# N E M A T O D E S

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## WHAT ARE NEMATODES?

Nematodes are wormlike animals with slender, cylindrical, unsegmented bodies tapering toward the head and tail. Females of some species swell up at maturity. (Examples: Root knot nematodes when they get ready to deposit their eggs.)

Over 15,000 species have been described by scientists. They are divided into two groups:

--Non-parasitic, which feed on microorganisms such as bacteria, fungi, and algae

--Parasitic, which feed on plant and animal life.

Nematodes live in soil, salt water, and fresh water. The size of nematodes varies considerably, but all plant parasite nematodes attacking grapes are microscopic in size. Size depends on the species, but they range from 1/64 to 1/16 of an inch in length.

Nematodes are virtually impossible to see under field conditions. They are small and have semi-transparent bodies. Occasionally female root knot nematodes can be seen protruding from the roots as white balls the size of a pinhead.

Terms used to classify nematode parasitism:

--Endoparasitic - refers to internal or those which spend most of their lives inside the root. (Example: female root knot nematode)

--Ectoparasitic - means external or outside the root; free-living in soil. (Example: dagger nematode)

--Sedentary - means sitting. (Example: root knot female embedded in root)

--Migratory - movable. Feeds on a root, then moves on. (Example: dagger nematode)

## CLASSIFICATION OF COMMON NEMATODE PARASITES FOUND IN CALIFORNIA

### Sedentary Endoparasitic Nematodes

Meloidogyne sp. (Root knot nematodes) *
Heterodera sp. (Cyst nematodes)

### Migratory Endoparasitic Nematodes

Pratylenchus sp. (Lesion nematodes) *
Ditylenchus sp. (Stem and bulb nematodes)
Aphelenchoides sp. (Foliar nematodes)

### Sedentary Ectoparasitic Nematodes

Tylenchulus sp. (Citrus nematodes) *

### Migratory Ectoparasitic Nematodes

Xiphinema sp. (Dagger nematodes) *
Trichidorus sp. (Stubby root nematodes)
Tylenchorhynchus sp. (Stunt nematodes)
Criconemoides sp. (Ring nematodes) **
Paratylenchus sp. (Pin nematodes) **
Longidorus sp. (Awl nematodes)
Helicotylenchus sp. (Spiral nematodes) **
Rotylenchus sp. (Spiral nematodes)
Hoplolaimus sp. (Lance nematodes)
Hemicycliophora sp. (Sheath nematodes)

* Nematodes of importance in grapes
** Nematodes of suspected importance in grapes

## ROOT KNOT NEMATODE (Melodiogyne sp.)

Life History - The infective cycle begins with second stage larvae. These slender worms are about 1/50 inch long.

The larvae can enter almost any part of the plant in contact with moist soil. Most often, penetration occurs near the root tips. Once the larvae have penetrated the plant tissue and commence feeding, they no longer move about.

In a suitable host plant, the females begin to lay eggs 20 to 30 days after penetration. The eggs are deposited within a gelatinous mass at the posterior end. The gelatinous mass serves to hold the eggs together and affords some protection. The eggs may be deposited on the outside or the inside of the root. This position is dependent upon how deeply the female is embedded in the root.

On hatching from the egg, the larvae may escape to the soil and search for new roots or remain and develop in the tissue where they were produced.

The time required for this animal to complete the egg to egg cycle varies. However, under favorable conditions we might expect one generation per month. Since each female produces from 200 to 500 eggs, over the course of a cropping season we can expect a substantial buildup of these animals, even when there is a low initial population in the soil at planting.

Maximum egg production in the case of most species occurs between 77° and 89° F.

Survival in the soil is probably in the egg stage.

