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ANR-689

ALABAMA A&M AND AUBURN UNIVERSITIES

# Nematode Pests of Annual and Perennial Flowers, Herbs, Woody Shrubs, and Trees

Plant parasitic nematodes are destructive soil pests that attack a wide range of herbaceous and woody ornamentals in home, leisure, and commercial settings across Alabama. Root-knot (*Meliodogyne incognita, M. arenaria, M. hapla*), lesion (*Pratylenchus vulnus*), ring (*Macroposthonia* and *Criconemoides* spp.), and stunt (*Tylenchorhynchus* spp.) nematodes cause considerable injury to annuals, perennials, herbs, and woody ornamentals. Other nematodes associated with the decline of woody ornamentals are also listed in Table 1.

Although nematode-related injury may occur in commercial greenhouses and landscapes, damaging populations of plant parasitic nematodes are most likely to be found on bed- or field-grown nursery stock. Home and commercial landscapes and abandoned vegetable gardens are also likely sites for high nematode populations, particularly of one or more species of root-knot nematode. Nematode damage in landscapes is more commonly reported on flowers and herbs than on woody ornamentals.

## Life Cycle

Nematodes are tiny, colorless, unsegmented roundworms. They usually live on wet surfaces in the spaces between soil particles. Most plant parasitic nematodes feed on the fine, fibrous roots, but a few nematode species will attack bulbs, corms, leaves, and shoot tips of a variety of flowers.

Nematodes use a needlelike stylet to puncture the cells in host tissues and suck out the contents. The larvae and adults of some nematodes move into the roots before feeding, while others feed on cells at or just below the root surface. Adult root knot nematodes, especially the females, feed at one site for most of their lives. Others, like the ring and stunt nematodes, migrate along the root, feeding as they move. Nematodes inject saliva into host tissues, which breaks down cell contents and, in the case of the root knot and dagger nematodes, stimulates the formation of root galls.

Female nematodes lay eggs singly or in masses in the roots or surrounding soil. The wormlike larvae usually go through four molts before reaching maturity. Nematode survival, growth, and reproduction depend largely on soil moisture, temperature in soil or host tissues, and the suitability of the host plant.

Root-knot nematodes can go from egg to reproducing adult (complete life cycle) in as little as 3 to 4 weeks. Others, such as the dagger nematode, may require 6 to 12 months. Under favorable conditions, nematode reproduction will continue until the food supply is exhausted. Nematodes survive poor soil conditions as eggs or larvae.

Plant parasitic nematodes are found in nearly all soil types, but they are most numerous in coarse-textured sandy or sandy-loam soils. Few nematode problems are seen on plants established on heavy clay soils. Soilless potting media used by most container nurseries and greenhouses are rarely infested with plant parasitic nematodes. However, nematodes introduced into a moist, well-drained potting medium will often flourish on the roots of its host. Soil moisture levels near field capacity favor nematode activity. In general, soil

Gradual decline in plant health followed by plant death may also be associated with nematodes.

moisture levels and temperatures that encourage plant growth will also favor nematode activity.

Several different species of plant parasitic nematodes are usually present in the soil before the establishment of landscape beds or field nurseries. Using fill soil and moving nematode-infested plants are two common ways nematodes spread within and to new landscape and nursery sites. Nematodes are also dispersed in soil clinging to shoes, clothing, tillage equipment, shovels and other tools, and tires of vehicles; in flowing water; and in eroded soil.

Nematodes move laterally through the soil at a very slow pace, usually 1 foot per month during the growing season. Some plant parasitic nematodes migrate through the profile of some coarse soils to depths of several feet, making them hard to control with a fumigant nematicide or solarization.

## Symptoms

Nematode-damaged plants typically show yellowing (chlorosis) of the leaves, reduced growth, and poor response to fertilizers and irrigation. These symptoms usually are not noticeable until considerable damage to the root system has been done. Dark, elongated spots followed by girdling of the feeder roots may be seen on plants parasitized by lesion nematode. As the loss of root function proceeds, early leaf shed, marginal leaf burn, twig dieback, severe stunting, and temporary mid-day wilting may be seen. Nematode-damaged plants are more likely to be killed by drought stress or cold injury than healthy plants. Nematode-damaged plants have no commercial value.

