# Nematodes in Vines

## Practical guidelines for the short- and long term control of nematodes

Compiled for the Deciduous Fruit Industry
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## INTRODUCTION

Nematodes are microsopic worm-like organisms that attack the roots of plants. Damaged roots result in a reduced uptake of nutrients and water.

Vines are attacked by various nematodes, of which the root-knot nematode is the most important (Fig. 1). Due to the large-scale use of root-knot nematode resistant rootstocks, the characteristic galls formed by the root-knot nematode are absent. The damage symptoms caused by other nematodes are not specific, both above and below ground. Dagger and ring nematodes are becoming an increasing problem in vines, and control of the latter is problematic.

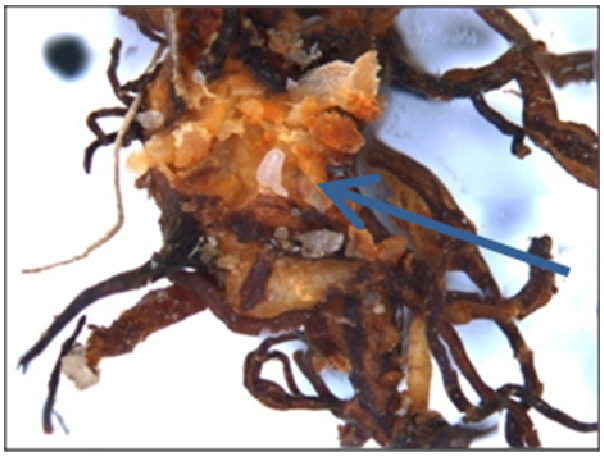

**Fig 1. *Meloidogyne* sp. (root-knot nematode)**

There are several reasons for the increase in nematode problems over the last number of years. The first reason is the greater awareness of nematode damage. A second reason is the increasing pressure to re-use soils. The most important reason however is the fact that within four months of the removal of vines or stone and pome fruit trees, vines are again established on the same soils. Associated herewith is the fact that few producers consider fumigating the soil, or realise how important it sometimes is.

Different nematodes attack different fruit types (Table 1).

**Table I: The host-nematode relationship of the most important nematodes on fruit**

| | Peaches | Plums | Apricots | Apples | Pears | Vines |
|---|---|---|---|---|---|---|
| **Root-lesion nematode*** | xx | xx? | x | xx | x | x |
| **Dagger nematode** | xx | xx | x | xxx | xx | xxx |
| **Spiral nematode** | | | | x | x | |
| **Stubby root nematode** | x | | | xx | xx | x |
| **Pin nematode** | | | x | x | | |
| **Root-knot nematode *(**)** | xxx | xxx | x? | | | xxx |
| **Ring nematode** | xxx | xxx | xxx | | | xxx |
| **Citrus nematode** | | | | | | x |

**Key Table I**

| | |
|---|---|
| **xxx** | Very important, can cause severe damage, occurs commonly |
| **xx** | Important, can sometimes cause severe damage when the counts are high, occurs commonly |
| **x** | Seldom causes a problem, little knowledge available regarding the extent of damage caused |
| * | Endoparasites |
| ** | Except for root-knot nematode-resistant rootstocks |
| **?** | Insufficient evidence to establish host status |

Nematodes are divided into two groups, depending on their feeding habits, viz. endo- and ectoparasites (Table II).

**Table II: Endo- and ectoparasitic nematodes on stone fruit**

| Endoparasites | Ectoparasites |
|---|---|
| *(feed within the root)* | *(feed outside on the root)* |
| Root-knot nematode | Ring nematode |
| Root lesion nematode | Dagger nematode |
| Citrus nematode | Stubby root nematode |
| | Spiral nematode |
| | Pin nematode |

## INFESTATION SOURCES

There are three possible infestation sources, viz. water, plant material and soil.

**Water**
Water originating from fast-flowing rivers with significant agricultural activity (particularly vegetable production) can act as a source of nematode infestation. Such water is however a minor source in comparison to the other two sources. The percentage of nematodes that originates from water is minimal. The build-up of nematodes in the soil is thus slow. If planting is commenced in relatively clean soil, then the vines will 'resist' this slow build-up of nematodes.

**Plant material**
Only rooted plant material can be a possible source of infestation. Such infestation is particularly true of the migrating endoparasite, root-lesion nematode and the obligate sedentary endoparasite, root-knot nematode. Both nematode types live in the roots. It has also been found that ring and dagger nematodes, with their long stylets, are inclined to cling onto roots and can thus be transported together with plant roots.

The current certification scheme requires that plant material must be visually free of nematode infestation. Symptoms of only one nematode i.e. the root-knot nematode, are visible.

Apart from the current certification scheme, there are guidelines in place which try to ensure that nurseries provide reasonably clean plant material. The plant material is thus unlikely to be the source of nematode problems in grapevines.

**Heeling in soil of producers**
Heeling in soil of both nurseries AND producers should be monitored and, if necessary, appropriate action must be taken. The same rules, as for all soils where planting will take place, apply here (see Control: Before planting/establishing new vines).

