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College of Agricultural, Consumer and Environmental Sciences

report on
**PLANT DISEASE**

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# LESION NEMATODES

Lesion or root-lesion nematode disease is caused by members of the genus *Pratylenchus*. The common name of these nematodes is derived from the often-conspicuous necrotic lesions they cause on host roots. In the past, the name meadow nematodes was used occasionally because of their abundance in this habitat from which the first species was described.

Lesion nematodes are migratory endoparasites that enter the host root for feeding and reproduction and move freely through or out of the root tissue. They do not become sedentary in the roots, as do the cyst or root-knot nematodes. Feeding is restricted almost entirely to the cortex of the root.

Lesion nematodes are more often a problem on perennial plants, both woody and herbaceous, than on row crops. The lesion nematodes are often present in the roots of row crops, but usually do not build up large enough populations in a single growing season on most types to cause an appreciable yield loss. However, corn (Figure 1) and occasionally soybeans can be severely damaged, particularly in less fertile soils, where the crop has been monocultured for several years, or where no nematicide has been applied. Damage to these crops is more serious and widespread in years when soil temperatures are unusually warm during the early part of the growing season.

*Figure 1. Corn field showing nematode injury to roots.*

Lesion nematodes are essentially worldwide in distribution. Five of the more than 40 species of *Pratylenchus* that have been described occur in Illinois: *Pratylenchus penetrans, P. alleni, P. hexincisus, P. neglectus,* and *P. scribneri.* Lesion nematodes may exist as a single species at a given site, or as a complex of two or more species.

*P. penetrans* is most often found in nurseries, orchards, and strawberry fields and is probably an introduced species in Illinois. In the eastern United States and in Canada, *P. penetrans* has been responsible for severe decline and for replant failure in many cherry, apple, and peach orchards (Figure 2). Because of its importance, this species has been studied more than any other lesion nematode. The other four species are most often found on row, forage, and small-grain crops and are probably indigenous to Illinois. Several additional species are encountered occasionally as introductions in infected plants.

## Symptoms

The most obvious aboveground symptoms of lesion nematode disease on herbaceous plants are round-to-oval patches of stunted and chlorotic (yellowish) plants, which give the field a ragged appearance. Damage is often most severe in the center of these areas, diminishing toward the edges to normal-appearing plants. There is a reduction in leaf size and number of leaves produced on heavily infected plants. Yields can be substantially reduced.

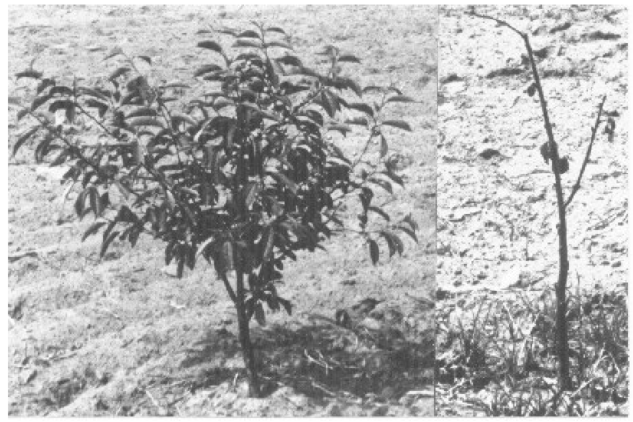

*Figure 2. Two one-year-old sour cherry trees. Left: tree in soil treated with nematicide. Right, tree in untreated soil (Dr. W. F. Mai, Cornell Univ.)*

Very high nematode populations may interact with other soilborne pathogens to kill initially weakened plants, resulting in barren areas in a field. The affected areas may increase in size as the season progresses. If growing conditions are otherwise favorable, however, moderately infected plants often appear to outgrow early damage, since the root systems are able to extend deep into the soil. Nevertheless, these plants usually will yield poorly. Lightly infected plants usually show no growth abnormalities, but under unfavorable growing conditions, damage still may be reflected by a slight reduction in yield. Lesion nematode damage to herbaceous plants is greatly enhanced by stress from other factors. The disease symptoms are more pronounced and yield reduction is greater when abnormally high temperatures occur early in the growing season, rainfall is inadequate, soil fertility is low or imbalanced, or root-rot organisms attack the plants.