Diagnosis of nematode injury cannot be based solely on above-ground symptoms. Nematode injury causes symptoms that are similar to those caused by low soil fertility, improper plant estab-

**Table 1.** Nematode Pests on Woody Ornamentals and Their Common Host Plants

| Nematode | Injury to Roots |
|---|---|
| Root knot (*Meloidogyne* spp.) | Oval to elongate galls ranging from 3 mm to 2 cm in diameter on fibrous root system. Galls are numerous on roots of susceptible host plants. Easiest nematode injury to diagnose from symptoms on roots. Adult females sedentary in root knots. May be confused with Rhizobium nodules (nitrogen fixing) on roots. Major hosts: begonia, boxwood, camellia, daylily, gardenia, gladiolus, Gerbera daisy, hibiscus, liriope plus numerous annual and perennial flowers. |
| Lesion (*Pratylenchus vulnus*) | Feeding on cortical tissues causes numerous small dark lesions on fibrous roots. Darkened and stunted roots and reduction in the size of the root system may also be seen on severely damaged plants. Moves through root tissues. Major hosts: boxwood, forsythia, pine, rose, willow, and some annual flowers. |
| Dagger (*Xiphinema* spp.) | Fibrous (smaller) roots and root tips are swollen and discolored. Several lateral roots may appear above the damaged root tips. Galls may be confused with those of root-knot. Migrates along roots. Major hosts: ash, azalea, maple, oak, and sycamore. |
| Stunt (*Tylenchorhynchus* spp.) | Feeds on root tips. Causes damage only when found in large numbers. Migrates through soil along roots. Major hosts: rhododendron and some pines. |
| Ring (*Macroposthonia* spp.) | Free-living in soil. Damage similar to that caused by *Pratylenchus* spp. Major hosts: Chinese and Japanese holly. |
| Reniform (*Rotylenchus* spp.) | Damage similar to that caused by *Pratylenchus* spp. Adult females sedentary in root tissues. Hosts include daylily, gardenia, hibiscus, liriope, and many foliage plants. |
| Stubby-root (*Paratrichodorus* spp.) | Free-living in soil. Feeding on root tips and young root causes a reduction in the length of the small fibrous roots. Damaged root system may appear coarse. |
| Sting (*Belonolaimus* spp.) | Free-living in soil. Infested roots often darken and rot. Root systems are sparse, stunted, or stubby. Major hosts: camellia, holly, juniper, magnolia, oak, pear, red cedar. |

lishment, diseases, drought, and a host of other causes of root injury. Nematode-damaged fibrous roots are typically discolored, short, stubby, and often few in number. Numerous small fibrous roots, however, may be associated with the feeding injury of several nematodes. Small galls or swellings are found on roots colonized by one of several root-knot nematodes or the dagger nematode. The root volume of severely nematode-damaged plants is much smaller than that of a healthy plant. See Table 1 for a summary of root damage caused by plant parasitic nematodes on ornamentals.

## Diagnosis

More than a quick examination is usually needed to diagnose nematode damage on ornamentals. The affected plants must be carefully examined to eliminate other possible causes of decline. Diagnosis must also be based on the nematode analysis of soil samples to determine the kinds and numbers of plant parasitic nematodes present. Soil fertility testing and pH analysis of soil from the affected sites are recommended as part of the diagnosis process.

Collect soil samples for nematode analysis before establishing new plantings. The best time to take soil samples is from mid-summer to early fall (when nematode populations reach their peak). On established ornamentals, however, nematodes may be found almost year-round. For plant problem diagnosis, soil samples must be taken in the root zones of plants showing typical decline symptoms, but not those of dead or dying plants. Nematode populations on the roots of dead or dying plants quickly drop to almost undetectable levels. See Extension publication ANR-114, "Collecting Soil and Root Samples for Nematode Analysis," for directions on collecting and handling of soil samples for nematode analysis.

## Control

Nursery and greenhouse crops have no tolerance for damaging plant parasitic nematodes. Transplanting nematode-infested container, B & B, or bare-root plant material usually results in the spread of the nematode. The shift from field production to container production in soilless bark media has largely eliminated the threat of root-feeding nematodes to most pot-grown annuals, perennials, herbs, and woody ornamentals. However, nematode infestations may occur when containers are placed on bare ground for an extended period of time.