**Soil**
The soil is the most important infestation source. Infestation in the soil is determined by previous crops, cover crops, weeds or natural vegetation (fynbos) that were present in the soil. If any of these plants were a host for the range of nematodes that occur on vines, then the population will increase rapidly in the presence of vines and subsequently cause damage.

## MONITORING

Always analyse both soil and root samples to determine infestation in the orchard.

**Prior to establishment**
Samples should be taken while a crop is still present, i.e. before trees, vines, or other crops are removed from the soil. When the host plants are removed, the nematodes revert to an egg stage, which then makes it impossible to determine populations at a commercial level.

**Shortly after establishment**
Since most nematodes only hatch in the presence of root exudates, it takes approximately eight months before nematode numbers are high enough to be observed.

**Established orchards**
Samples can be taken throughout the year. Populations are highest in the summer months and decline as the soil becomes colder. Recommendations based on the results are adjusted according to the time of sampling. Soils which are unusually wet or dry should preferably not be sampled.

**Water**
The monitoring of water is impractical and is not recommended.

## CONTROL

***PREVENTION IS BETTER THAN CONTROL!***

The result of the nematode analysis determines which control measures must be applied.

**Before planting/establishing new vines**
It is critical to minimise the number of nematodes before planting new vines. Identify at least one (or more) year(s) in advance which blocks are going to be re-established. Then determine the risk-level of the soil in terms of nematode infestation by having the soil analysed (see Monitoring). It is particularly old vine and stone fruit soils that cause problems because the same range of nematodes attack these crops (Table 1). Other crops that hold possible risks include most vegetables, cucurbits, Port Jackson, Acacia, Black Wattle and rye. Except for rye, most of these plants are excellent hosts for root-knot nematodes. Rye is a good host for root-lesion nematodes.

Always remove as many of the old roots of the previous crop as possible. It is particularly the endoparasitic root-lesion and root-knot nematodes that find shelter in the roots.

There are four control options that can be considered at this stage, and they are largely determined by the infestation in the soil and time period between plantings:

- The existing crop can be treated to reduce the number of nematodes in the soil. More than one treatment is often necessary and this option must be evaluated timeously (about two years before the new planting). This option should be considered if re-establishment is planned for the same year.

- Where root-knot nematode numbers are particularly high and fumigation is not an option, resistant rootstocks must be considered. Most vines (resistant rootstocks excluded) are exceptionally susceptible to root-knot nematodes (Table III). This resistance only applies to root-knot nematodes and the vines will still be attacked by other nematodes.

- A rest period of one year, but preferably longer (3 years), should be considered with the establishment of a poor or non-host crop in a rotation system. Non-hosts include *Tagetes* and *Crotalaria* spp as well as *Eragrostis* for long-term establishment. Crops considered weak hosts include oats, triticale and wheat. Rye must be avoided where root-lesion nematode occurs. Much research still needs to be done to determine the extent of susceptibility of these crops to various nematodes. This is one of the large gaps in our knowledge base. It is important to conduct an analysis of the nematode infestation again, just before the crop dies or is ploughed in.

**Table III: Nematode resistance on certain vine rootstocks**

| Rootstock | Root-knot nematode *M incognita* | Ring nematode *M xenoplax* | Dagger nematode *X americanum* | Root-lesion nematode *P vulvus* | Citrus nematode *T semipenetrans* |
|---|---|---|---|---|---|
| Ramsey | R | | | R | R |
| SO4 | R | | | | |
| Dog Ridge | R | S | S | MR | MR |
| Freedom | R | S | S | MR | S |
| Harmony | R | S | S | S | S |
| Paulsen 775 | R | | | | |
| Richter 99 | MR | S | S | S | MR |
| 101-14 Mgt | MR | | | | |
| 143 B Mgt | MR | | | | |
| Paulsen 1103 | MR | | | | |
| Richter 110 | MS | | | | |
| US 8-7 | MS | | | | |
| Paulsen 1447 | MS | | | | |
| Metallica | S | | | | |
| 140 Ruggeri | S | | | | |
| Jacquez | S | | | | |

**Scale Table III:**

**R** -Resistant
**MR** -Mildly resistant
**MS** -Mildly susceptable
**S** -Susceptable

- If the nematode population is exceptionally high, and no fallow period is planned, it is sometimes essential to fumigate the soil before the new vines are established. Some producers believe that chemical treatment after establishment gives the same results as fumigation. This is however not true. Fumigation can only be carried out prior to establishment. The following fumigants can be considered: 1,3-D + chloropicrin (Telopic); ethylene dibromide (EDB); furfural (Protect) and metham sodium (Herbifume). Each of these fumigants has very specific requirements to guarantee successful treatment. These include temperature, soil type, moisture, organic material content, etc. The requirements are available from Nemlab or the agricultural chemical companies.

Other possible options include solarisation and biofumigation.

