# NEMATODE ALMANAC

VANDINTER SEMO

SEED & SERVICES

# Combatting roundworm

## (Nematode control)

Although nematodes contribute to a healthy soil, there are numerous nematodes that pose a serious threat to crops. Most of the harmful nematodes live underground and mainly damage the roots of crops. The best-known nematodes are the cyst nematodes, such as the potato cyst nematode which is responsible for potato senescence. Other well-known nematodes are the root knot nematode and the root lesion nematode.

With the breeding of catch crops, Vandinter Semo focuses on the natural combatting of harmful nematodes.

**Bert-Jan van Dinter**
Director

## Every nematode deserves tailor-made control

There are numerous types of nematodes. Each with a unique set of characteristics. This makes them a threat to a large number of crops. Because of this diversity, it is important to know which type of nematode needs to be combatted in order to use the most effective green manure. In this nematode almanac, we name the different nematodes and the most appropriate green manure to naturally combat or to control nematodes.

## Which nematodes do we mean?

+ Potato cyst nematode
+ Beet cyst nematode
+ Root knot nematode
+ Root lesion nematode
+ Free-living/stubby root nematode
+ Stem nematode

## Choose a safe green manure

Legend

| Legend increment | |
|---|---|
| ? | unknown |
| A | active decline |
| - | not |
| • | little |
| •• | mediocre |
| ••• | strong |
| B | breed-dependant |

| Legend damage | |
|---|---|
| | unknown |
| | not |
| 5 - 15% | little |
| 15 - 33% | mediocre |
| >33% | strong |

| Soil types | |
|---|---|
| S | sand |
| RP | reclaimed peat |
| SC | sandy clay |
| C | clay |

