Nematode Control in the Home Vegetable Garden

►Most gardeners are familiar with problems caused by diseases and insects because such problems are easily recognized. Few gardeners, however, are aware of the damage nematodes can cause.

Nematodes are microscopic (less than 1 mm long), wormlike animals too small to be seen with the unaided eye (figure 1). The majority of plant parasitic nematodes live in the soil and damage plants by feeding in large numbers on the roots, impairing the plant's ability to take up water and nutrients. Severe root damage (figure 2) caused by nematodes typically results in aboveground symptoms that may include stunting (figure 3), yellowing of leaves (figure 4), loss of plant vigor and/or an overall general decline in plant performance. Damage is often more pronounced when plants are under other stresses such as lack of water or nutrients or when damaged by other diseases or insects. Although nematodes rarely kill plants, they can drastically reduce plant growth and yields. Nematodes are usually confined to localized areas in the garden spreading very slowly under their own power; however, nematodes may be dispersed more rapidly by the movement of infested soil through cultivation, on soil clinging to garden tools and tillers, in water, or on roots of transplants.

Though there are at least 10 different genera of plant parasitic nematodes found in Alabama, the most important is the root- knot nematode. Root-knot nematodes have a wide host range, but the most serious problems occur on broadleaf crops. Root-knot nematodes attack the roots of plants causing distinct

Figure 1. Nematodes are microscopic, wormlike animals. (Photo credit: Jonathan D. Eisenback, Virginia Polytechnic Institute and State University, Bugwood.org)

Figure 2. Severe root damage caused by nematodes.

Figure 3. Severe root damage caused by nematodes.

Figure 4. Root damage caused by nematodes can result in yellowing of leaves on infected plants.

knots, swellings, or galls to form on the infected roots (figure 5). Galls may grow as large as one inch in diameter when they merge, but usually, they are not much larger than a pea. There are several different species of root-knot nematodes in Alabama and several may be present in any one location depending on which crops were grown previously (different species have different host ranges), sources of contamination, and geographical region in the state. Nematode species other than root-knot nematodes can cause damage to vegetables. These species include dagger, reniform, ring, stubby root, stunt, sting, root lesion, and cyst nematodes. With the exception of the cyst nematode, which produces distinctive egg-containing cysts on roots, the identification of these other nematode species requires laboratory analysis.

Nematode management requires long-term planning. No current control practice will permanently eradicate nematodes from the garden. Nematodes can be effectively managed in the home garden by the use of one or more of the following practices.

Table 1. Plant Families

Family Name	Members
Goosefoot	beets, Swiss chard, spinach
Composite	chicory, dandelion, endive, lettuce, marigolds, sunflower
Mustard (Crucifers)	alyssum, bok choy, broccoli, brussels sprouts, cabbage, cauliflower, collards, kale, mustard, radishes, turnip
Gourd (Cucurbits)	cucumber, gourds, cantaloupe, pumpkin, squash, watermelon
Grass	barley, corn, oats, rice, rye, wheat
Pea (Legumes)	alfalfa, beans, lupines, peanuts, English and southern peas, soybeans
Lily	asparagus, chives, garlic, leeks, onions, shallots
Buckwheat	buckwheat, rhubarb, sorrel
Mallow	okra, cotton
Bindweed	sweet potato
Rose	brambles, strawberries, apples, peaches
Nightshade	eggplant, pepper, petunias, Irish potato, tomato
Parsley	carrot, celery, chervil, dill, parsley, parsnip

