

Controlling nematodes in gardens

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Nematodes cause serious damage to gardens in Southeast Missouri. These pests can occur in other Missouri areas but are less common there. Nematodes are a greater problem where there are long, warm growing seasons and lighter, sandier soils.

Characteristics

Nematodes are worm-shaped animals. Most nematodes are very small, often about $\frac{1}{25}$ of an inch in length. Figure 1 shows a highly magnified root-knot nematode.

Nematodes feed on microorganisms, other nematodes, animals and plants. Generally, plant nematodes feed only on plant roots. Though others may be present, root-knot nematode does the most damage to garden vegetables.

Nematodes hatch from eggs in spring or summer and then move through the soil in search of plant roots. During its lifetime, a nematode may move only a few inches. Nematodes forcibly enter and feed on roots of susceptible plants.

After development, an adult female produces approximately 300 eggs. Some of these eggs soon hatch, and the life cycle is repeated. But other eggs are dormant until the next year.

Root-knot nematodes thrive best at 70 to 75 degrees F and can complete a full life cycle in approximately 20 to 30 days. Many generations may develop during a single growing season, vastly increasing the nematode population.

Nematodes may be naturally present in a garden, or they can be introduced on infested transplants and soil-bearing tillage tools. Make constant effort to avoid all sources of nematode infestation. Once present, nematodes are almost impossible to eliminate.

Plant symptoms

Plants affected by nematodes show foliar symptoms similar to those caused by inadequate moisture, poor nutrition or root rot. Affected plants may be stunted and have pale or yellow green foliage. They may wilt readily on warm breezy days even when soil moisture is adequate. Plant symptoms may range



Figure 1. Juvenile of root-knot nematode penetrating a tomato root. Magnified 1800 times. Micrograph, courtesy of USDA-ARS, Beltsville, Maryland.

from unnoticeable to severe depending on the susceptibility of the plant, environmental conditions and the number of nematodes attacking the plant.

If a nematode problem is suspected, check the roots. Nematode feeding causes the formation of root tumors (irregular, enlarged, "knotty" tissue) for which the nematode was named. Figures 2 and 3 show roots of vegetables damaged by root-knot nematode. In the more severe and advanced stages, roots decay and disintegrate by the end of the growing season. Problems caused by other nematodes can be diagnosed by soil analysis (see page four).

Nodules on the roots of beans and peas can be mistaken for early symptoms of root-knot nematode. Nodules are beneficial structures caused by certain bacteria that supply nitrogen to peas and beans. Figure 4 shows both nodules and nematode galls on the roots of beans. Note that nodules are nearly round objects attached to the side of roots rather than being swollen parts of the roots.



Figure 2. Nematode-damaged roots of okra. Arrows mark some definite galls caused by nematode attack.

Crops affected

Most vegetables can be attacked by root-knot nematode. Some of the most susceptible crops are those that require a long, warm growing season to mature. Tomatoes, okra, beans, squash, peppers, carrots, cucumbers, muskmelons, eggplant and watermelons are among the most susceptible. Nematode damage also has been observed on swiss chard, peas, parsnips, Irish potatoes, New Zealand spinach, and on fall-grown turnips and spinach. But on these vegetables, damage does not occur as often and is not as severe.

Control

If nematodes are causing damage, one or more control measures may be used. These include:

- Relocating the garden.
- Growing nematode-resistant varieties.
- Growing early cool-season crops that are least affected.
- Treating the soil with a chemical to kill the nematodes.

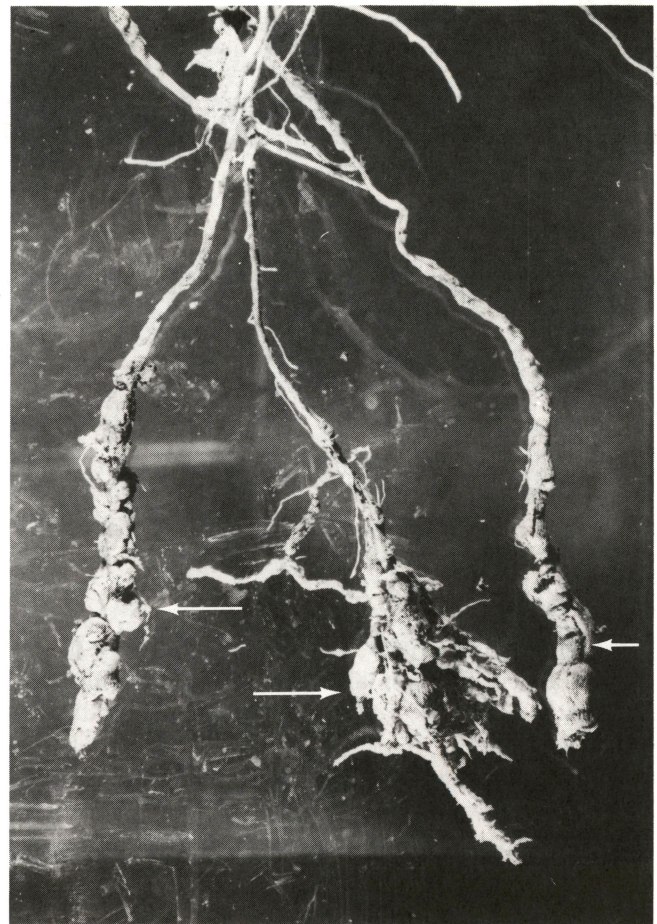


Figure 3. Nematode-damaged roots of tomato. Arrows mark some definite galls caused by nematode attack.