The most common symptom on susceptible trees or shrubs is a slow decline as the nematodes increase to very high numbers over the years. The foliage of diseased trees may appear lighter green or chlorotic. Seasonal growth of infected plants is less than would be expected in a healthy plant. Flowers or fruit may be reduced substantially in number and quality. The vigor of the host is reduced, and the plant may be predisposed to winter injury or other infectious diseases. Replacing the affected plant without soil treatment frequently results in poor growth and sometimes in the death of the new plant (Figure 2).

Symptoms of lesion nematode damage resemble those of other soilborne diseases, nutrient deficiencies, insect damage, or cultural and/or environmentally induced stress. Thus, a soil test is necessary to determine whether a nematode problem exists. If a nematode problem is suspected, collect soil and root samples from the root zone in the affected areas and submit to the University of Illinois Plant Clinic or other reputable lab for nematode analysis.

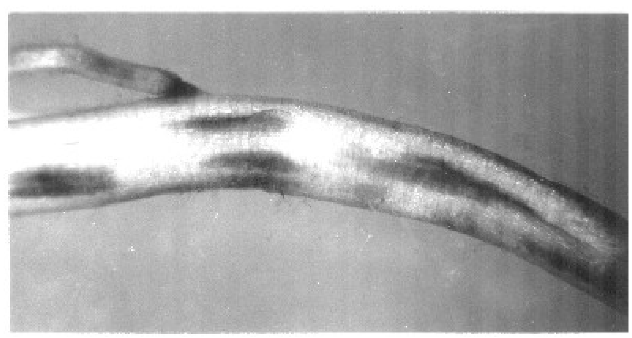

*Figure 3. Lesions on root of strawberry caused by Pratylenchus penetrans.*

The symptoms on infected roots initially are small, light-to-dark brown lesions (Figure 3). These lesions tend to expand and to merge as the growing season progresses, giving the roots a discolored appearance overall. Nematode feeding causes cortical tissue disintegration and girdling, resulting in the sloughing off of the epidermis and remaining cortex, root pruning, and a reduction in the size of the root system.

The root destruction in severely infected plants may be almost complete. Such plants can be pulled from the soil easily (Figure 4). Moderately infected plants have stubby, brownish roots. Most of the remaining roots will be near the soil surface.

Lesion formation results from an interaction of plant glycosides with enzymes released by the nematode during feeding. The chemicals are toxic to invaded and adjacent host cells. The degree of host-parasite interaction depends on the concentration and location of specific glycosides within the root tissue and on the concentration of enzymes released during feeding. The wounds produced by the nematodes provide a means of entry for a wide variety of relatively nonspecific soil micro-organisms, including root-infecting pathogens, that may also contribute to lesion formation and may enhance the disease.

*Figure 4. Left, lesion nematode-infected strawberry plant; right, healthy plant (J.L. Townshend, Canada).*

Plants differ in their tolerance to lesion nematodes. Some plant species are damaged by a relatively low population, while others can support a large population without visible adverse effects. The threshold populations necessary to cause economic damage have been determined for only a few plants. Even so, the thresholds probably vary from year to year depending on the weather, and from one site to another as related to different edaphic conditions.

The degree of damage depends on a number of environmental conditions. Injury is usually most severe in light-textured soils that are low in nutrients (e.g., nitrogen, potassium, or calcium) and in organic matter. Plants under moisture and high temperature stress are most likely to suffer damage. In a year of high stress, damage can be substantial. When growth conditions are optimum, there may be no noticeable injury, even with high populations of lesion nematodes in the roots.

## Disease Cycle

The members of the genus *Pratylenchus* are small, vermiform (worm-like) nematodes. They are 0.3 to 0.9 millimeter long. These nematodes are virtually transparent and are invisible to the naked eye.