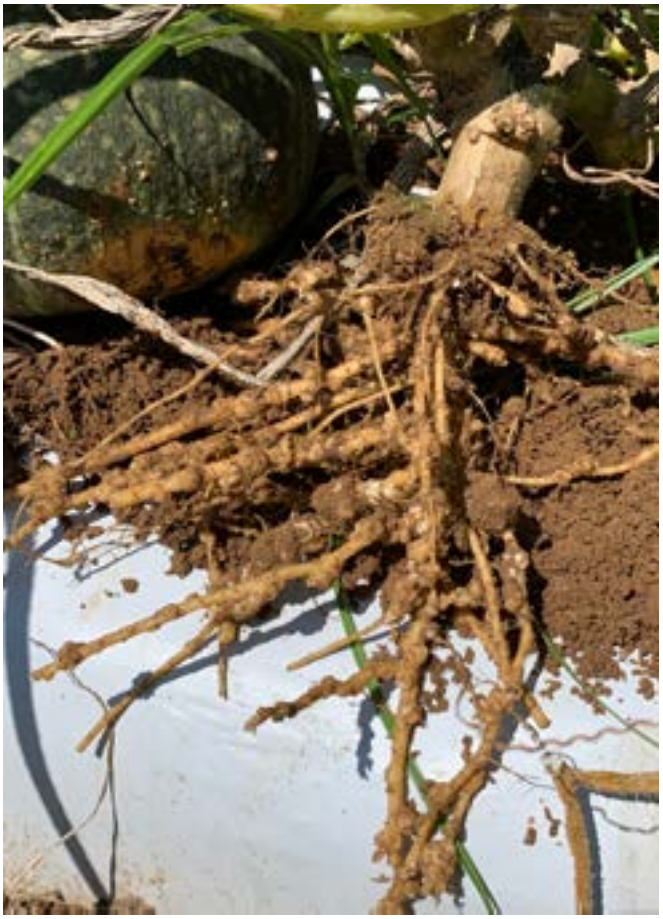

Figure 5. Root damage caused by nematodes can result in stunting of infected plants.

Site Selection

Consider nematodes when selecting a site for a vegetable garden. Have the soil from the proposed area tested for nematodes before planting. If possible, collect soil in the fall when nematode populations are highest. The worst time to sample is in late winter or early spring as nematode populations are at their lowest during this period and may not be detected in the sample. Take samples with a soil probe or hand shovel in a zigzag pattern across the garden area from the top 8 to 10 inches of soil. Mix samples thoroughly and remove 1 pint of soil for laboratory analysis. For more information on collecting soil samples for nematode analysis, see Extension publication “Collecting Soil and Root Samples for Nematode Analysis,” ANR-0114.

Table 2. Vegetable Varieties Resistant to Root-Knot Nematodes	
Crops	**Variety**
Sweet potato	Bayou Belle, Bonita, Covington, Hernandez, Jewel, Murasaki
Southern pea	California Blackeye #5, Magnolia Blackeye, Mississippi Purple, Mississippi Shipper, Mississippi Silver, Zipper Cream
Lima beans	Nemagreen
Cayenne-type pepper	Carolina Cayenne, Charleston Hot
Tomato	Beefmaster VFN, Burpee's Super Beefmaster VFN, Better Boy Hybrid VFN, Amelia VR, Celebrity, Crista, Mountain Merit, Mountain Rouge, Red Bounty, Red Mountain
Tomato (Roma)	Granadero, Mariano

Avoidance (Time of Planting)

Damage from nematodes can be avoided by planting crops when nematodes are less active in the early spring. Carrots, lettuce, Irish potato, and other cool-season crops are susceptible to root-knot nematode, but may only endure minor damage because nematodes are inactive at low soil temperatures (below 60 degrees F). Unfortunately, other common garden vegetables, such as tomato, pepper, cucumber, and okra, grown during mid- to late summer are highly susceptible to root-knot.

Sanitation

Sanitation aids in reducing plant parasitic nematode populations. Nematode-infected plants (including roots) should be removed from the garden and destroyed as soon as the vegetables have been harvested. This practice can be particularly effective in small gardens. Plow the garden immediately after the final harvest to bring plant roots to the surface. Work the soil in this manner two to four times during the winter. The drying action of the wind and sun will destroy many nematodes and their eggs, thus preventing further buildup. Vegetable roots left in the soil through the winter serve as hosts on which nematodes can maintain or increase their population for the following year.

Crop Rotation

Rotating crops from year to year can be an effective means of controlling plant parasitic nematodes. Closely related crops are more likely to support the same nematodes, diseases, and other pests than unrelated plants. Vegetables in the same family should never be grown in the same location more than once every three years. If space is available, rotate garden sites. Where garden space is limited, rotate related vegetables in one family group with vegetables in an unrelated family group. For specific family groupings, refer to table 1. Crop rotation is not always an effective strategy for controlling root-knot nematodes because of their wide host range. However, rotating crops in combination with fallowing or soil solarization can be used to manage most nematode problems.

Use of Resistant Varieties

Resistant varieties offer the easiest, least expensive, and most effective method of controlling nematodes in the home garden. Unfortunately, resistant vegetable varieties are only available for root-knot nematodes in a limited number of crops (table 2). Nematodes are unable to feed on a resistant variety, resulting in a population decline over time due to starvation (as long as weed hosts of the nematodes are also eliminated). Asparagus, onion, and strawberry are resistant to most root-knot nematode populations in Alabama. Refer to table 2 for vegetable varieties resistant to root-knot nematodes. Also check seed catalogs each year to identify newly released vegetable varieties with resistance to nematodes.

Fallowing

The practice of fallowing prevents any vegetation from growing in the garden area, thus starving the nematode population. The target area must be kept completely weed free to prevent nematodes from surviving on alternate hosts. One year of fallowing will lower the nematode population to a level when an annual crop can be grown successfully. The longer an area is fallowed, the greater the decrease in the nematode population. Soil that is being fallowed should be roto-tilled every two weeks to reduce weeds and to expose nematodes to the sun.