Relocating. Where space permits, choosing another garden site is a worthwhile consideration. However, moving the garden to a new site does not assure complete escape from nematodes. They may be present in many areas because they can survive and sometimes thrive on the roots of certain farm crops, weeds and woody plants. If the new site has a population of root-knot nematodes, continuous gardening with susceptible crops can soon increase nematode numbers to damaging levels. This may necessitate another move or other measures.

Resistant varieties. The use of nematode-resistant varieties is a good control choice, with few if any important disadvantages. This choice solves the problem with minimal effort, expense, and eliminates the need for using chemicals. However, resistant varieties are not available for all vegetable crops, and in some cases, resistance is incomplete.

Fortunately, many nematode-resistant varieties of tomato are now available. One recently developed by the University of Missouri is the variety Conquest. It has been tested and proven to be a good performer when grown in nematode-infested soils in Southeast



Figure 4. Bean roots with beneficial nodules (left arrow); Damaging nematode galls (right arrow).

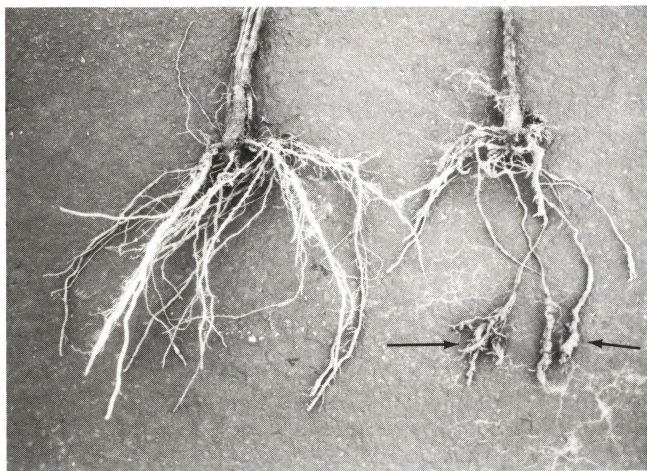


Figure 5. Left: Healthy roots of the nematode-resistant tomato variety, Conquest. Right: Nematode-damaged roots of a susceptible tomato variety. (Photographed at the end of the growing season.)

Missouri. Figure 5 shows the healthy root system of Conquest compared to roots of a susceptible variety grown in a soil infested with root-knot nematode.

Other good choices are Celebrity and Better Boy. These are widely available and produce acceptable yields and quality. Other varieties might be considered on a trial basis because information on their adaptability is lacking.

A list of vegetable varieties with resistance to root-knot nematodes is given in Table 1. Varieties marked with an asterisk (*) are preferred, based on current information and local experience. There are no nematode-resistant varieties available for crops other than those listed in Table 1. Use other measures if you plan to grow susceptible crops on nematode-infested soil.

Early season cropping. Lettuce, onions, radishes, leafy greens, green peas, early beans, cabbage (and related plants), corn and Irish potatoes are crops that can be planted early, and thus, escape serious nematode damage. These spring planted crops grow when temperatures are unfavorable for nematodes and

Table 1. Vegetable varieties resistant to root-knot nematode.

Lima bean		
Nemagreen*	Westan	Ventura
Green or English pea		
Blue Bantam		Carter's Dairy
Burpeeana Early*		Early Wando
Southern pea		
<u>Popular Varieties</u>		<u>Old Varieties</u>
California Blackeye		Alacrowder
Colossus (crowder)		Arlington
Erectset (cream)*		Brabham Victor
Mississippi Purple (crowder)*		Clay
Mississippi Silver (crowder)*		Conch
Purple Hull Pink Eye*		Dixielee
Texas Cream 40		Dixie Queen
Zipper Cream		Extra Sugar Crowder
Mississippi Pinkeye		Extra Early Blackeye
		Florcream
		Iron
		Louisiana Purchase
		Mississippi Crowder
		New Era
Bell or sweet pepper		
All Big		
Sweet Potato		
<u>Popular Varieties</u>		<u>Old Varieties</u>
Jasper*		Acadian
Jewel*		Carogold
Nugget		Georgia Red
Painter*		Goldrush
Travis*		Heartogold
		Kandee
		Nemagold
		Porto Rico
Tomato		
Beefmaster	Jackpot	Royal Flush
Better Boy*	Lady Luck	Small Flush (cherry)
Better Bush	Lemon Boy (yellow)	Small Fry (cherry)
Big Pick	Manalucie	Summer Delight
Big Quick	Milagro	Summer Flavor
Big Set	Monte Carlo	Brand 5000
Big Seven	Nemared	Sunburst
Bonus Hybrid	Nematex	Sunripe
Carmen	Patio Prize	Super Beefsteak
Carnival	Patriot	Super Bush
Casino Royale	Pelican	Super Fantastic
Cavalier	Pik Red	Super Steak
Celebrity*	Pink Droplet (cherry)	Sweet Chelsea (cherry)
Champion	President	Sweet Million (cherry)
Coldset	Quick Pick	
Conquest*	Red Chief	Terrific
Contessa	Red Express	Tropic Boy
Corona	Red Glow	Ultra Boy
Early Set	Red Star	Ultra Girl
Empire	Resa Plus	Valerie
Extra Early	Roma (pear)	Vineripe
First Lady	Ronita	Whopper
Fresh Pak	Rossol	Wonder Boy
Full House	Royal Chico (pear)	
Gator		
Hybrid Ace		
*Suggested Varieties		