To identify nematode-infested sites, sample fields going into ornamental production before establishing plants. Avoid any sites where damaging nematodes are found. Periodic soil sampling is suggested until field-grown ornamentals are marketed. Controlling broadleaf weed hosts of damaging nematodes is also critical in field nurseries.

Nonsterile soil must never be used in potting media. Propagating or growing ornamentals in fumigated or steam-sterilized soil in ground beds is a questionable practice, because eliminating plant parasitic nematodes and other soil fungi is impossible. The nematode status of stock plants, particularly those propagated from bulbs, rhizomes, or stolons should be checked for nematodes by periodic soil analysis.

Crown container beds for fast drainage, and cover them with plastic or another weed barrier plus a thick gravel layer. Flood-prone areas should not be used for container production.

Other sanitation practices, including the following, are also recommended:

- Clean containers, benches, and other work areas with a disinfectant.
- Clean pruning shears and other tools with a solution of alcohol or disinfectant soap.
- Use covered concrete pads or bins for medium component storage.
- Clean tillers, shovels, and similar equipment with water or dilute soap solution after working in nematode-infested beds and before working in other beds.

In established landscape plantings, woody plants can tolerate the feeding of some plant parasitic nematodes without any noticeable damage. Plant reaction depends on the kind(s) of nematodes present and their populations in the soil. Although nematode damage is rare on woody plants, small numbers of one or more nematode species are probably present on the roots of nearly all of them and some feeding does occur.

Additional watering, mulching, and fertilization may improve the health and appearance of nematode-damaged plants. Severely damaged plants should be removed and destroyed.

Tolerance or resistance of woody plants can often be used, particularly in home landscapes, as a control strategy against certain plant parasitic nematodes. Avoid planting annuals, perennials, herbs, and woody ornamentals in sites where the kinds of nematodes known to damage that plant occur.

Woody plants susceptible to attack by one or more root-knot nematode species include abelia, bottle brushes, boxwood, Chinese tallow tree, daylily, fig, forsythia, gardenia, hibiscus, ixora, Japanese holly, pittosporum, eastern and chinese redbud, and rose. Flowering dogwoods are subject to attack by the southern and northern root-knot nematodes.

**Table 2.** Tolerance of Some Popular Woody Ornamentals to Four Common Nematodes*

| | Nematode Reaction | | | |
|---|---|---|---|---|
| Host Plant | Peanut Root Knot | Stunt | Lesion** | Ring |
| Azalea | T | I | O | T |
| *Aucuba japonica* | HI | I | O | I |
| *Buxus microphylla* (Japanese boxwood) | HI | O | O | O |
| *Buxus sempervirens* (American boxwood) | O | T | HI | O |
| *Camellia japonica* | T | T | O | O |
| *Camellia sasanqua* | T | T | O | T |
| *Gardenia jasminoides* | I | T | T | T |
| *Gardenia radicans* | HI | T | O | T |
| *Ilex cornuta* (Chinese holly) | | | | |
| cv. *Burfordi* (Burford) | T | T | O | T |
| cv. *Rotunda* | I | I | O | I |
| *Ilex crenata* (Japanese holly) | | | | |
| cv. Compacta | HI | T | O | I |
| cv. Convexa | HI | T | O | I |
| cv. *Helleri* | HI | I | O | I |
| cv. Rotundifolia | HI | I | O | T |
| *Ilex vomitoria* nana | T | T | O | T |
| *Juniper* spp. | | | | |
| Blue rug | T | T | HI | T |
| Shore juniper | T | T | O | T |
| Spiney Greek | T | T | I | T |
| Ligustrum (privet) | T | T | O | T |
| *Nandina domestica* | T | T | O | T |
| *Photinia* x *fraseri* (red tip) | T | T | O | T |
| Rose | I | I | I | T |

HI: Plants highly intolerant (severe stunting, branch dieback and death, heavy nematode reproduction).

I: Plants intolerant (some stunting, but plants will grow satisfactorily, some nematode reproduction).

