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Nematodes: Plant Parasitic, various

Introduction

Living in the cold Northeastern U.S. we are fortunate to have less plant parasitic nematode problems than those living further south. Still, some Northerners who grow plants outdoors do have problems with nematodes. Many annual ornamentals are at risk if planted in soil heavily infested with nematodes. They may develop serious root problems, grow poorly, and fail. There presently are no nematode "cures", but proper planning prior to establishment of plants and the care given to them after planting can have a substantial effect on their performance.

The nematodes discussed here fall into two groups, nematodes that spend there life cycle in the soil and roots of plants and those that spend at least part of their time feeding on the foliage of plants. Of the soil types, the most common is the root knot nematode, *Meloidogyne* spp. Root knot nematodes have a broad host range of more than 200 reported plants. Other commonly found root feeding nematodes include Stunt (*Tylenchorhynchus* spp.), Lance (*Hoplolaimus* spp.), Spiral (*Helicotylenchus* spp.), Lesion (*Pratylenchus* spp.), Cyst (*Heterodera* spp.), and Ring (*Criconema* spp.). Most foliar nematodes belong to the genera *Aphelenchus* or *Aphelenchoides*. The Pine Wood nematode (*Bursaphelenchus xylophilus*) is unique as it attacks mainly Japanese Black Pine trees and harms the tree by plugging up the sieve tubes of the tree's vascular system.

Symptoms and Signs

Symptoms may vary based on the plant part(s) attacked, species of nematode(s) present, and other pests or stress factors affecting the plant.

Above Ground Symptoms

Nematodes that feed on the roots cause above ground symptoms that are similar to those resulting from many kinds of root injury. Foliage loses its luster and wilts. Prolonged root stress caused by nematodes may result in yellowing and eventual loss of foliage. New flushes of growth are stunted and weak, with fewer and smaller leaves than healthy plants. Plants tend to wilt more readily during low water or drought conditions than non-infested plants. The damage is usually distributed irregularly, since nematodes are rarely distributed evenly in the soil.

Figure 1: Characteristic angled foliar lesions (provided by the **Plant Disease Diagnostic Clinic, Cornell University)**

Nematodes that feed on the foliage produce characteristic angled lesions on broad leaved plants (**Fig.1**). Infections on narrowed leaved plants can be misleading due to the small, strap-like leaves lacking the characteristic angular lesions. Instead, random leaves may turn completely brown and die (**Fig. 2**).

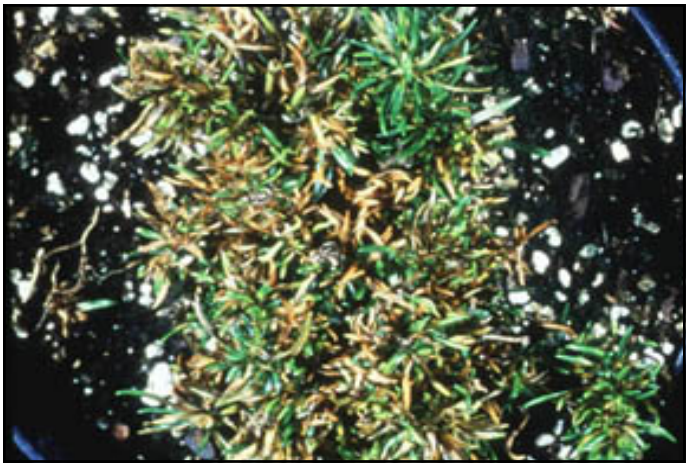


Figure 2: Damage on strap-like leaves (provided by **Karen L Snover-Clift, Cornell University)**

Root Symptoms

Root symptoms vary widely. Some kinds of nematodes cause tissues on which they feed to grow strangely (root-knot and some foliar nematodes, for instance); some stop the growth of the roots; others kill the cells on which they feed as they move through the roots (**Fig. 3**), leaving patches of dead tissue as they move on. Depending on the kinds of nematodes involved, damage may include galls, stunting, and decay of roots; infested roots are often darker in color than healthy roots. Fungi and bacteria which cause root rots, wilt, and other plant diseases often infect nematode-damaged roots earlier and more severely than uninjured roots. Some viruses can also be transmitted by nematodes.