The disease (life) cycle of a lesion nematode is rather simple (Figure 5). Sexual reproduction occurs in *P. penetrans* and *P. alleni*. After mating, the female lays its eggs singly or in small groups in the host root or in the soil near the root surface. The first larval stage and molt occur within the egg. The egg hatches within 1 to 3 weeks, depending on the soil temperature. The second-stage larva emerges from the egg and undergoes three more molts before becoming an adult. Males are rare or absent in *P. hexincisus, **P. neglectus,*** and *P. scribneri**.*** Eggs develop parthenogenically; otherwise, the life cycle is the same as that of sexually reproducing species.

All life stages outside the egg are infective. Lesion nematodes appear to be attracted to host roots, especially to the region of root hair production and to the root tips. Most penetration, however, occurs behind the region of elongation. The nematode may feed ectoparasitically (from the root surface) for a brief period before entering the root, eventually penetrating the root by forcing its way between or through the epidermal cells. Entrance is aided by the mechanical action of the nematode's feeding structure, the stylet, and by the cell wall-degrading enzymes secreted through esophageal glands. Once inside the roots, the nematode feeds on cortical cells (Figure 6), creating cavities as tissue is destroyed.

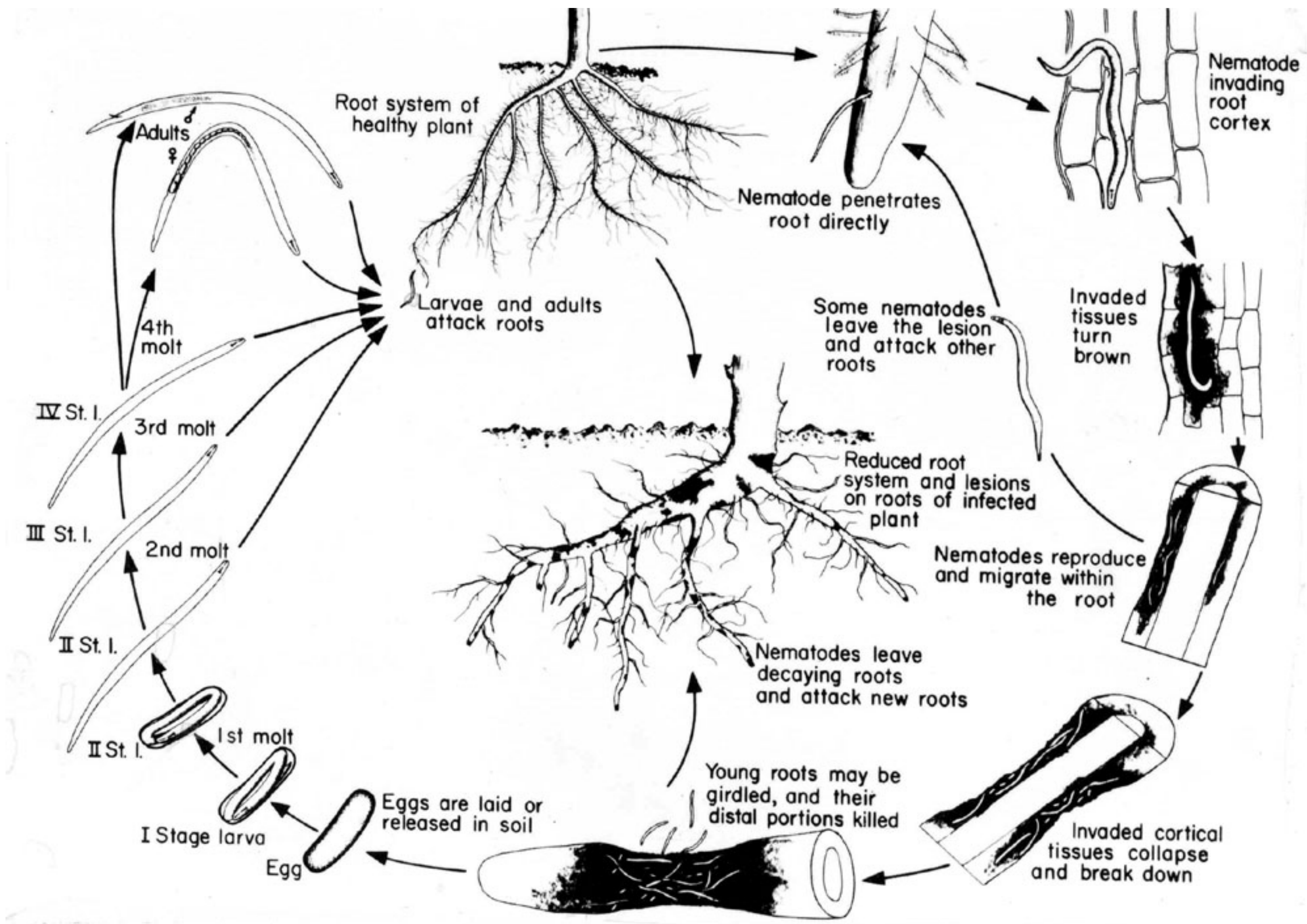


*Figure 5. Disease (life) cycle of lesion nematode (Dr. G.N. Agrios).*

When an infected root becomes highly necrotic, dies, or otherwise becomes unfavorable for feeding and reproduction, the nematode migrates through the cortex to a healthier area or into the soil to another root. Lesion nematodes do not attack the root stele, as do cyst and root-knot nematodes.

Lesion nematodes overwinter as eggs, larvae, or adults in host roots or soil. The length of the life cycle depends on the species and the soil temperature. For example, the optimum temperature for population development on soybeans for *P. alleni, P. neglectus*, and *P. scribneri* is 86°F (30°C) while that for *P. penetrans* is 77°F (25°C). The optimum for *P. hexincisus* on corn is 86°F (30 °C).