T: Plants tolerant, will grow satisfactorily.

O: Plants have not been tested.

*Data in part courtesy of R. H. Jones, D. M. Benson, and K. R. Barker, Department of Plant Pathology, North Carolina State University at Raleigh.

***Pratylenchus vulnus*

**Table 3.** Response of Some Woody Ornamentals to the Northern Root Knot Nematode, *M. hapla*

| Host Plant | Reaction to Northern Root Knot Nematode |
|---|---|
| *Abelia* x *grandiflora* (glossy abelia) | HI |
| *Acer palmatum* (Japanese maple) | T |
| *A. saccharum* (sugar maple) | T |
| *Buxus harlandii* (Korean boxwood) | T |
| *B. sempervirens* (American boxwood) | T |
| *Cornus florida* (flowering dogwood) | HI |
| *Euonymus alata* (burning bush) | T |
| *Hydrangea paniculata* cv. Grandiflora (old-fashioned snowball) | HI |
| *Ilex* x *attenuata* (Foster holly #2) | T |
| *Ilex crenata* cv. *Hetzii* (Japanese holly) | T |
| *Ilex* 'Nellie R. Stevens' | T |
| *Juniperus chinensis* cv. *Hetzii Glauca* | T |
| *J. horizontalis* cv. Plumosa (Andorra juniper) | T |
| *J. conferta* cv. Blue Pacific (Blue Pacific shore juniper) | T |
| *Ligustrum sinense* (variegated Chinese privet) | I |
| *Magnolia* x *soulangiana* cv. Alexandrina (saucer magnolia) | T |
| *Metasequoia glyptostroboides* (dawn redwood) | T |
| *Nandina domestica* (nandina) | I-HI |
| *Pinus strolus* (white pine) | T |
| *P. virginiana* (Virginia pine) | T |
| *Photinia* x *fraseri* (red tip photinia) | HI |
| *Prunus cerasifera* (purpleleaf plum) | T |
| *Prunus cistena* (purpleleaf sandcherry) | T |
| *Prunus glandulosa* (flowering almond) | T |
| *Prunus serrulata* (Kwanan cherry) | T |
| *Prunus* x *yedoensis* (Yoshino cherry) | T |
| *Rhododendron catawbiense* cv. Boursalt | T |
| *Rhododendron* cv. Cannon's Double (Deciduous Azalea) | T |
| *Spirea* x *bumalba* cv. *Froebelii* (spirea) | HI |
| *Spirea* x *vanhouttei* (spirea) | HI |
| *Thuja occidentalis* cv. *Globosa* (globe arborvitae) | T |
| *T. occidentalis* cv. *Pyramidalis Nigra* | T |
| *Tsuga canadensis* (Canadian hemlock) | T |
| *Viburnum carlesii* (Korean spice viburnum) | HI |

Adapted from: Bernard, E. C. and W. T. White. 1987. Parasitism of Woody Ornamentals by *Meloidogyne hapla*. Annals of Applied Nematology 1:41-45.

**Table 4**. Response of Some Woody Ornamentals to the Southern Root Knot Nematode, *M. incognita*

| Host Plant | Reaction to Southern Root Knot Nematode |
|---|---|
| *Camellia sasanqua* (sasanqua camellia) | I |
| *Cedrus deodara* (deodar cedar) | T |
| *Chamaecyparis pisifera* (Japanese falsecypress) | T |
| *Cotoneaster horizontalis* (rockspray) | T |
| *Elaeagnus pungens* (thorny eleagnus) | T |
| *Hedera helix* (English ivy) | I-T |
| *Ilex cornuta* cv. Burfordii (Burford holly) | HI |
| *Ilex creneta* cv. Hetzii (Japanese holly) | I |
| *Jasmenum nidiflorum* (winter jasmine) | HI |
| *Juniperus horizontalis* cv. Douglasii (creeping juniper) | I-T |
| *Loropetalum chinese* | I-T |
| *Osmanthus* x *fortunei* (Fortune's osmanthus) | HI |
| *Poncirus trifolitata* (hardy orange) | I |
| *Prunus laurocerasus* cv. Zabeliana (cherry laurel) | T |
| *Syringa persica* (Persian lilac) | HI |
| *Thuja occidentalis* cv. Woodwardii (white cedar) | T |
| *Thuja orientalis* cv. Berkmanns (Oriental arborvitae) | T |
| *Vitex angus-castus* (chastetree) | HI |

HI: Plants highly intolerant (severe stunting, branch dieback and death, heavy nematode reproduction).