Legend Source: PPO-AGV, IRS, HLB and Eurofins

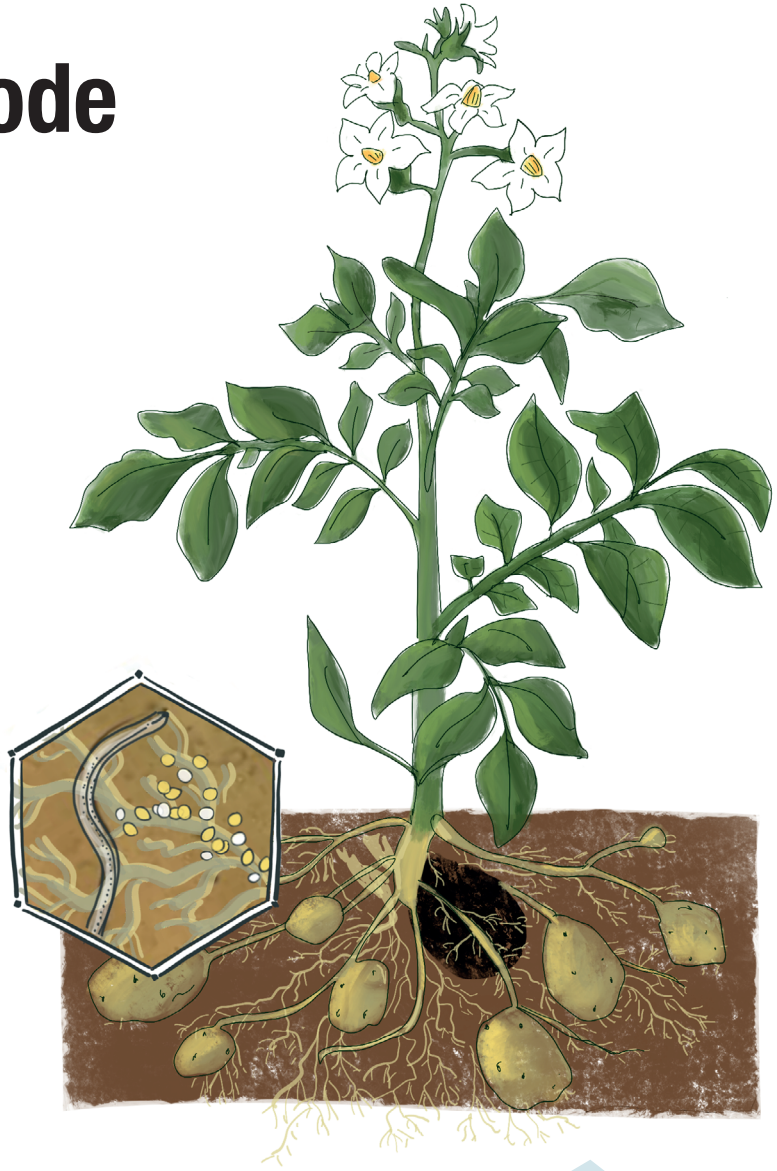
# The cyst nematode

## *(Globodera and Heterodera)*

The potato cyst nematodes and the beet cyst nematodes are the most well-known cyst nematodes in Europe. They multiply on the important agricultural crops of potato and beet, hence their names.

Typical of the cyst nematode is the characteristic that the eggs in the hardened shell (the cyst) of the dead female can survive for years.

The larvae (juveniles) are lured out of the cysts by specific attractants of a host plant and they can penetrate the roots to feed and to multiply. This creates a growth disorder in the host plant which can lead to a yield loss of up to 80%.

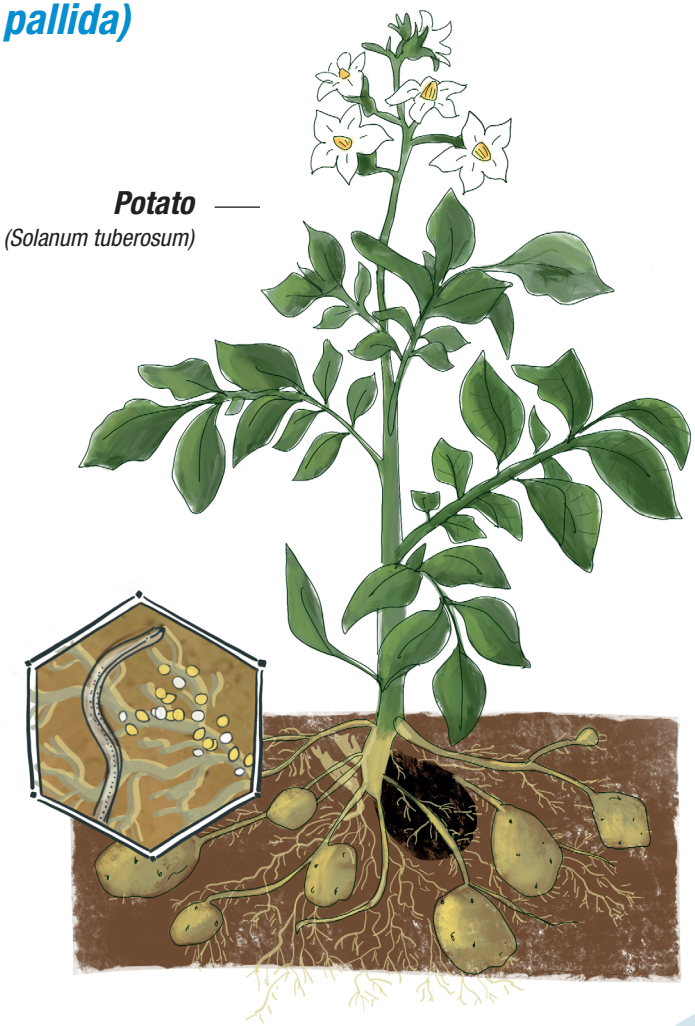


# Potato cyst nematodes

## *(Globodera rostochiensis and Globodera pallida)*

Potato cyst nematodes can be divided into the yellow (G. rostochiensis) and the white (G. pallida) potato cyst nematode.

