



Root-knot Nematode in Field Corn

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Order: Tylenchida

Family: Heteroderidae

Species: *Meloidogyne incognita* (southern root-knot nematode), *M. arenaria* (peanut root-knot nematode), *M. javanica* (Javanese root-knot nematode), *M. hapla* (northern root-knot nematode; not found in corn)

Size: Adult females are up to 1/16 inch in diameter.

Color: Adult females are a translucent cream color.

Description: Adult females are pear shaped and sedentary.

Range: *M. incognita*, *M. arenaria*, and *M. hapla* are commonly found throughout Virginia. However, *M. javanica* is rare and found mostly in the warmer areas such as near the coast.

Habitat: Root-knot nematodes are obligate endoparasites that complete most of their life cycle inside the host plant. The only stages found outside the host plant are the egg, the motile portion of the second juvenile stage, and the adult vermiform male.

Hosts: Root-knot nematodes have a wide range of hosts. The more than 2,000 host plants include all major field crops, most vegetable crops, fruit trees, ornamental plants, and weeds. Some of the common host plants are bean, cabbage, cantaloupe, carrot, celery, chard, corn, cotton, cucumber, dandelion, eggplant, lettuce, mallow, okra, onion, peach, pepper, plantain, potato, pumpkin, purslane, radish, rhubarb, sorghum, soybean, spinach, squash, sugarbeet, sugarcane, sweet potato, tobacco, tomato, turnip, and watermelon.

Life Cycle: The short-lived adult males are vermiform and motile, and move into the surrounding soil to copulate with nearby females. However, males are not necessary since female root-knot nematodes are able to reproduce asexually. Adult females deposit eggs into a protective gelatinous matrix, near or just outside the root surface. A single female lays about 500 to 1,500 eggs during her life, which lasts about two to three months (Fig. 1). Eggs hatch only under favorable conditions, such as adequate moisture and warm temperatures. The life cycle takes anywhere from 17 to 57 days, depending on the host plant and environmental conditions. Typically, root-knot nematode development begins inside the egg. After the completion of embryogenesis, the first-stage juvenile remains inside the egg until it molts into the second-stage juvenile. Second-stage juveniles hatch from the egg and move freely in the soil in search of a suitable host plant (Figs. 2a, 2b). Root-knot nematode second-stage juveniles undergo an additional three molts before transforming into the adults. Root-knot nematodes have a low host plant penetration rate at temperatures below 50°F, and a reduced reproduction rate at temperatures below 58°F.

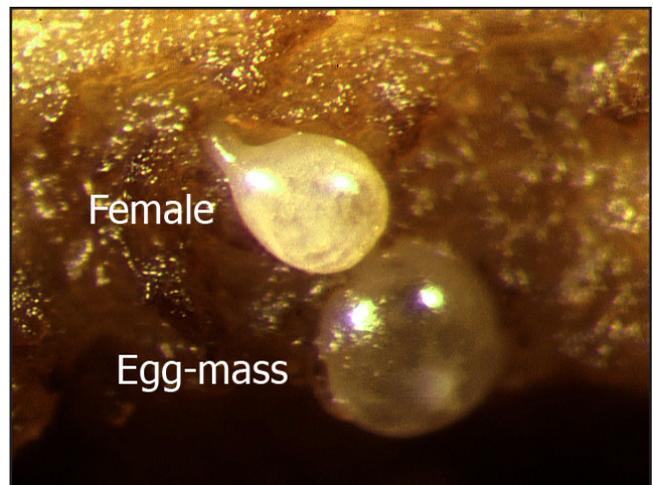


Fig. 1: Root-knot nematode female and an egg-mass dissected from a galled root.



Fig. 2a. Second-stage juveniles of root-knot nematode, *Meloidogyne* sp.

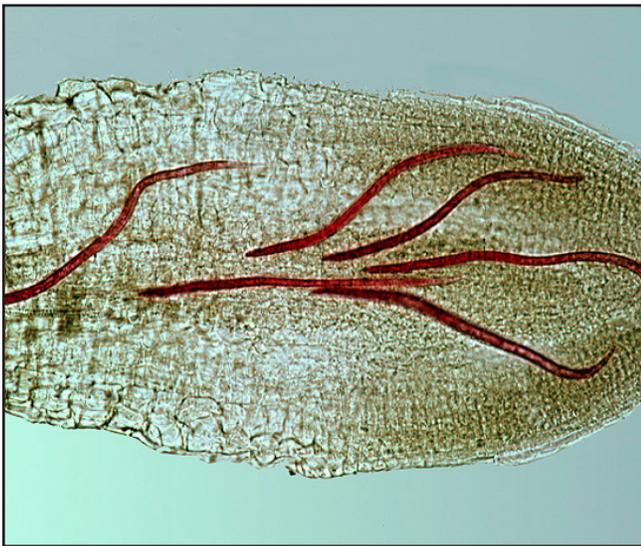


Fig. 2b. Second-stage juveniles of root-knot nematode, *Meloidogyne* sp., inside a plant root.