I: Plants intolerant (some stunting, but plants will grow satisfactorily, some nematode reproduction).

T: Plants tolerant, will grow satisfactorily.

O: Plants have not been tested.

Adapted from Nemec, S. and F. Ben Struble. 1968. Response of Some Woody Ornamental Plants to *Meloidogyne incognita*. Phytopathology 58:1700-1703.

Field-grown boxwood is also subject to attack by the lesion nematode. Oleander and butterfly bush are hosts of the reniform nematode.

Woody ornamentals least likely to be damaged by nematodes include 'Formosa' azalea, camellia, Inkberry, Little Red, Chinese and yaupon holly, as well as lantana, ligustrum, and juniper. The reaction of some common woody ornamentals to damaging nematodes may be seen in Tables 2, 3, 4, and 5.

The perennials stone cress (*Aethionema cordifolium*), purple coneflower (*Echinacea purpurea*), lemon bee-balm (*Monarda citriodora*), and patrinia (*Patrinia scabiosifolia*) did not support the reproduction of the peanut or southern rootknot nematode, while purple robe coneflower (*Nierembergia hippomanica*) was highly resistant to both nematodes. Although some galling was seen on toadflax (*Linaria cymbalaria*) and blue carpet-catmint (*Nepeta nervosa*), the peanut and Southern root gall index for these perennials were no where near severe as that noted on a susceptible tomato. Other perennials that are not good hosts for the peanut and southern root-knot nematodes include *Achillea*, *Fragaria*, *Geranium cinereum*, *Heuchera cylindrica*, *Heucherella*, *Phlox paniculata,* and *Polygonium affine. Penstemon* selections and *Salvia nemerosa* are good host plants for both of these nematodes. The reactions of other selected annual and perennial flowers are listed in Tables 6 and 7.

**Table 5.** Reaction of Selected Landscape Trees to Peanut (*M. arenaria*), Northern (*M. hapla*), Southern (*M. incognita*), and Javanese (*M. Javanica*) Root Knot Nematode.

| | Peanut Root Knot | | Northern | Southern | Javanese |
|---|---|---|---|---|---|
| | Race 1 | Race 2 | Root Knot | Root Knot | Root Knot |
| *Aesculus flava* (yellow buckeye) | I | HI | O | I | HI |
| *Ailanthus altissima* (tree of heaven) | R | R | R | R | R |
| *Betula nigra* cv. Heritage (River birch) | O | HI | O | O | O |
| *B. platyphylla* var. *japonica* (Asian white birch) | O | HI | HI | HI | HI |
| *B. papulifolia* (gray birch) | HI | HI | O | HI | HI |
| *Celtis occidentalis* (common hackberry) | T | I | R | I | I |
| *Fagus grandifolia* (American beech) | T | T | R | R | R |
| *Ginkgo bibola* (ginkgo) | I | HI | T | I | I |
| *Gleditsia triacanthos* (honey locust) | R | R | R | R | R |
| *Juglans nigra* (black walnut) | R | R | R | R | R |
| *Koelrenteria paniculata* (golden-rain tree) | HI | I | T | HI | I |
| *Liquidamber styraciflua* (sweet gum) | R | T | R | T | R |
| *Maclura pomifera* (Osage orange) | R | R | R | R | R |
| *Magnolia grandiflora* (southern magnolia) | R | R | R | R | R |
| *Prunus osium* (sweet cherry) | T | T | T | T | T |
| *P. cerasifera* (purple leaf plum) | HI | HI | HI | HI | HI |
| *P. mahaleb* (perfumed cherry) | HI | HI | HI | HI | HI |
| *Pyrus calleryana* (flowering pear) | R | R | R | R | R |
| *Robinia pseudoacacia* (black locust) | HI | HI | HI | HI | HI |
| *Sassafras albidum* (sassafras) | R | R | R | R | R |
| *Sophora japonica* (Japanese pogodatree) | HI | O | O | O | T |
| *Ulmus parvifolia* (Chinese elm) | I | HI | R | HI | HI |
| *Zelkova serrata* (Zelkova) | R | I | R | T | I |