The larvae (juveniles) are lured out of the cysts by specific substances from the root of the potato. The larva enters the root and stimulates the plant to form a so-called feeding cell, on which it can feed. This causes growth damage to the potato, which can lead to a yield loss of 80%. The young females burst through the root and are visible as cysts on the roots. The males leave the root to fertilize the females, which stick to the root. When the eggs are fully grown, the female dies, then the cyst is ripe. The mature cysts release themselves from the root and remain in the soil after harvesting. Cysts can still contain viable eggs eight to ten years after the last potato cultivation.



## Disease profile

Remaining growth visible at the closing of the crop

In case of heavy contamination, visible (oval) patches

Around mid-June (longest day) cysts can be seen on the roots

Yield loss

## Damage prevention

Company hygiene

Soil sample research with species determination

More extensive crop rotation with the use of resistant and tolerant potato varieties

Use of catch crop (sticky nightshade, potato)

Storage control of potato in other crops

Soil treatment with nematicide

## The most important green manure crops which combat the potato cyst nematode

| | | | Green manure in early stubble (July – mid-August) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cyst nematodes | Soil type | | Sticky nightshade (May) | Radish | White mustard | English ryegrass | Italian ryegrass | Phacelia | White clover | Leaf cabbage | Tagetes on fallow land (May – July) | Japanese oats on fallow land (May – July) | Rye in late stubble (Aug – Oct) |
| Potato cyst nematode | SRPSC | | AB | - | - | - | - | - | - | - | - | - | - |

For comprehensive legend, see page 3

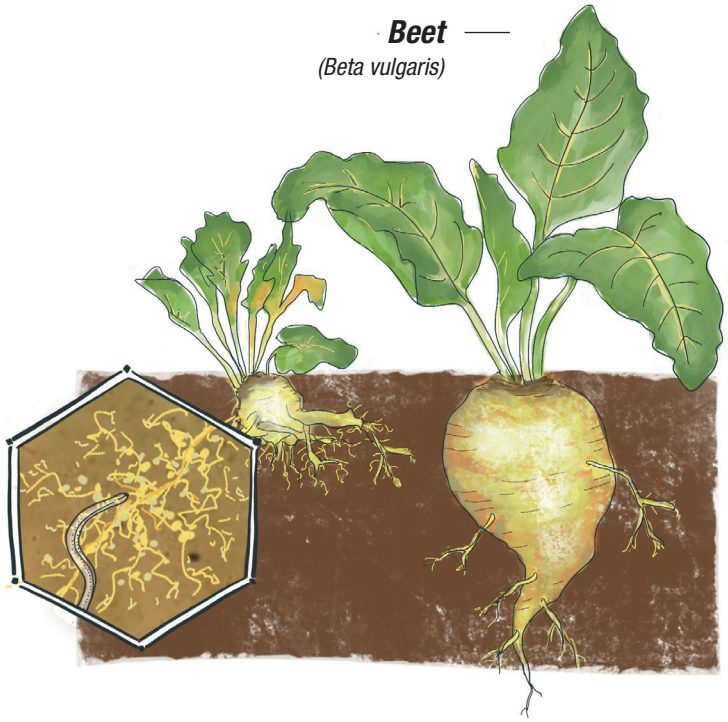
# Beet cyst nematodes

## *(Heterodera schachtii and Heterodera betae)*

Beet cyst nematodes can be divided into the white (H. schachtii) and yellow (H. betae) beets cyst nematode.

Beet cyst nematodes propagate alongside beets on host plants such as spinach, rapeseed, and legumes. After the larvae hatch, they penetrate the roots of a host plant to feed. This creates stunted growth which can lead to plant loss. There may also be patches, visible through hanging leaves.

The white beet cyst nematode becomes active at temperatures above 8°C, the yellow beet cyst nematode above 15°C. The mature females eventually break through the root surface, visible as white cysts. With the yellow beet cyst nematodes, these cysts then change colour from yellow to brown, and with the white beet cyst nematode from white to brown. Three to four generations can develop per year.