complete all or most of their development before nematode damage becomes serious.

However, late summer plantings of these crops for fall production can be severely damaged by nematodes. Nematode damage permanently retards growth and development of these plants. On infested soils, plant spring crops early. Chemically treat the soil when planting susceptible varieties from May to September.

Chemical soil treatment. Nematicides are chemicals used for nematode control. Normally, they are applied to the soil before planting a susceptible crop. A nematicide treatment can be beneficial where nematodes are causing serious damage. However, nematicides are costly, require extra labor, may pose some degree of hazard during application, may delay planting, and are only effective for a few weeks.

A nematicide labeled and available for gardener use is Vapam. When properly applied, the chemicals penetrate the soil, killing nematodes, certain soil insects, disease organisms and weeds. The chemical is a liquid that can be purchased in small (quart and gallon) quantities.

Mix Vapam with water and apply it to warm, moist soil that has been cultivated and is free of clods. The soil temperature should be between 60 and 90 degrees F. Immediately after application, apply additional water to the soil surface to seal it. This holds the chemical fumes in the soil for a longer time and aids in nematode control. Covering the soil with a plastic tarp further confines the fumes to the soil and enhances nematode control.

Because of the soil temperature requirement and the waiting period after treatment, plant early spring crops without treating the soil. Areas to be planted with full-season susceptible crops should be treated when moisture, temperature and soil conditions are proper. Even if this delays planting, the expected benefits should far exceed that from a poorly applied treatment. The nematicide may be applied to the entire garden or only to beds or rows where plants are to be grown. Full treatment of the entire garden can be done best in the fall when environmental conditions are good and there is no rush to plant. Of course this would require early removal of any crops or plants that are still growing or bearing.

The Vapam label describes application methods, rates, safety precautions and other important details. **Read and follow all label information to ensure safe and effective usage of the product.** Vapam is available from some of the larger garden centers and vegetable seed companies.

Management

Root-knot nematodes can severely restrict all the vital functions of plant roots including the absorption and transfer of water and nutrients. Providing the essentials for plant growth such as fertilizer and water cannot stop this damage, but a shortage of them can compound the damage. Use of the many proven crop management practices is always advisable, but that's especially so if nematodes are present. Ensure that the soil is well drained, has a high level of plant nutrients, a favorable pH (acidity) range, and contains a generous percentage of organic matter. A soil test will tell which of these factors are lacking. In addition, providing for adequate and uniform moisture, and preventing damage from diseases and insects are important.

Some people say that certain plants such as marigold, chrysanthemum and castor bean kill nematodes or somehow protect susceptible plants from nematode attack. It is known that some plants, such as the marigold, resist nematodes or make unfavorable hosts for nematode development. However, interplanting such plants among susceptible vegetables has not proven to be an effective and practical measure of nematode control.

Soil analysis

A positive means of diagnosing a nematode problem is a laboratory soil analysis. A good sample taken between late May and early September is essential for accurately assessing the presence of nematodes, species involved, and their relative abundance.

A sample should consist of several subsamples taken from different areas of the garden. Each subsample should represent the upper 7 to 8 inches of soil and an area of about 100 square feet. A hand trowel makes an adequate sampling tool if the soil is soft or has been tilled recently. Make a trowel-size hole 7 to 8 inches deep, and then remove a slice of soil from the side of the hole. This is a subsample.

Collect the subsamples in a container and mix thoroughly. From this mixture, remove about 1 pint as the sample. The sample should be promptly sealed in a plastic bag and mailed. If shipment is delayed, keep the sample out of the sun and reasonably cool.

Check with your University Extension Center about the fee for a nematode analysis, how to make payment and other details.

The Diagnostic Clinic, 108 Waters Hall, University of Missouri, Columbia, MO 65211, does the analysis of nematodes.



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