HI: Heavy nematode reproduction and severe galling of roots
I: Nematode reproduction and galling on roots
T: Little nematode reproduction and light galling on roots
R: No nematode reproduction or galling on roots

Adapted from: Santamour, F. S. and L. G. H. Riedel. 1993. Susceptibility of various landscape trees to rootknot nematodes. J. Arboric 19:257-259.

**Table 6.** Sensitivity of Some Annuals to Root Knot Nematode

| | | | |
|---|---|---|---|
| **Immune** | | | |
| African marigold | *Tagetes* sp. | Rudbeckia | *Rudbeckia* sp. |
| French marigold | *Tagetes* sp. | Ageratum | *Ageratum* sp. |
| Coreopsis | *Coreopsis lanceolata* | Evening primrose | *Oenothera erythrocephala* |
| Argemone | *Argemone* sp. | Gaillardia | *Gaillardia* sp. |
| **Highly Resistant** | | | |
| Michaelmas daisy | *Aster tradescanti* | Scarlet sage | *Salvia splendens* |
| Lupine | *Lupine* sp. | Arctotis | *Arctotis stoechadifolia* |
| Calliopsis | *Coreopsis tinctoria* | Phlox, Big Drummond | *Phlox drummondii* |
| Four-o'clock | *Mirabilis jalapa* | Phlox, dwarf | *Phlox drummondii nana compacta* |
| Cosmos | *Cosmos bipinnatus* | Phlox, starred | *Phlox drummondii stellaris* |
| Zinnia (small) | *Zinnia elegans* | Statice | *Limonium sinatum* |
| Zinnia (large) | *Zinnia elegans* | Globe amaranth | *Gomphrena globosa* |
| Sweet alyssum | *Lobularia maritima* | Gerbera daisy | *Gerbera jamesonii* |
| Torenia, blue | *Torenia fournieri* | Vinca | *Catharanthus rosea* |
| Torenia, white | *Torenia* sp. | Stock | *Matthiola* sp. |
| Thunbergia | *Thunbergia* sp. | Leptosyne | *Coreopsis* sp. |
| Blue sage | *Salvia farinacea* | | |
| **Moderately Resistant** | | | |
| Godetia | *Godetia* sp. | Lantern groundcherry | *Physalis franchetii* |
| China aster | *Callistephus chinensis* | Perennial sweet pea | *Lathyrus latifolius* |
| Penstemon | *Penstemon* sp. | Liatris spicata | *Liatris spicata* |
| Dianthus | *Dianthus* sp. | Clarkia | *Clarkia* sp. |
| Portulaca | *Portulaca* sp. | Shasta daisy | *Chrysanthemum maximum* |
| Verbena | *Verbena* sp. | Candyturft | *Iberis umbellata* |
| Mignonette | *Reseda odorata* | | |
| **Susceptible** | | | |
| Acroclinium | *Helipterum roseum* | Mexican tulip poppy | *Hunnemania fumariaefolia* |
| Linaria | *Linaria* sp. | Annual chrysanthemum | *Chrysanthemum coronarium* |
| Poppy | *Papaver* sp. | Dimorphotheca | *Dimorphotheca sinuata* |
| Moonflower | *Ipomoea* sp. | English daisy | *Ibellis perennis* |
| Perennial chrysanthemum | *Chrysanthemum* sp. | Scarlet climer | *Ipomoea* × *multifida* |
| Nicotinia | *Nicotiana alata* | California poppy | *Eschscholtzia californica* |
| **Highly Susceptible** | | | |
| Coleus | *Coleus* sp. | Butterfly flower | *Schizanthus* sp. |
| Columbine | *Aquilegia* sp. | Morning-glory | *Ipomoea* sp. |
| Sunflower | *Helianthus annuus* | Larkspur | *Delphinium* sp. |
| Chinese forget-me-not | *Cynoglossum* sp. | Lobelia | *Lobelia erinus* |
| Baby's breath | *Gypsophila* sp. | Helichrysum | *Helichrysum* sp. |
| Gilia | *Gilia* sp. | Amaranthus | *Amaranthus* sp. |
| Matricaria | *Matricaria* sp. | Calendula | *Calendula officinalis* |
| Nasturtium | *Tropaeolum* sp. | Balsam | *Impatiens balsamina* |
| Snapdragon | *Antirrhinum majus* | Blue Lace Flower | *Trachymene caerulea* |
| Hollyhock | *Althea rosea* | Annual Sweet Pea | *Lathyrus odoratus* |
| Salpiglossis | *Salpiglossis sinuata* | Celosia | *Celosia argentea* |
| Pansy | *Viola tricolor* | Dolichos | *Dolichos* sp. |
| Centaurea | *Centaurea cyanus* | Gourd | *Cucurbita* sp. |