Population Buildup of Root Knot Nematode

Assume:
1) One female produces 350 eggs
2) Only 50% are able to penetrate and reproduce
3) Egg to egg requires 30 days

| | | |
|---|---|---|
| At time zero | 1 | female penetrates |
| 1 month later | 175 | of the progeny penetrate |
| 2 months later | 30,600 | of the progeny penetrate |
| 3 months later | 10.7 | million of the progeny penetrate |
| 4 months later | 1.9 | billion of the progeny penetrate |

LIFE HISTORY OF THE ROOT-KNOT NEMATODE

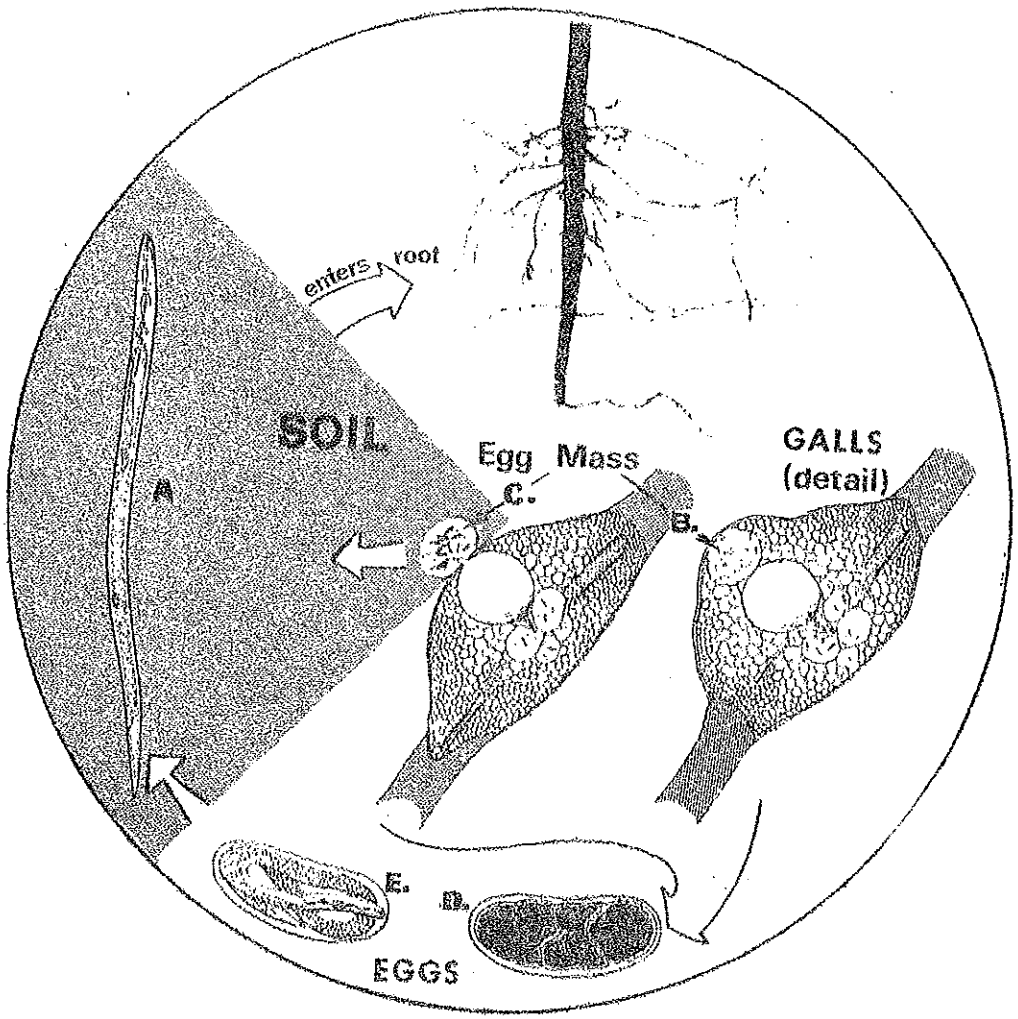
A. Second-stage larva in soil

B. Galled plant roots

C. Adult female within galled root, with egg mass protruding into the soil

D. Developing single egg

E. Larva within egg just before emergence



DAGGER NEMATODE (Xiphinema sp.)

Little is known of the biology of this nematode. It lives free in the soil and feeds on young roots.

Symptoms include a clubbing of the roots, much like that induced by Phylloxera and root knot. Also, and more generally, feeder roots in dagger-nematode-infested soil are short and dark in color, almost black. Many times they are dead or near death.

In California we are mainly concerned with two species, X. index and X. americanum. X. index occurs in a few locations in the San Joaquin Valley. Its principal host is grapes. Most of the Lodi vineyards are infested with X. index. This animal is an important economic pest because it damages roots by feeding, and it can transmit a virus: grape fan leaf complex which includes vein banding.