***Solarisation*** is a method to control soil-borne organisms and pathogens through the use of raised soil temperatures (above 50°C). The temperature is increased by placing a thin, transparent poly-ethylene plastic over a moist soil surface. Solarisation reduces the nematode population drastically, but will not totally eradicate it.

***Biofumigation*** or biological fumigation is a technique that uses certain plants' own protection functions to control a range of organisms and pathogens, including fungi, bacteria, nematodes, insects and certain weeds. The plants produce special volatile compounds, of which glucosinolates are the most important. Plant types particularly suitable for biofumigation include the family Brassicaceae (cabbage, cauliflower, broccoli, kale, canola and mustard), and the family Moringaceae (horseradish and certain types of radishes). The plants are harvested prematurely, finely slashed, and immediately incorporated into the soil. The land then lies fallow for 10 – 14 days before the next crop is planted.

Do not try to solve a nematode problem with chemicals after establishment. This is a short-sighted approach.

**Shortly after establishment**

It is extremely important that populations are limited to the minimum during this stage as roots that are damaged do not recover easily and will never reach their full potential. If the result of nematode analysis recommends chemical treatment after establishment, the first treatment can be applied 6 weeks after planting, and followed up 2 months later with a second application, if necessary. Thereafter, monitor the populations on a regular basis.

Currently (June 2013) cadusafos (Rugby), fenamiphos (Nemacur, Fenamiphos, Spitfire), furfural (Crop Guard) and the solids and solubles of killed *Myrothecium verrucaria* (DiTera) are registered on vines.

The recommended dosages prescribed on the label must be used. It is important to wash the nematicide in with sufficient water (10 – 20 mm). It is also important that the planting row or ridge is free of cover crops or weeds at the time of application.

**Established vineyards**

First determine the level of infestation before any action is taken against nematodes. The result of the nematode analysis will indicate the number of treatments. The treatments must commence just before root growth peaks in the spring and autumn. The optimum stage for treatment is within 30 days after harvest, followed by the period just before and after bud-burst. Treatments can be applied throughout the year, but the above-mentioned times give the best results.

It is important that the period between the follow-up treatments is kept to 6 months. The year-on-year treatments are not successful. The ring and dagger nematodes are more difficult to control and it takes longer to obtain a reduction in their numbers. It is unnecessary to eradicate nematodes. Try to reduce nematode numbers to acceptable levels.

Currently (June 2013) cadusafos (Rugby), fenamiphos (Nemacur, Fenamiphos, Spitfire), furfural (Crop Guard) and the solids and solubles of killed *Myrothecium verrucaria* (DiTera) are registered on vines. The recommended dosages prescribed on the label must be used. It is important to wash the nematicide in with sufficient water (10 – 20 mm). It is also important that the planting row or ridge is free of cover crops or weeds at the time of application. Due to the possibility of accelerated microbial degradation, it is important to alternate the nematicides.

**Water**

Water cannot be treated chemically, it can however be filtered. Any filter, including sandfilters, will give a measure of control. Filters with 5 µm pores are required to totally exclude nematodes from water, but this is impractical in a vineyard situation.

The infestation from rivers can also be drastically reduced by pumping water into dams. The water should preferably stand for 48 hours to give the nematodes time to settle, and then water must be drawn from the surface.

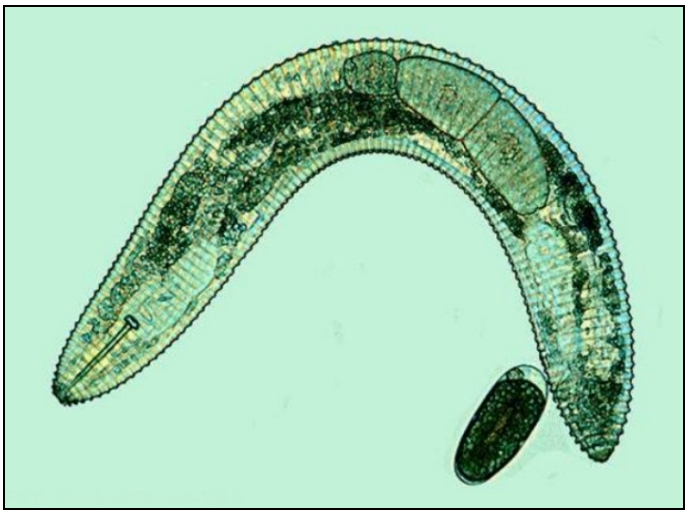

**Fig 2. *Criconemoides xenoplax* (ring nematode)**

## GENERAL ROOT HEALTH

Promoting root health is essential. Nematodes are stress pathogens so healthy roots mean fewer nematode problems.

Various root stimulants in a chemical or biological form can be added to the soil. Any physical soil stresses must also be addressed. Consideration must also be given to adding a mulch on top of the soil or the addition of any other form of organic material.

None of these additions will control high nematode populations, but will encourage root health and natural enemies (beneficial soil organisms), thereby reducing nematode damage. Over time nematode numbers will then decrease.