## Disease profile

Plant failure and at later stages patches on "dormant beets"

Severely stunted growth

Formation of many lateral roots with visible cysts

Yield loss

## Damage prevention

Company hygiene

Soil sample research with species determination

More extensive crop rotation with the use of a partially resistant beet variety

Use of resistant cruciferous green manures (radish, white mustard)

Soil treatment with nematicide

## The most important green manure crops which combat the beet cyst nematode

| | | | Green manure in early stubble (July – mid-August) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cyst nematodes | Soil type | | Sticky nightshade (May) | Radish | White mustard | English ryegrass | Italian ryegrass | Phacelia | White clover | Leaf cabbage | Tagetes on fallow land (May – July) | Japanese oats on fallow land (May – July) | Rye in late stubble (Aug – Oct) |
| White beet cyst nematode | SRPSC | | - | AB | AB | - | - | - | - | ••• | - | - | - |
| Yellow beet cyst nematode | SRP | | - | AB | AB | - | - | - | ? | ••• | - | - | - |

For comprehensive legend, see page 3

# Root knot nematodes

## *(Meloïdogyne spp.)*

From an agricultural point of view, the following four root knot nematode species are problematic: the Columbia root knot nematode (M. chitwoodi), the false Columbia root knot nematode (M. fallax), the Northern root knot nematode (M. hapla) and the barley root knot nematode (M. naasi).

Root knot nematodes penetrate the roots and cause considerable damage. The feeding cells they create lead to knots on the roots. This leads to yield and quality damage.

Especially the correct soil temperature is decisive in the occurrence of damage caused by root knot nematodes. In the egg masses, the eggs are relatively unprotected. In the absence of a host plant, the natural mortality of root knot nematodes is therefore high. The nematodes multiply on many host plants, with 3 to 4 generations per year. This makes it very difficult to expand the crop rotation plan as a control measure.

## Disease profile

In many cases no damage can be seen above ground.

Visible underground at the roots due to the formation of knots

Chitwoodi and Fallax often have inconspicuous elongated knots

In the case of mixed populations, often indistinguishable, thus analysis is needed

Yield, but mainly quality loss

## Damage prevention

Company hygiene

Soil sample research with species determination

Do not include bad host plants in the crop rotation

Use of resistant green manures

Soil treatment with nematicide

## The most important green manure crops which combat the root knot nematode

| | | | Green manure in early stubble (July – mid-August) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Root knot nematodes | Soil type | | Sticky nightshade (May) | Radish | White mustard | English ryegrass | Italian ryegrass | Phacelia | White clover | Leaf cabbage | Tagetes on fallow land (May – July) | Japanese oats on fallow land (May – July) | Rye in late stubble (Aug – Oct) |
| Northern root knot nematode | SRP | | ? | •• | • | - | - | •• | ••B | • | ••B | - | - |
| Barley root knot nematode | SRPSC | | ? | - | - | ••• | ••• | - | ? | - | - | ? | •• |
| Columbia root knot nematode | SRP | | •• | - B | •• | • | •• | • | ••B | ? | - | •• | ••• |
| False Columbia root knot nematode | S | | ? | - B | •• | ••• | ••• | • | ••B | ? | - | ? | •• |

