Nematodes are small roundworms that live in soil water, and plant tissue. They are too small to be seen with the naked eye and are identified with the aid of a microscope. Over 1,239 nematode species are parasitic on plants. In addition to those that feed on plant roots there are species that feed on or in plant stems, leaves, buds and flowers. Many nematode species cause decline in ornamentals.

SYMPTOMS OF NEMATODE ATTACK

Nematode damage to crops is often overlooked because of the small size of nematodes and the fact that they seldom kill plants. Usually, there is a retardation of plant growth which spreads through the field over several growing seasons from an initial small area of plant decline. Other above ground symptoms of nematode attack are plant stunting, yellowing, die-back, deficiency symptoms and loss of plant vigor. Affected plant roots may possess numerous galls, root decay, or a general reduction of root growth.

WAYS THAT NEMATODES CAUSE CROP LOSS

1. Nematodes alone are capable of causing a decline in plant growth, yield and quality.
2. Nematode affected plants are not capable of efficient utilization of water and plant food. Often plants show deficiency symptoms where soil is amply fertilized; therefore, there is a waste of fertilizer.
3. Damage in nursery plants is caused indirectly by nematodes which transmit virus diseases.
4. Plant varieties resistant to diseases caused by fungi and bacteria may become susceptible and die from these diseases because nematodes create "ports of entry" for other soil-borne diseases.

NEMATODE ASSAY AND CONTROL SERVICE

The identification of nematode diseases requires the services of a nematologist and specialized equipment. Nematode control by chemicals, crop rotation, or resistant varieties depends upon a positive identification of the kinds of nematodes involved in each nematode disease situation. For this reason, the Plant Disease Clinic in the Plant Pathology and Physiology Department at V.P.I. provides a nematode assay and control service to aid you in nematode disease identification and control recommendations. Contact the V.P.I. Cooperative Extension Office in your county for information on methods of collecting and handling plant and soil samples for nematode assay.
CHEMICAL CONTROL PROCEDURES

The most effective way to control nematode diseases of plants is by chemical soil treatment, especially where several kinds of nematodes are present. Currently soil fumigants are in widespread usage for nematode control.

METHODS OF CHEMICAL APPLICATION

1. **Broadcast (overall) treatment** - should be used as a preplant application of soil fumigants. This method generally produces the best results. Follow these simple steps when applying soil fumigants: (A) Work crop remains into soil so they are well decomposed before applying soil fumigants. (B) Deep tillage to a depth of 12" is essential, break up all clods and loosen soil thoroughly. (C) At time of treatment, the soil should be in good seedbed condition, with a temperature between 50°F and 80°F at the 5" level and with adequate moisture for good seed germination. (D) Use a fertilizer containing at least 30% of the nitrogen in the nitrate form to avoid nitrogen deficiency. (E) Soil surface should be sealed immediately after chemical application with a plastic tarp or with a roller or cultipacker depending upon chemical used. (F) **CONSULT CONTAINER LABEL FOR ADDITIONAL INFORMATION.**

2. **Row Treatment** - Postplant treatment to established plants may be accomplished by applying Nemagon or Fumazone through two chisels spaced 12" apart per row. This is used primarily as a salvage operation and generally is not as effective as the preplant broadcast (overall) application method.

PLANT TOLERANCE TO VARIOUS CHEMICALS

The bottom of the next two pages contain listing of nursery plants reported as TOLERANT and MODERATELY TOLERANT to NEMAGON or FUMAZONE. Any plants not listed should be treated at a low dosage level and on a small scale until tolerance is determined. Do not apply either materials to carnations, chrysanthemums or dwarf palm.

