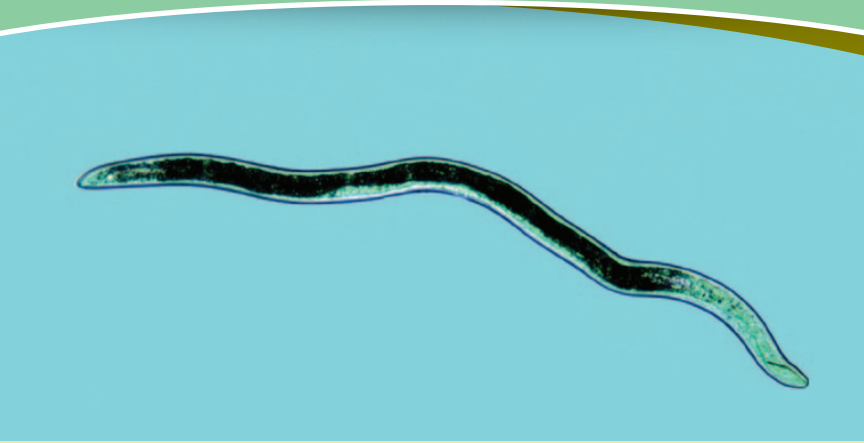
SYMPTOMS

Above-ground symptoms include stunting and yellowing. Dark, sunken lesions first appear along the root axis and root tips, and then enlarge to girdle the roots or extend longitudinally down the root axis. Girdled roots can break off, giving a stubby root appearance. Root proliferation will occur above the points of attack, resulting in a characteristic multi-branched root appearance of plants infected with sting nematode.

MANAGEMENT

One effective tactic to manage sting nematodes is to avoid planting in very sandy soil. They can only be a problem in areas with greater than 80 percent sand and less than 10 percent clay. Nematicides may be cost-effective, especially if they are placed in areas of the field with very sandy soil.

STUBBY ROOT NEMATODE



LIGHT MICROGRAPH OF A FEMALE STUBBY ROOT NEMATODE, Paratrichodorus spp.

OVERVIEW

Stubby root nematode has not been found in very many fields in our survey, but where it has been found, its numbers have been great enough to warrant control measures, especially with other nematodes present.

STUBBY ROOT NEMATODE

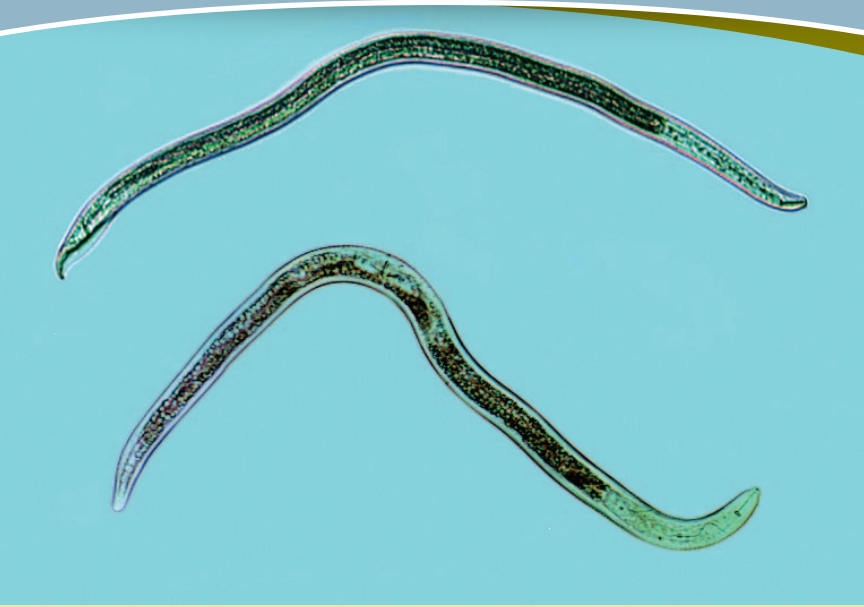
SYMPTOMS

Stubby root nematodes may reduce overall growth of the plant and yield, especially during growing seasons with long periods of drought.

MANAGEMENT

Practices that minimize the impact of stubby root nematodes can be economically viable but have not been available. Crop rotation and other cultural practices may be helpful in reducing their number; however, nematicide application usually costs more than the benefit that can be achieved.

STUNT NEMATODE



LIGHT MICROGRAPH OF A FEMALE AND MALE STUNT NEMATODE, **Tylenchorhynchus spp.**

OVERVIEW

Stunt nematode has been commonly found in Virginia soybean fields and often at levels great enough to warrant control, especially if the crop has been under stress.

STUNT NEMATODE

SYMPTOMS

Stunt nematodes may reduce overall plant size and yield; however, **the population has to be high and the growing season must contain long periods of drought before this effect is evident.**

MANAGEMENT

No effective management practices are available for reducing the populations of stunt nematodes other than crop rotation and other cultural practices.

FARM LEADERS of the national soybean checkoff initiated the Information and Technology Transfer project, a collaborative effort between the soybean checkoff, numerous state soybean boards and their respective land-grant universities to distribute checkoff-funded and other critical production research information to help soybean farmers improve their profitability. This guide is part of this effort. The United Soybean Board neither recommends nor discourages the implementation of any advice contained herein, and is not liable for the use or misuse of the information provided.

for more info please visit

www.UnitedSoybean.org

www.ext.vt.edu

Our soybean checkoff.
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