For comprehensive legend, see page 3

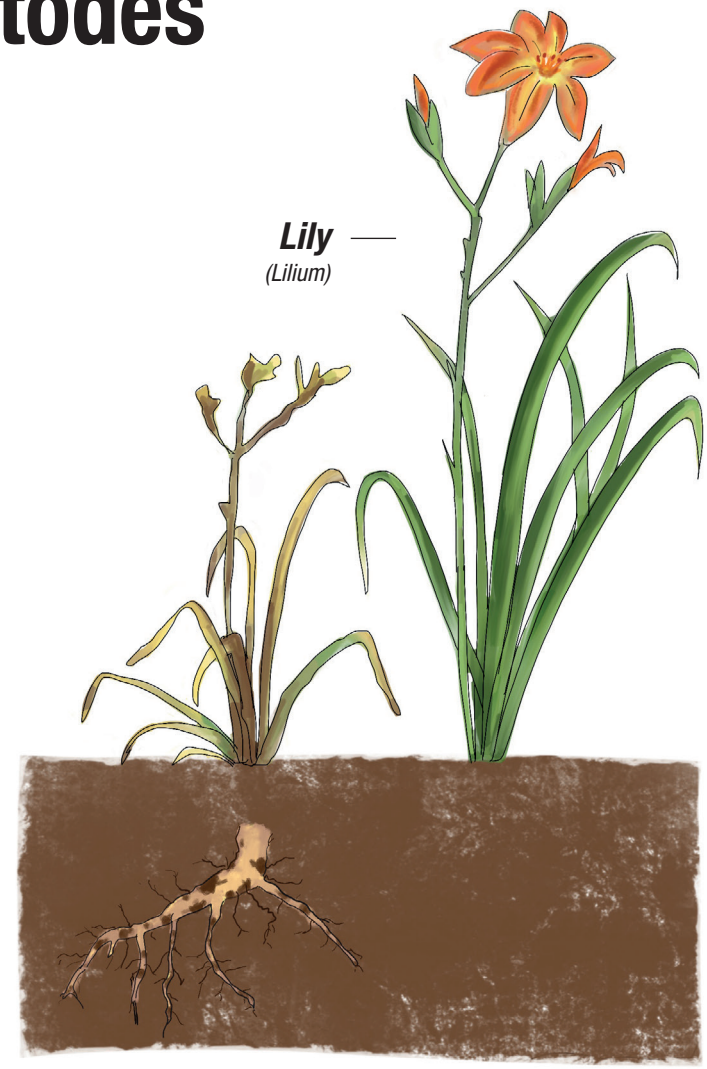
# Root lesion nematodes

## *(Pratylenchus penetrans)*

Root lesion nematodes are mobile and not bound to a root. The root lesion nematodes eat their way through the root cells of the host plant. This creates the characteristic brown linear spots on the roots (lesions).

When many larvae are active, the entire root system is damaged. As a result of being damaged by root lesion nematodes, the plant becomes more sensitive to harmful soil fungi.

Root lesion nematodes have a short life cycle, with 2-3 generations per year and multiply on a large number of host plants (including many weed species). Expanding the crop rotation plan as a control measure is therefore very difficult. Root lesion nematodes can lead to large loss of yield in the cultivation of lilies, beets, grain, barley and potatoes, among others.



## Disease profile

Often typical lesions visible on the roots

Stunted in growth

In case of heavier infestations, sometimes plant failure caused by damaged root system

When damaged, is often more sensitive to fungi

Yield loss

## Damage prevention

Company hygiene

Soil sample research

Ensure good pH and high organic matter content

Prevent weed growth, also after main cultivation

Use of resistant green manures or non-host plants

Soil treatment with nematicide

## The most important green manure plants which combat the root lesion nematode

| | | | Green manure in early stubble (July – mid-August) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Root lesion nematodes | Soil type | | Sticky nightshade (May) | Radish | White mustard | English ryegrass | Italian ryegrass | Phacelia | White clover | Leaf cabbage | Tagetes on fallow land (May – July) | Japanese oats on fallow land (May – July) | Rye in late stubble (Aug – Oct) |
| Root lesion nematode | SRPSC | | • | ••• | ••• | • | ••• | ••• | ••• | ? | A | - | •• |
| Grain root lesion nematode | SRPSC | | ? | ? | ? | •• | •• | ? | •• | ? | A | - | ••• |