CHEMICALS RECOMMENDED FOR NEMATODE CONTROL IN NURSERY CROPS

<table>
<thead>
<tr>
<th>Crop</th>
<th>Application</th>
<th>Rates</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ornamentals:</td>
<td>FUMAZONE 70E</td>
<td>1/2 to 1 teaspoon per square yard to soil</td>
<td>Tolerant Plant Species: (1) Punch holes 1' apart and 10&quot; deep in soil around plants in the root zone area. (2) Prepare a diluted emulsion by mixing 1 teaspoon of Nemagon EC-2 or Fumazone 70E per gallon of water. (3) With a sprinkling can drench the area with one gallon of this dilute emulsion per square yard (3' x 3'). Sprinkle plants and treated area with water from garden hose to further wash chemical to root zone.</td>
</tr>
<tr>
<td>Small area treatment to</td>
<td>NEMAGON EC-2</td>
<td>depending upon plant species tolerance.**</td>
<td></td>
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<tr>
<td>soil around established</td>
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<td></td>
<td></td>
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<tr>
<td>plants)</td>
<td></td>
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<td></td>
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<tr>
<td>(Postplant Application)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Crop</td>
<td>Nematicides*</td>
<td>Application Rates</td>
<td>Remarks</td>
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<tr>
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<td>-------------------------------------------------------------------------</td>
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<tr>
<td>(Small area treatment to seedbed without plants)</td>
<td>DOWFUME MC-2</td>
<td>2 lbs. per 100 sq. ft.</td>
<td>To obtain best results - plow or spade area to 12&quot; depth, prepare soil until it is free of clods and in good seedbed condition. Introduce chemical under a gas-tight cover over area being treated. FOLLOW MANUFACTURER'S INSTRUCTIONS.</td>
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<tr>
<td></td>
<td>STARBRAND</td>
<td>2 lbs. per 100 sq. ft.</td>
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<tr>
<td></td>
<td>BROM-O-GAS</td>
<td>2 lbs. per 100 sq. ft.</td>
<td></td>
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<tr>
<td>(Preplant Application)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(Large area field or seedbed treatment)</td>
<td>AGEL MB-68</td>
<td>Use at a rate of 3-2/3 pints (60 fluid ounces) per 1000 sq. ft.</td>
<td>Apply through a tractor-mounted chisel-type broadcast liquid fumigant unit. The chisels should be spaced 12&quot; apart with fumigant injected 6 to 8&quot; deep. NO PLASTIC FILM IS NEEDED WITH THIS TREATMENT; FOLLOW MANUFACTURER'S INSTRUCTIONS.</td>
</tr>
<tr>
<td>(Preplant Application)</td>
<td>DOWFUME MC-33</td>
<td>350 lbs. per acre for overall treatment</td>
<td>Apply as a preplant application; This treatment is effective against nematodes and other soil-borne pests. Treated area must be immediately covered with a plastic film. A mechanical applicator and plastic tarp layer is available for seedbed and field treatment; FOLLOW MANUFACTURER'S INSTRUCTIONS.</td>
</tr>
<tr>
<td></td>
<td>STARBROM TG-67</td>
<td>350 lbs. per acre for overall treatment</td>
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<tr>
<td>VORLEX</td>
<td></td>
<td>40 to 60 gal. per acre for overall treatment</td>
<td>Apply as a preplant application; This treatment is effective against nematodes and other soil-borne pests. Treated area must be immediately covered with a plastic film. A mechanical applicator and plastic tarp layer is available for seedbed and field treatment; FOLLOW MANUFACTURER'S INSTRUCTIONS.</td>
</tr>
<tr>
<td>VAPAM</td>
<td></td>
<td>1.5 gal. in 40 gal. water per 100 sq. yds. overall treatment</td>
<td>Apply as a preplant application; This treatment is effective against nematodes and other soil-borne pests. Treated area must be immediately covered with a plastic film. A mechanical applicator and plastic tarp layer is available for seedbed and field treatment; FOLLOW MANUFACTURER'S INSTRUCTIONS.</td>
</tr>
<tr>
<td>Crop</td>
<td>Nematicides*</td>
<td>Application Rates</td>
<td>Remarks</td>
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<td>--------------------------------------------------------------------------</td>
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<tr>
<td>D-D</td>
<td>30 gal. per acre overall treatment</td>
<td>Apply as a preplant application: Overall application: Apply 14 days prior to seeding or planting in treated area. Inject chemical to a depth of 10&quot; through chisels spaced 12&quot; apart. Seal surface immediately with a roller or cultipacker to prevent rapid escape of soil fumigant. FOLLOW MANUFACTURER'S INSTRUCTIONS.</td>
<td></td>
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</tbody>
</table>