Adapted from C. C. Goff, 1936. Relative Susceptibility of Some Annual Ornamentals to Root-Knot, Univ. FL. Ag. Expt. Stn. Bull. 291.

**Table 7.** Sensitivity of Selected Bedding Plants to Three Species of Root Knot Nematode (*Meloidogyne sp.*)

| Bedding Plant | Cultivar | Southern Root Knot | Peanut Root Knot | Japanese Root Knot |
|---|---|---|---|---|
| Ageratum | Blue Mink | HR-I | HR | HR-I |
| Alyssum | Rosie O'Day | ---- | HR-I | HR-I |
| Celosia | Century Mix | HS | HS | HS |
| Coleus | Rainbow | S | HS | S |
| Dianthus | Baby Doll Mix | HR | HR | HR |
| Marigold | Dwarf Primrose | HR-I | HR | HR-I |
| Periwinkle | Little Bright Eye | HR-I | HR | HR |
| Petunia | Dwarf Bedding | MS | HS | HS |
| Salvia | Bonfire | HR-I | – | MS |
| Snapdragon | First Ladies | HS | HS | HS |
| Verbena | Florist | MR | HS | HS |
| Zinnia | Scarlet | MR | HR | HS |

HS = highly susceptible, S = susceptible, MS = moderately susceptible, MR = moderately resistant, HR = highly resistant, HR-I = highly resistant to immune.

From: McSorley, R. and J. J. Fredrick. 1994. Response of some common annual plants to three species of *Meloidogyne*. Supplement to Journal of Nematology 26(4S):773-777.

Renovation of nematode-infested landscape and production beds often presents some problems. Soil fumigation or soil solarization will suppress nematode populations, but treatments must be repeated yearly to be effective. Fumigation or solarization may be used to reduce nematode populations before planting trees and shrubs in nematode-infested soils. See Extension publication ANR-713, "Soil Solarization for the Control of Nematodes and Soilborne Diseases," for additional information on soil solarization. However, depending on the plant(s) established, nematode numbers may recover to previous levels in treated beds within one growing season. In addition, fumigant nematicides may not be used around established plants. Because of poor residual control, preplant fumigation of infested beds for field production of woody ornamentals is not recommended.

See Table 8 and Extension publication ANR-30, "Nematode Control in the Home Garden," for directions on using fumigant nematicide. All preplant fumigant nematicides are **RESTRICTED USE PESTICIDES** that require Pesticide Applicator Certification for their purchase and application. To reduce root knot nematode populations, heavily infested production fields should be planted to bermudagrass, tall fescue, or another turfgrass for 3 to 5 years. All broadleaf weeds must be controlled in the infested production fields.

