

# Nematodes in Pome Fruit

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



Compiled for the Deciduous Fruit Industry  
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### INTRODUCTION

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

Pome fruit is primarily attacked by root-lesion, dagger and stubby root nematodes. Root-knot nematodes, which cause the characteristic galls on roots, do not attack pome fruit. Due to the absence of these galls it is mistakenly believed that nematodes do not attack pome fruit. Galls caused by woolly apple aphid are often mistaken for root-knot nematode damage. It is particularly stubby-root nematodes in very sandy soils that are often the cause of severely stunted pear trees.



Fig 1. *Xiphinema* spp. (Dagger 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 pome fruit, stone fruit, and even vines, pome fruit is 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 I).

**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	xxx	x
Pin nematode			x	x		
Root-knot nematode *(**)	xxx	xxx	x?			xxx
Ring nematode	xxx	xxx	xxx			xxx
Citrus nematode						x

#### Key to Table I

<b>xxx</b>	Very important, can cause severe damage, occurs commonly
<b>xx</b>	Important, can sometimes cause severe damage when the counts are high, occurs commonly
<b>x</b>	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 pome fruit**

<b>Endoparasites</b>	<b>Ectoparasites</b>
<i>(feed within the root)</i>	<i>(feed outside on the root)</i>
Root-lesion nematode	Dagger 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 nematode infestation source. Such water is however a minor source of infestation in comparison to the other two sources. The percentage of nematodes that originate 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 trees will 'resist' this 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. The root-lesion nematode lives in the root and is thus distributed with the plant material. It has also been found that 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. The symptoms of the nematodes that attack pome fruit are however not easily 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 the pome fruit industry.

### 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 trees).

### 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. Should any of these plants have been a host for the range of nematodes that occur on

pome fruit, then the population will increase rapidly in the presence of pome fruit 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 will determine which control measure is applied.

### Before planting/establishing new trees

It is of critical importance to minimise the number of nematodes before planting new trees. 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 pome fruit, stone fruit and vine 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 and rye. Most of these crops are excellent hosts 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 nematode that finds shelter in the roots.

There are three 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.
- 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.
- If the nematode population is exceptionally high, and no fallow period is planned, it is sometimes essential to fumigate the soil before the new trees 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 requirements 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.



Fig 2. *Paratrichodorus* sp. (stubby root nematode)

Currently there are no rootstocks that provide resistance to any of the nematodes that attack pome fruit.

Trying to solve a nematode problem post-plant using chemicals only is short-sighted and can be difficult to achieve.

#### **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 the 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) and furfural (Crop Guard) are registered for use against nematodes on pome fruit. 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 orchards**

Always 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 optimum stage for treatment is at green tip, followed by a treatment (if necessary) from mid-December to early January. Treatments can be applied throughout the year, but the above-mentioned times give the best results.

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

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### **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 an orchard situation.

The infestation from rivers can also be drastically reduced by first 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.

## **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 be given to placing 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.