**TOLERANT SPECIES**

- Ajuga
- African Violet
- Aglaonema
- Amaryllis
- Anchusa
- Andromeda
- Apple
- Ardisia japonica
- Arrowwood
- Asclepias
- Ash
- Asparagus fern
- Astilbe
- Azalea
- Barberry Red Leaf
  & Dwarf
  - Crepe myrtle (purple) Gypsophilum
  - Croft lilly
- Heliposis
- Hellebrous
- Oak, live
- Potentilla
- Oak, Northern Red
- Hemlock
- Oak, White
- Pachysandra
- Pyrethrum, seed
- Pansy
- Sansevieria
- Peach
- Schefflera
- Pear
- Sedum
- Bottle Brush
- Caryopteris
- Centranthus
- Cherry, Mahaleb
- root stock
- Euonymus Vegetus
- Ligustrum-Privet
- Peperomia
- Spirea
- Exochorda
- Fatshedera
- Lilly of the Valley
- Periwinkle
- Syring-lilac
- Evergreen
- Firethorn
- Forget-me-nots
- Maple, red
- Maranta
- Mountain Ash
- Plum
- Weigela
- Funkia
- Pilea
- Pine, white
- Tritoma
- Taxus
- Macrophyllum
- Pilea
- Pitcher, Vari.
- Violet
- Forget-me-nots
- Maple, red
- Maranta
- Mountain Ash
- Plum
- Weigela
- Yew, Japanese
- Pothos
- Zinna
**Crop**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Nematicides</th>
<th>Application rate-gal/A for designated row spacings per 400' of row per chisel, cc*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ornamentals:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Field treatment to soil around established plants)</td>
<td>NEMAGON 12.1</td>
<td>2 1.5 1.2 1 .86 312</td>
</tr>
<tr>
<td></td>
<td>NEMAGON 12.1 EC</td>
<td>2 1.5 1.2 1 .86 312</td>
</tr>
<tr>
<td>FUMAZONE 86</td>
<td>2 1.5 1.2 1 .86 312</td>
<td></td>
</tr>
<tr>
<td>FUMAZONE 86E</td>
<td>2 1.5 1.2 1 .86 312</td>
<td></td>
</tr>
<tr>
<td>NEMAGON 12.1</td>
<td>1.32 1.0 .8 .66 .55 208</td>
<td></td>
</tr>
<tr>
<td>NEMAGON 12.1 EC</td>
<td>1.32 1.0 .8 .66 .55 208</td>
<td></td>
</tr>
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<td>1.32 1.0 .8 .66 .55 208</td>
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<tr>
<td>FUMAZONE 86E</td>
<td>1.32 1.0 .8 .66 .55 208</td>
<td></td>
</tr>
</tbody>
</table>

**Remarks**

FOR TOLERANT PLANT SPECIES: AT TIME OF PLANTING OR POSTPLANT TREATMENT.

Use 2 chisels per row and in such a manner as to treat both sides of the row, with chisel injection lines 6" from stem of plant on each side of plant. Use a narrow chisel and seal opening made by chisel with a press wheel or similar sealing device. Inject chemical to a 10" depth.

FOR MODERATELY TOLERANT PLANT SPECIES:

At time of planting or postplant treatment. Use 2 chisels per row in such a manner as to treat both sides of the row. Chisel injection lines should be 6" from stem of plant on each side of the row. Use a narrow chisel and seal soil opened by chisel with a press wheel or similar sealing device. Inject chemical to a 10" depth.

* A cubic centimeter (cc) is a unit of liquid measure. Some conversion units are: 1 teaspoon=5cc; 1 cup=237cc; 1 pint=463cc; 1 quart=946cc; and 1 gallon=3,785cc. Baby milk bottles and prescription bottles are usually marked with cc units and are useful in measuring fumigants.

**MODERATELY TOLERANT SPECIES**

- Artemesia
- Blueberry
- Camellia, Japanica (Var. Pink Perfection)
- Camellia, Japanica (Var. Shell Pink)
- Camellia Sasanqua (Var. Elizabeth)
- Campanula (Florida, August Beauty)
- Chrysanthemum
- Delphinium
- Echinops
- Forsythia
- Gardenia fortuniana (Var. Mystery)
- Gardenia jasminoides (Florida, August Beauty)
- Geum
- Gladiolus
- Lythrum
- Magnolia grandiflora
- Magnolia soulangeana (Var. Jiminy Cricket)
- Phlox
- Pine, slash (Var. Dr. Huey)
- Pyrethrum, plants
- Rosa fortuneana (Var. Countessa Vandal)
- Rosa (Var. Happiness Rose)
- Rosa (Var. Isobel Harkness)
- Stantolina
- Vinca
- Rosa (Var. Countess Vandal)
- Rosa (Var. Happiness Rose)
- Rosa (Var. Isobel Harkness)
- Stantolina
- Vinca
Trade and brand names are used only for the purpose of information and the Virginia Cooperative Extension Service does not guarantee nor warrant the standard of the product, nor does it imply approval of the product to the exclusion of others which may also be suitable.

KEYS TO PROPER USE OF PESTICIDES

1. Read the label on each pesticide container before each use. Follow instructions to the letter; heed all cautions and warnings, and note precautions about residues.

2. Keep pesticides in the containers in which you bought them. Put them where children or animals cannot get to them, preferably under lock and away from food, feed, seed, or other material that may become harmful if contaminated.

3. Dispose of empty containers in the manner specified on the label. If disposal instructions are not printed on the label, burn the containers where smoke will not be a hazard, or bury them at least 18" deep in a place where water supplies will not be contaminated.

SEE YOUR DOCTOR IF SYMPTOMS OF ILLNESS OCCUR DURING OR AFTER USE OF PESTICIDES.