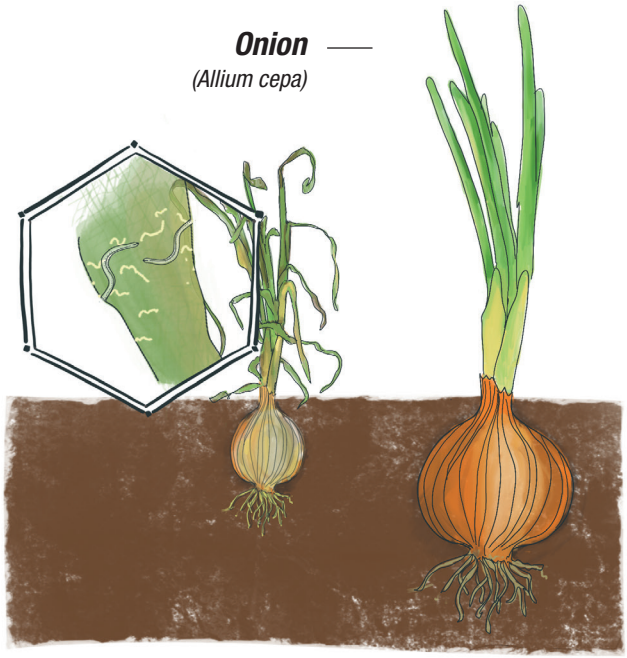
For comprehensive legend, see page 3

# Stem nematodes

## *(Ditylenchus dipsaci)*

Stem nematodes are harmful to a wide range of agricultural and horticultural crops: onions, flower bulbs, carrots, maize, potatoes, legumes and sugar beets. Stem nematodes penetrate the plant tissue and damage the cell walls, leading to growth defects. Noticeable is the curved growth of stalks and stems. In flower bulbs, slits develop in the bottom of the bulb. The leaves of onions are small, the bulbs cracked.

Stem nematodes can survive for years without a host plant. By sticking together, they prevent dehydration. They have a short life cycle with as many as 5-7 generations per year and with 500 eggs. Stem nematodes cause a lot of damage right up to the end of the cultivation. Even in storage, for example of onions, reproduction continues and additional damage occurs. In the event of contamination by stem nematodes, the advice is not to store the products and not to grub up in the case of severe contamination.



## Disease profile

Deformed growth and plant failure

Usually starts with a small patch that gets bigger during the season

Stunted growth and sensitive to rot

With carrots and beets, often only visible at the end of the season as rotten heads

## Damage prevention

Company hygiene & soil sample research

Ample crop rotation

Prevent dumping of sieved soil from contaminated plots

Stem nematodes can tag along with both seed and planting material, use material that is guaranteed free of nematodes

Note the host plant status of green manure crops

## The most important green manure crops which combat the stem nematode

| | | | Green manure in early stubble (July – mid-August) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stem nematode | Soil type | | Sticky nightshade (May) | Radish | White mustard | English ryegrass | Italian ryegrass | Phacelia | White clover | Leaf cabbage | Tagetes on fallow land (May – July) | Japanese oats on fallow land (May – July) | Rye in late stubble (Aug – Oct) |
| Stem nematode | SRPSCC | | ? | ? | ? | • | • | ? | ••• | • | ? | - | •• |