**Table 8.** Nematicides Cleared for Use on Ornamental Crops

| Nematicide | Rate | Comments | Plant List |
|---|---|---|---|
| chitin and other organic nitrogen sources | | | |
| CLANDOSAN 618 25G | 1 to 3 tons/A. | BROADCAST: Use highest rate for rootknot nematode control. Apply at first flush of growth in spring and again in midsummer. Works best when applied before planting and incorporated. | All but may damage plants when used at high rates. ***Organic Nematicide Treatments.*** |
| NEM-A-CIDE | 4.5 to 14 lb./100 sq.ft. | BANDED: Apply to ½ area between rows and incorporate. | |
| CLANDOSAN 618 | 2.5 to 7.5 lb./cu.yd. soil | BULK SOIL MIX: Mix thoroughly. **NOTE**: Urea nitrogen in formulation must be considered when determining soil fertility requirements. Safe to use around home landscapes. | |
| *Myrothecium verrucania* | | | |
| DITERA ES | 5 to 40 gal./A | BROADCAST OR BAND: Apply to soil before container-grown plants. Apply to foliage of target plants. Higher rates and/or multiple applications may be required in coarse (light) soils. Product may not be effective in controlling heavy nematode infestations. See product label for additional mixing and application instructions. | |
| DITERA DF | 13 to 100 lb./A | | |
| DITERA WDG | 13 to 100 lb./A | | |
| | Preplant Fumigant Nematicides | | |
| dichloropropene + chloropicrin | | SOIL FUMIGATION: Apply to soil in seedbed condition, free of clods and undecomposed matter. Soil temperature at 6-inch depth should be between 50° and 80°F. Telone II is effective against nematodes only. See product label for specific application restrictions. **RESTRICTED USE PESTICIDES**. **CERTIFIED APPLICATOR USE ONLY** | All, but refer to label for any exceptions . |
| TELONE C-17 | 11 to 17 gal./A | | |
| dichloropropene | | | |
| TELONE II | 9 to 15 gal./A | | |
| metam-sodium | | | |
| VAPAM | 40 to 100 gal./A | | |
| dazomet | | | |
| BASAMID 99G | 222 to 350 lb./A (5 to 8.1 lb./1,000 sq. ft.) | | |

The biological nematicides Clandosan 618 and DiTera, when tilled into the soil before planting, will suppress populations of some plant parasitic nematodes. Since these products will give only a single season's suppression of nematode populations, they should only be used as preplant treatments in beds that will be planted to annuals or tender perennials. To continue to suppress nematode numbers, yearly retreatments of annual beds will be required. Treating established nematode-damaged annuals, perennials, shrubs, and trees with either Clandosan 618 or DiTera ES is unlikely to reduce numbers or improve plant growth.

The addition of organic compost to landscape beds before planting will increase the moisture holding capacity, nutrient content, and tilth of the soil. When incorporated into nematode-infested beds, organic composts not only may reduce stress and stimulate root development but also offset the impact of nematode feeding on plant vigor. Also, higher organic matter content may also stimulate the activity of pests and parasites of root-feeding nematodes, which may reduce their populations in the soil.

Trap crops may be used to suppress populations of damaging nematodes in landscape beds and gardens in place of fumigant nematicide. French dwarf marigold has been successfully used to control several rootknot nematodes. For 1 year's nematode control, marigolds must be solid-seeded across the infested bed and grown for several months before being turned under as a green manure. The French dwarf marigolds Single Gold, Tangerine, Lemondrop, and Happy Days as well as the hybrid Polynema have worked in field trials. See Extension publication ANR-856, "Nematode Suppressive Crops," for additional information on green manure and nematode trap crops.

## Additional Sources

Walker, J. T. and J. B. Melin. 1998. Host status of herbaceous perennials to *Melodogyne incognita* and *M. arenaria*. Supplement to Journal of Nematology 30(4S):607-610.

Williams-Woodward, J. L. and R. F. Davis. 2001. *Meloidogyne incognita* and *M. arenaria* reproduction on dwarf hollies and lantana. Supplement to Journal of Nematology 33(4S):332-337.

Severe galling due to root knot nematode on begonia roots.

Sparce, unthrifty top growth on bottlebrush is typical of nematode injury on some ornamentals.

ALABAMA COOPERATIVE Extension SYSTEM

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Use pesticides **only** according to the directions on the label. Follow all directions, precautions, and restrictions that are listed. Do not use pesticides, fungicides, or herbicides on plants that are not listed on the label.

The pesticide, fungicide, and herbicide rates in this publication are recommended **only** if they are registered with the Environmental Protection Agency and the Alabama Department of Agriculture and Industries. If a registration is changed or cancelled, the rate listed here is no longer recommended. Before you apply any pesticide, fungicide, or herbicide check with your county Extension agent for the latest information.

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