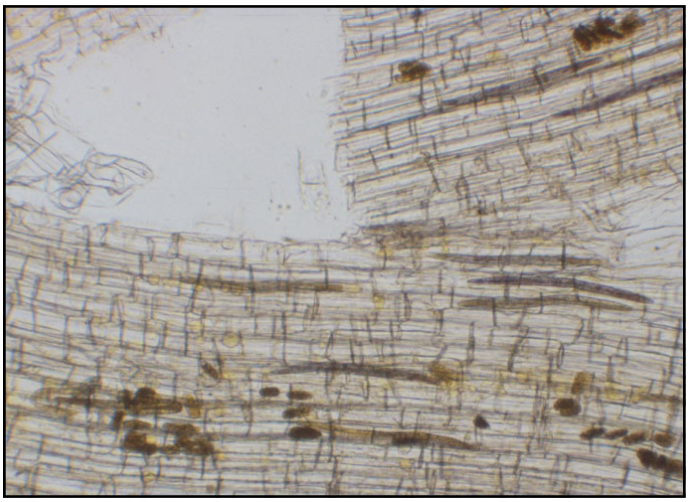


Figure 3: Vermifom plant parasitic nematodes within root tissue (provided by **Dr. Eric B. Nelson, Cornell University)**

Among the dozens of nematode species associated with landscape ornamentals, only a couple seem to cause most of the serious problems. The root-knot nematodes (*Meloidogyne* spp.) are by far the most important. Their easily-recognized galls in the roots make their presence easy to detect (**Fig. 4**). Galls result from growth of plant tissues around juvenile nematodes which feed near the center of the root. Root-knot gall tissue is firm without a hollow center, and is an integral part of the root; removing a root-knot gall from a root tears root tissue. Nodules formed on roots of many legumes because of beneficial *Rhizobium* spp. (nitrogen-fixing bacteria) and most other natural nodules or bumps are loosely attached to the root and have hollow centers. Active Rhizobium nodules have a milky fluid in the center.

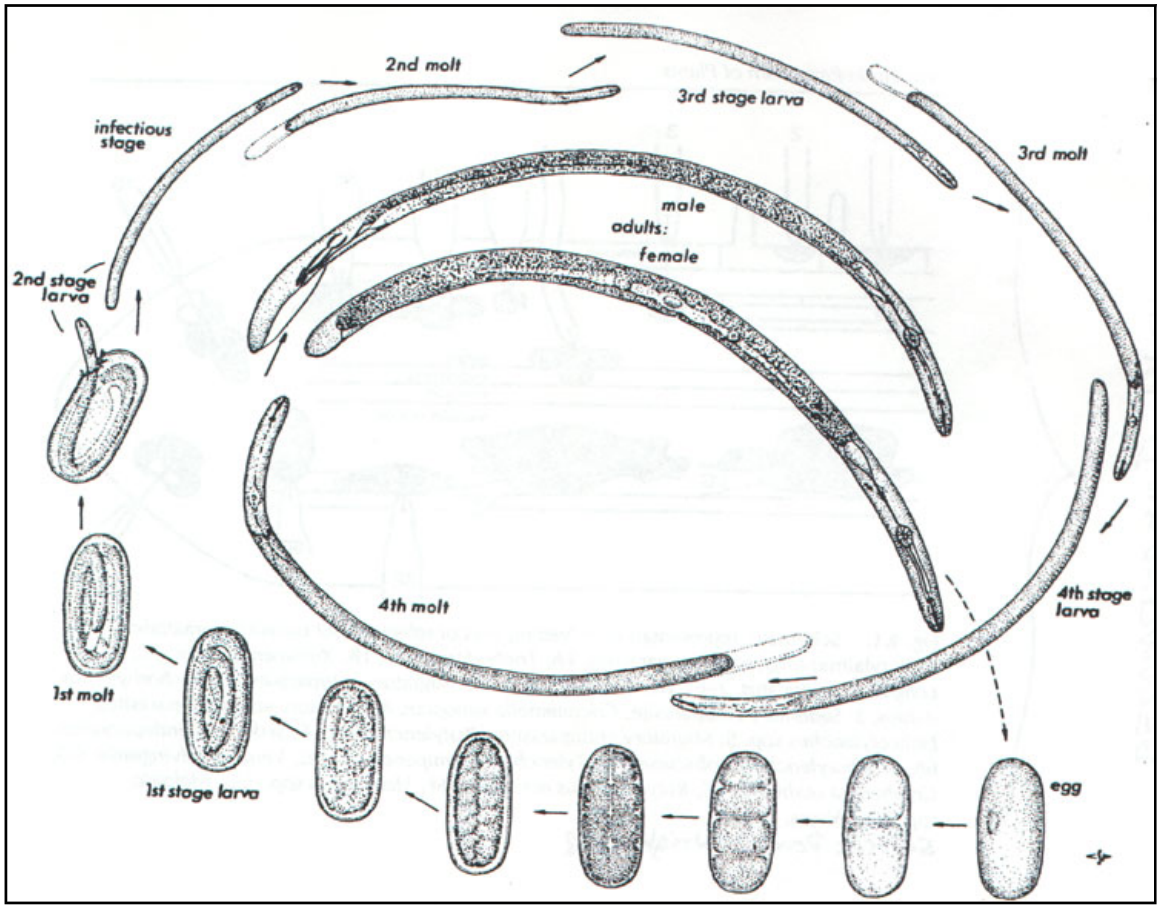
Figure 4: Root knot nematodes cause symptoms of galling in the root system (provided by the **Plant Disease Diagnostic Clinic, Cornell University)**