For comprehensive legend, see page 3

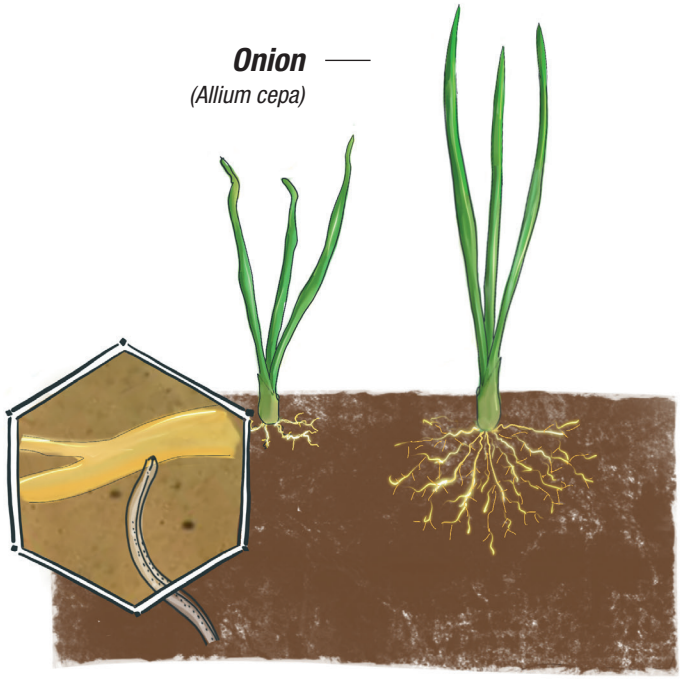
# Free-living/stubby root nematodes

## *(Trichodoridus and Paratrichodorus)*

Free-living nematodes mainly occur on lighter clay, sandy clay and sandy soils. They do not penetrate the roots, but damage the roots by pricking them from the outside for food. Plants react with the formation of new lateral roots. The result is a bushy root system.

The free-living nematodes are able to transmit the tobacco rattle virus and the pea early browning virus if it is present in the soil. In the event of contamination, there is loss of revenue in addition to loss of quality. The free-living nematode reproduces substantially in moist soil during a cool and damp spring.

Free-living nematodes have many host plants and that makes it difficult to expand the crop rotation plan. They have a life cycle of 3-4 generations per year. After biological soil disinfection, the population of nematodes can decrease by more than 70%.



## Disease profile

Irregular damage pattern with alternating healthy and damaged plants

Stunted growth

Transferring viruses such as tobacco rattle virus to potatoes

Especially problems with emergence in wet and cool spring

## Damage prevention

Company hygiene

Soil sample research

Increasing the pH and organic matter content can restrict damage

Choosing the right green manure and forage

Soil treatment with nematicide

## The most important green manure crops which combat the free-living nematode

| | | | Green manure in early stubble (July – mid-August) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Free-living/stubby root nematodes | Soil type | | Sticky nightshade (May) | Radish | White mustard | English ryegrass | Italian ryegrass | Phacelia | White clover | Leaf cabbage | Tagetes on fallow land (May – July) | Japanese oats on fallow land (May – July) | Rye in late stubble (Aug – Oct) |
| Rotylenchus uniformis | S | | ? | ? | ? | •• | •• | | ? | •• | | ? | • |
| Pin nematode | SRPSCC | | ? | ? | ? | ? | ? | ? | ? | ••• | ? | ? | ? |
| Trichodorus primitivus | SRPSC | | ? | ••• | ••• | ••• | ••• | • | ? | ? | ? | ? | ? |
| Tabaco rattle virus (transmitted by T. primitivus) | SRPSC | | ? | ? | ? | ? | - | ? | ? | ? | • | ? | ? |
| Trichodorus similis | SRPSC | | ? | •• | ••• | ••• | ••• | ? | ? | ? | ? | ? | ••• |
| Tabaco rattle virus (transmitted by T. similis) | SRPSC | | ? | - | ••• | ? | ••• | ? | ? | ? | ? | ? | ? |
| Paratrichodorus pachydermus | SRPSC | | ? | •• | ••• | ••• | ••• | •• | ? | ? | ? | ? | ••• |
| Tabaco rattle virus (transmitted by P. pachydermus) | SRPSC | | ? | - | ? | •• | •• | ••• | ? | ? | ? | ? | ? |
| Paratrichodorus teres | SRPSC | | ? | • | • | ••• | ••• | ? | ••• | ? | ? | ? | ••• |
| Tabaco rattle virus (transmitted by P. teres) | SRPSC | | ? | - | ••• | •• | ? | ••• | ••• | ••• | ••• | ? | •• |

For comprehensive legend, see page 3

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