Plant Stress Reduction

The less stress plants are under, the better able they are to withstand nematode attack. Watering plants deeply and less frequently will encourage the development of a deep root system that will reduce stress on plants and can help minimize nematode problems. Proper management of diseases and insects can also reduce stress and help reduce damage from nematodes. Nutrient deficiencies and soil compaction can inhibit root development and increase plant sensitivity to nematode damage. Nematode damage is more severe in sandy soils than in heavy soils.

Addition of Organic Soil Matter

Organic soil amendments can improve plant health and vigor, but they must be incorporated before seeding or transplanting. Organic amendments, such as compost incorporated into the soil, will improve soil structure and increase moisture retention. Organic materials can also encourage the biological management of nematodes in infested gardens. Compost and aged pine bark are two amendments that can improve soil conditions and plant health. Pine bark, which works best if fresh and ground into small pieces, has been reported to help suppress damage from root-knot nematodes. This should be done a month or more before planting.

Suppressive Crops

Nematode suppressive crops naturally combat nematodes. Several plants minimize nematode damage in vegetable crops (table 3). These plants produce nematicidal (killing) and nemastatic (suppressive) organic compounds that are toxic to nematodes. These compounds are released from the roots of living plants or by plants being incorporated into the soil as green manure. Some plants may act as trap crops that prevent nematodes from maturing and reproducing once they invade the roots. Some marigolds, a few varieties of chrysanthemums, castor beans, partridge peas, several Crotalaria spp., velvetbeans, and rapeseed (canola) are considered nematode suppressive plants. Growing a nematode suppressive crop will not eliminate nematodes from the soil; however, it may reduce nematode numbers enough to allow production of a crop in a nematode-infested area. Nematode populations often rebound to pretreatment levels when a susceptible vegetable is grown following a nematode suppressive crop. Nevertheless, the use of a nematode suppressive crop has been shown to be as effective as or somewhat better than fallowing an area to reduce the nematode population.

Soil Solarization

Soil solarization is a simple, safe, and effective method of nematode control. It allows the grower to bypass lengthy crop rotations and gives the added benefit of controlling other soil pests such as insects and weeds. Radiant heat from the sun is the lethal agent involved in soil solarization. A clear polyethylene mulch or tarp is used to trap solar heat in the soil. Over a period of several weeks to a few months, soil temperatures become high enough to kill nematodes, as well as many other soil pests and weed seed to a depth of 8 inches. None of the pests will be completely eradicated, but their numbers will be greatly reduced, allowing the successful production of a crop. In sandy or sandy-loam soils, nematodes may survive at depths below the lethal temperature zone. As a result, some damage may be seen on deep-rooted crops, but those with shallow root systems should escape serious injury.

The soil to be solarized must be cultivated until it is loose and friable with no large soil clods or debris. A roto-tiller will eliminate clods and other debris removing air pockets that reduce heating of the soil or that keep the tarp from fitting tightly over the soil surface. Make sure moisture levels are adequate for working the soil before laying the plastic tarp. Use a clear, UV-stabilized plastic tarp or sheeting 1 to 4 millimeters thick. The edges of the tarp must be buried to a depth of 6 inches in the soil to prevent blowing or tearing by the wind. White or black plastic will not transmit enough solar radiation to raise soil temperatures to lethal levels for many soil pests. Long, hot sunny days are needed to reach the soil temperatures required to kill soil pests and weed seed. The longer the soil is heated, the better and deeper the control of nematodes and other soil pests will be. In Alabama, a tarping period of 4 to 6 weeks in the summer should be sufficient to kill nematodes and soilborne plant pathogens. For effective spring or fall solarization, a 6- to 8-week period is required to ensure good pest control.

Table 3. Reaction of Nematode Suppressive Crops to Root-Knot Nematode Species

	Root-Knot Species			
Suppressive Crop	**Southern**	**Peanut**	**Northern**	**Javanese**
French Marigold				
Tangerine	**	**	**	--
Happy Days	--	--	--	**
Lemon Drop	**	--	--	--
French Dwarf Double	--	--	--	--
Chrysanthemum				
Escapade	**	--	--	--
Castor Bean				
Bronze King	**	--	--	--
Hale	--	**	--	--
Partridge Pea	--	**	--	--
Crotalaria				
Showy Crotalaria	**	**	--	**
Florida Velvetbean	**	**	--	**
Common Vetch				
Cahaba White	**	**	--	**
Vantage, Nova II	--	**	--	**
Vanguard, Warrior	--	**	--	**
Rapeseed				
Jupiter, Cascade, Elena, Indore, Humus, Bridger, Dwarf Essex	**	--	--	**

** indicates a high level of suppression

-- indicates no suppression or no data available

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