Lesion nematodes remain inactive when soil temperatures are below 59°F (15°C); except for *P. penetrans*, there is little activity until temperatures rise above 68°F (20°C). *P. penetrans* completes its life cycle in 30 days at 86°F (30°C), 35 days at 76°F

*Figure 6. Strawberry root with lesion nematode in cortex (Dr. J.L. Townshend, Canada).*

(24°C) and 86 days at 59°F (15°C). Although the other species have not been thoroughly studied, their developmental biology is probably similar to that of *P. penetrans*. Since most species have an optimum temperature above the maximum usually encountered in Illinois soils, the populations of lesion nematodes tend to build up more slowly in Illinois than in southern regions of the United States.

**INTERACTIONS**

Lesion nematodes commonly interact with other soilborne pathogens such as fungi, bacteria, and other species of nematodes. These interactions may have no detectable effect on the host plant, the effects may be additive, or they may be synergistic (causing more damage than the combined effects of the individual pathogens). Nematodes can lower the resistance of plants to other pathogens. Lesion nematodes are known to interact with *Verticillium* and *Fusarium* fungi, which cause wilt diseases on pepper, eggplant, tomato, potato, and numerous other plants. Lesion nematodes also interact with *Trichoderma viride* on alfalfa and celery. Such disease complexes may kill plants, whereas nematodes alone seldom cause such a severe reaction.

DISSEMINATION

Lesion nematodes are probably present in most Illinois soils, but may be absent from some portions of a field, orchard, or garden. Some individual species, such as *P. penetrans*, are found only in certain locations into which they have been introduced. Adults and larvae are able to move through the soil, but this mode of dissemination to uninfested areas is probably not much more than a foot per year. Dissemination can occur naturally by surface-drainage or irrigation water, wind, or wildlife. Rain runoff can move eggs, larvae, or adults; flooding could be involved in long-distance transport. Even though larvae and adults rapidly die when removed from a moist environment, plowing or other tillage activities can transport all nematode stages if the soil is moist. Wildlife can carry soil from an infested field on their feet or bodies.