X. americanum is more widely distributed than X. index, and it has a wider host range. It has been found about the roots of corn, citrus, pome and stone fruits, grapes, strawberries, oaks, and pines.

ROOT LESION NEMATODE (Pratylenchus sp.)

This nematode is classed as a migratory endoparasite. All stages may be infective. It is capable of entering or leaving a root at any time. It is a long, threadlike animal which requires from 6 to 10 weeks to develop from the egg to the time it lays an egg. About half of this developmental period is spent as an adult. The female will lay from 1 to 2 eggs per day during this time.

These nematodes possess a stylet or spear. The spear is hollow and is the route through which the nematode takes food. In addition, the spear is used to make a hole in the root through which it can gain entry. After entering the root, the nematode forces its way through or between the cells of the cortex, feeding as it moves. This feeding results in the death of the cells. When enough of the cells are killed, a lesion develops. On large roots this lesion is quite visible. On small roots a girdling can take place which results in the death of the root below the girdle--these roots can no longer supply water and nutrients to the top.

In many orchards, digging reveals few roots. Soil samples may indicate the presence of lesion nematodes. In such a situation the nematodes may have contributed to declining trees by an effective job of root pruning.

CITRUS NEMATODE (Tylenchulus semipenetrans)

The larvae emerge from the egg as second stage, having molted once in the shell. For the larvae to develop they must feed. In the presence of a satisfactory host, the larvae will feed and molt 3 more times at which time the adult female

becomes sedentary. These sedentary adult females become saccate and begin egg laying. The eggs are deposited in a gelatinous material secreted by the female. Each female can lay between 75 and 100 eggs.

The cycle from egg to egg requires 6 to 8 weeks (75°F).

14 days to hatch (second stage)
2nd to 3rd stage - minimum 2 days
3rd to 4th stage - minimum 4-1/2 days
4th to adult - minimum 7-1/2 days

The second stage larvae is the persistent form. Living second stage larvae have been found in the soil 4 years after the removal of lemon trees.

In the way of root symptoms, there is a thickened and irregular appearance. Soil tends to cling to the roots producing a "dirty appearance."

Host range: Citrus, persimmon, grapes, olives, lilac, and kumquat.

## NEMATICIDAL CHEMICALS

### 1,3-D Type

Principal Components: 1,3-dichloropropene and 1,2-dichloropropane

Formulation: 100% active

Trade Names: D-D® (Shell Chemical Co.)
Telone® (Dow Chemical Co.)
Vidden-D® (Dow Chemical Co.)

Specific Gravity: Vidden-D and D-D - 10 lbs/gal.
Telone - 10.2 lbs/gal.

Banned

DBCP (At present time DBCP is banned for use in California.)

Principal Component: 1,2-dibromo-3-chloropropane

Formulations: 8.6 lbs. DBCP/gal (50% by vol.)
12.1 lbs. DBCP/gal

Trade Names: Fumazone 86© (Dow Chemical Co.)
Nemagon 8.6 E© (Shell Chemical Co.)

Specific Gravity: Technical DBCP - 17.3 lbs/gal.

Note: May or may not formulate as EC

Methyl Bromide

Principal Component: Methyl Bromide

Formulations: 1) 100% active
2) 98% active
3) 67% active

Trade Names: Dowfume MC-2® (Dow Chemical) (contains Chloropicrin)
Dowfume MC-33® (Dow Chemical) (contains Chloropicrin)
Brom-O-Gas® (Great Lakes Chemical Co.) (contains Chloropicrin)
Terr-O-Gas® (Great Lakes Chemical Co.) (contains Chloropicrin)

Specific Gravity: Technical Methyl Bromide - 14.4 lbs/gal.

The materials listed are those most commonly used as soil fumigants for nematode control. They may be formulated in various ways and by various companies. For this reason it is important to know the quantity of active material, either by weight or volume, in the formulation to be used. Generally, the weight of the active ingredient in a formulation will be the most useful factor in determining the volume of formulation necessary to obtain a particular volume of technical chemical. This conversion is particularly important because the University of California recommendations for nematode control are stated in terms of the volume of technical chemical per acre, not the volume of a particular formulation.