Type of Damage: The second-stage juvenile enters the plant root behind the root cap, in the zone of elongation where it then migrates toward the root tip. Once it reaches the root tip, it turns 180° and travels in the center of the root cylinder to the zone of differentiation. In the zone of differentiation, the second-stage juvenile injects esophageal gland secretions that cause proxylem root cells to divide, enlarge, and form multinucleate giant cells. These giant cells act as metabolic sinks that actively transfer nutrients from host plant to the developing nematode. Cells around the developing juvenile also become hypertrophic and more numerous, which ultimately results in the formation of the characteristic root galls, associated with *Meloidogyne* infections.

Although corn is not often damaged by root-knot nematodes, it can serve as a host to three of the four common species of *Meloidogyne* (*M. incognita*, *M. arenaria*, and *M. javanica*); therefore, root-knot nematode populations may be increased during corn production so that the crop following corn in a rotation scheme may be severely affected if it is sensitive to one of these nematodes.

Corn damaged by root-knot nematodes often is stunted and has the appearance of moisture and nutrient deficiencies. Severe infestations can result in the death of younger plants. Affected plants typically occur in patches in the field and symptoms are often attributed to other causes such as compacted or acidic soils, nutrient deficiencies, or soil insects, such as annual white grubs, wireworms, or seedcorn maggot. Root-knot nematodes typically are more common and most damaging to plants in light, sandy-textured soils. Belowground symptoms include roots that are galled, stunted, and discolored (Fig. 3). Sometimes the corn root system may appear healthy and galls may be small and difficult to notice even though root-knot nematode numbers may be very high. In either case, root growth is often restricted to shallow depths of only 8 or 10 inches below the surface when heavily infected. This reduces yield by restricting access to water and nutrients that are needed for plant growth and development. In field corn, root-knot nematodes may also cause stubby root symptoms because they stop the growth of root tips.

If nematode populations are high and growing conditions are good, damage may not be visible, but yield may be reduced. Severe damage is often visible and yield losses heavy if corn was stressed during the early part of the season. A fourth common species of root-



Fig. 3: Comparison between root-knot nematode infected root (left) and a non-infected root (right).

knot nematode, *M. hapla* (northern root-knot nematode), is not a parasite of corn.

Control Methods

Non-chemical: Rotating corn with a non-host crop such as alfalfa or oats may be effective in reducing root-knot nematode populations. Because different species have different host ranges, it is always good practice to identify the particular species in the field before deciding on crop rotation as a management strategy. Plants that are non-hosts of *M. incognita* can serve as good hosts for *M. arenaria* or *M. javanica*. Fields with successive seasons of corn will suppress populations of northern root-knot nematode, *M. hapla*, but at the same time this scheme may enhance populations of other root-knot, stubby-root, lesion, sting, lance, and ring nematodes.

Resistant cultivars are currently unavailable for southern root-knot nematode, *M. incognita*; however, there are a few commercial cultivars that are resistant to *M. arenaria* and *M. javanica*. In order to utilize these

resistant lines, an accurate identification to species is necessary because more than one species of root-knot nematodes may occur in some fields.

Chemical: The decision to apply nematicides should be based on root-knot nematode counts from soil samples collected in the fall immediately after harvest. Usually corn production is not adversely affected until an economic threshold of 500 second-stage juveniles per 500 cubic centimeters of soil is detected. At this level, it may be cost effective to apply a nematicide in cornfields with root-knot nematode counts that exceed this economic threshold [<http://ipm-www.ento.vt.edu/states/va.html>]. The history of a field with nematode problems should be taken into account when a nematicide or other control tactic is being considered. For more details on nematicides and their application rates, refer to the Pest Management Guide: Field Crops, Virginia Cooperative Extension publication 456-016, <http://www.pubs.ext.vt.edu/pmg/>.