The transport of infected plants or those growing in infested soils is an important means of dissemination, especially with perennial plants and annuals grown as transplants. The movement of infected plants or propagative parts has been responsible for disseminating lesion nematodes long distances, even inter-continentally, and for introduction of alien species into new regions of the country.

## Control

1. Maintain optimum growing conditions. The greatest damage by lesion nematodes occurs on plants which are under stress. The amount of injury to plants can be reduced, or in some cases eliminated by maintaining optimum growing conditions. Plants should be provided with adequate moisture, nutrients, and soil aeration at all times. Controlling other diseases and insects also reduces plant stress.

2. Rotate crops. Despite the wide range of hosts for lesion nematodes, crop rotation can provide control in some instances. The use of crop rotation depends on the species involved and the economic feasibility of such rotations. The two *Pratylenchus* species most commonly associated with field crops in Illinois are *P. hexincisus* and *P. scirbneri*. They often occur in mixed populations and have been associated with damage and yield loss in corn and soybeans. The use of poor hosts in a rotation scheme should be an effective method of management of these two species. Host suitability studies indicate corn and potato are good hosts for both *Pratylenchus* species, whereas alfalfa and red clover

were nonhosts. Wheat and rye were better hosts for *P. hexincisus* than *P. scribneri,* whereas sorghum, soybean, tomato, and white clover were better hosts for *P. scribneri*. Other species of lesion nematodes damage both grasses and broad-leafed plants. Keeping the crop free of weeds and volunteer plants that may serve as hosts for the species of lesion nematode involved can also aid in disease control.

3. Treat propagation material with heat. A hot water treatment is an effective method of eradicating lesion nematodes from the roots of transplants. The time and temperature to use will depend on the plant and variety and **must** be controlled closely. Temperatures of 113° to 131°F (45° to 55°C) sustained for 10 to 30 minutes are commonly used. Before making a large-scale treatment, treat several plants of each variety to make sure that heat damage will not occur.

4. Treat the soil with dry or moist heat. This method is commonly used to control nematodes and other soilborne pathogens in the greenhouse and the home. The method is economical and is highly effective if performed correctly. However, its application is limited to relatively small quantities of soil. Nematodes are killed by exposure to temperatures of 105° to 126°F (40° to 52°C), depending on the species. Any method that will thoroughly heat the soil and plant residues above these temperatures will kill the nematodes. Aerated steam is the most efficient method, but baking small quantities of soil in an oven at 180°F (82°C) for 30 minutes or 160°F (71°C) for 60 minutes is also effective, especially for the homeowner where a small quantity of soil is needed.

5. Apply nematicides. The use of chemical fumigants to control lesion nematodes can be effective and economical, especially where high-value crops are involved. Preplant fumigation with nematicides may be necessary in order to control replant and other lesion nematode diseases in orchards, nurseries, strawberry beds, and other areas. The specific situation dictates whether the expense of such fumigation is warranted. Fumigants are not economical for field and forage crops in Illinois and generally cannot be used in home plantings except by certified, professional pesticide applicators trained in handling and applying soil fumigants.

   Certain granular insecticide-nematicides show promise for early-season control of lesion nematodes on some annual row crops and vegetables, and in nurseries, nonbearing fruit orchards and turfgrass areas, but these insecticide-nematicides are not yet registered for use on most plants. Refer to the pesticide label, contact your pesticide dealer, or check with your county Extension adviser for up-to-date information on usage. All of these chemicals are **high toxic** and must be applied only by certified pesticide applicators.

6. Resistant varieties. Population development of *P. scribneri* and *P. hexincisus* varies among cultivars of corn, soybean, and wheat; however, more information is needed before this can be used in the management of the nematode. Varietal differences are also known to occur in tomato and potato with other species of lesion nematodes. Resistant varieties are not currently available.

Specific nematode recommendations are published in the Illinois Agricultural Pest Control Handbook and Illinois Urban Pest Management Handbook. These publications are available in your nearest extension center or campus-based extension offices.