Laboratory Soil Sample Analysis

Laboratory soil sample analysis or foliar analysis is the only way to detect the kinds of nematodes associated with a problem and may be necessary to identify the most effective control measures. Contact your local county extension agent for more information on nematode assays.

Disease Cycle

Nematodes are microscopic, worm-like, animals with life cycles that include one egg stage, four juvenile stages and one adult stage. Nematodes overwinter using a number of strategies: in the egg phase, within the dead female body, or in plant material. As the weather warms in the spring, the nematodes become active and begin feeding. Some female species become enlarged when mature. They either produce and then deposit a mass of eggs outside of their bodies--as do



Life Cycle of a Plant Parasitic Nematode
(provided by **Ayoub, 1980**)

female Root Knot nematodes, or they house the eggs within their bodies--as do female Cyst nematodes.

Management Strategies

In most cases, there are many attractive plants which could be planted into a site without serious damage or immediate losses. With proper care, an attractive landscape can be established and maintained, despite nematodes. The keys to minimizing the effects of nematodes on landscape ornamentals are good horticultural care and preventive maintenance as outlined below.

Prepare new planting sites properly

Give plants the best chance to become rapidly established. Native soil into which annuals are to be planted should be prepared well, including removal of any old roots, debris, etc., from the site. Water and nutrient holding capacity of the soil and activity of natural enemies of nematodes are improved by incorporating organic soil amendments into the soil before planting.

Replace infested (contaminated) soil

It may be simpler to remove all soil or planting mix from an annual bed and replace it with new nematode-free planting medium. Nematodes eventually will invade the new medium, and bedding plant roots can grow out of the new medium into the infested native soil, but infestation will be delayed and damage less severe.

Use nematode-free stock

No matter how perfect and pest-free the planting site, a nematode infestation already started in roots of transplants will do the most damage. Buy only top quality plants. Reject any that have clear evidence of nematodes or other problems.

Select plants that are well adapted

Plant suitability to the location is important at all levels: region (climate), soil type, shade, drainage, etc. Plants that are "out of place" are more likely than well-adapted ones to suffer environmental stress. Moreover, a plant species that is "well adapted" to an area probably has some degree of tolerance or

resistance to locally common pests, including some nematodes.

Avoid nematode-susceptible plants

Do not use plants that are very susceptible to nematodes known to occur in that planting site. Plants vary widely in their susceptibility to different nematodes, just as they vary in form, flower color, and season of bloom. Most references to "nematode susceptibility" in popular literature refer to one or more root-knot nematode species, unless they specify others. Such lists are often incomplete, but it is quite likely that any plant identified as "nematode susceptible" should not be planted where root-knot nematodes are known to be serious. See **Table I** below for information on herbaceous plants and their observed response to specific nematodes.

Keep other pests under practical control

Stress from pests can set plants up for nematode infection just as readily as an over- or under-supply of nutrients or water. Overuse of pesticides can also injure plants, so use judgment in their application, and always follow the instructions on the pesticide label --- it's the law.

Maintenance

Give the plants optimum care from the start and for as long as you want them to perform well. Please note that "optimum" does not mean "maximum". Fertilize

Common Name	Scientific Name	Nematode	Comment
Alyssum	*Lobularia maritima*	root-knot	very light infestation
Ageratum	*Ageratum houstonianum*	root-knot	not infested
Ageratum	*Ageratum* sp.	root-knot	not infested
Argemone	*Argemone* sp.	root-knot	not infested
Bahiagrass	*Paspalum notatum*	root-knot	Northern resistant
Bermuda grass, Coastal	*Cynodon* sp.	root-knot	Northern resistant
Coreopsis	*Coreopsis lanceolata*	root-knot	not infested
Corn	*Zea mays*	root-knot	Northern resistant
Dianthus	*Dianthus chinensis*	root-knot	light infestation
Evening primrose	*Oenothera lamarkiana*	root-knot	not infested
Gaillardia	*Gaillardia* sp.	root-knot	not infested
Marigold, African	*Tagetes erecta*	root-knot	not infested
Marigold, French	*Tagetes patula*	root-knot	not infested, lesion suppressive
Marigold, 'Tangerine'	*Tagetes patula*	Northern root-knot	root knot suppressive, lesion suppressive
Okra	*Abelmoschus esculentus*	root-knot	Northern resistant
Periwinkle	*Vinca rosea*	root-knot	very light infestation
Petunia	*Petunia* x *hybrida*	root-knot	light infestation
Rudbeckia	*Rudbeckia* sp.	root-knot	not infested
Scarlet sage, salvia	*Salvia splendens*	root-knot	very light infestation
Watermelon	*Citrullus lanatus*	root-knot	Northern resistant
Verbena	*Verbena* x *hybrida*	root-knot	light infestation
Zinnia	*Zinnia elegans*	root-knot	very light infestation

Table I

as needed to maintain healthy growth, not to produce excessive, succulent growth that invites attack by nematodes and other pests. Water deeply, to encourage development of a deep root system which can exploit a larger volume of soil for water and nutrients. Frequent shallow watering causes plants to develop a shallow root system. A large root system can better withstand a small amount of nematode damage without major compromise to the overall health of the plant than can a shallow, already minimal, root system.

Do not allow maintenance to lapse

Sudden dry periods or pest outbreaks can weaken plants in a very short time. Even under normal conditions, erratic or inadequate watering can weaken a plant so that it can no longer tolerate a modest nematode population that may have existed for years.

Mulches

Keep the plant root zone mulched to keep roots cool in hot weather and minimize evaporation of water from the soil surface. Organic mulches also contribute organic matter to the soil, thus enhancing the capacity of the soil to retain water and nutrients. Mulches reduce stress on the plant as a whole and on the root system specifically. Greater soil organic matter content also stimulates activity of natural enemies such as certain fungi, predatory nematodes, etc. which can help suppress nematode populations.

Chemical controls

Most chemicals that have historically been used for nematode control or suppression are highly toxic and have very limited uses usually involving soil sterilization before planting. In addition, these chemicals have often been recommended only for crop production or other commercial uses, and had few if any applications in landscape plantings.

Currently only one product has limited lawn & landscape uses in New York State. Basamid G will kill nematodes and plants and can be used to fumigate soil when renovating lawns or prior to planting landscape beds. However, this is a toxic material that can be harmful to beneficial soil organisms, and alternatives should be carefully considered before use. Basamid G is restricted-use in New York, and should be applied by a trained applicator.

Table I was compiled from various fact sheets and scientific articles. Bedding plants as well as vegetables and grasses are included. Plants listed were either not infested, lightly infested, resistant to, or actually suppressive of the various nematodes listed.

Sources:

Hagan, Austin et al. *Nematode Suppressive Crops.* 1994. Circular ANR-865. Alabama Extension Service.

Jones, R. K. *Nematode Management in Bedding Plants in the Landscape.* 1995. Plant Pathology Information Note. Ornamental No. 31. North Carolina Cooperative Extension Service.

Lehman, P. *Factors Influencing Nematode Control With Marigolds.* 1974. Nematology Circular No. 50. Florida Department of Agriculture and Consumer Services, Division of Plant Industry.

McSorley, R. and Frederick, J. *Response of Some Common Annual Bedding Plants to Three Species of Meloidogyne.* 1994. Journal of Nematology. 26 (4S):773-777.

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READ THE LABEL BEFORE APPLYING ANY PESTICIDE! Changes in pesticide regulations occur constantly. All pesticides distributed, sold, and/or applied in New York State must be registered with the New York State Department of Environmental Conservation (DEC). Questions concerning the legality and/or registration status for pesticide use in New York State should be directed to the appropriate Cornell Cooperative Extension Specialist or your regional DEC office.

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