
Organic Crop Protectants
AT LAST.
A NEMATICIDE
SAFE TO USE ANY TIME
& ALMOST ANYWHERE.
eco-nemguard
ORGANIC* NEMATICIDE
CAUTION
Microscopic view of a nematode taken from an infected root system.
eco-nemguard™

INTRODUCTION

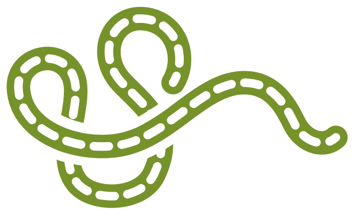
Nematodes are the single most important cause of crop losses world-wide in a large number of crops.

There are many different types of plant pathogenic nematodes but they all have two features in common:

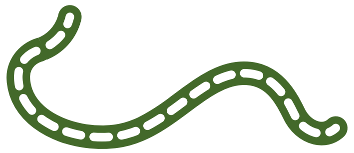
- They cause directly or indirectly yield reduction/total crop loss.
- They cause significant reduction in crop quality and therefore marketability/value.

A wide range of crops suffer from nematode damage. The society of Nematology and other organisations estimated in 2015 that crop losses due to nematodes were $100 billion + annually.

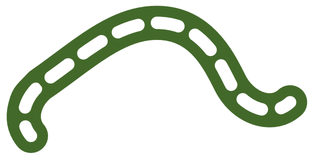
This handbook explains these pests and the lifecycle of the root knot nematode (Meloidogyne Spp.) in particular, the role of garlic extract and the active ingredient di-allyl polysulfides (DAS) found within it, and the finished product containing DAS – Eco-nemguard™.



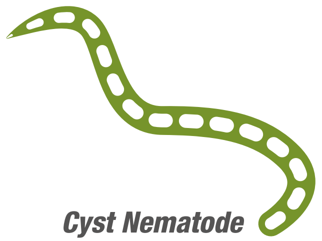
longidorus



Meloidogyne



Criconemella



Cyst Nematode

NEMATODES

The nematodes that growers are most concerned about are those that are plant parasitic.

They are simple organisms, consisting of only about 1,000 somatic cells in a “tube within a tube” body form. The exterior tube is the outside body wall or cuticle, and the interior tube is the digestive tract that extends from the anterior mouth to the anus near the tail.

Plant parasitic nematodes have a stylet; a spear-like mouthpart used to cut into or pierce plant cells. They possess digestive, nervous, excretory and reproductive systems but do not have circulatory or respiratory systems. They cannot see so they find their way through soil to hosts by means of physical cues and chemical receptors.

Plant parasitic nematodes live in water films in soil or in and around plant parts such as roots, stems and leaves. They may be general feeders or have very specific host-parasite relationships with a limited number of host plants.

Plant parasitic nematodes invade the roots of plants and position themselves to divert nutrients away from the plant and towards their own growth.

There are two types of plant parasitic nematodes. Ectoparasites feed from the outside of plant tissue and endoparasites which enter the plant tissue in order to feed. These parasites destroy the plant by damaging its vascular tissue and interfering with the transport of nutrients or by creating open wounds that leave it susceptible to other pathogens.

One type of plant parasitic nematode called root knot (species Meloidogyne) has been estimated to cause $80 billion dollars in crop damage annually. Other plant parasitic nematode species include root-lesion nematodes (Pratylenchus), pin nematodes (Paratylenchus), ring nematodes (Criconemella), stubby-root nematodes (Trichodorus and Paratrichodorus), daggar nematodes (Xiphinema) and “mint nematodes” (Longidorus).

There is a further division of nematode types between ‘cyst’ and ‘free living’. In the former, the female converts herself at the end of her life into a protective shell or ‘cyst’ in which to enclose her eggs, while in the latter, there is no such protective shell.

It makes cyst nematodes particularly difficult to control, as there is limited opportunity for ovicidal activity on the eggs themselves.

ROOT KNOT NEMATODES (RKN)

The most common nematode species

Meloidogyne spp. are obligate sedentary endoparasitic nematodes. The three main species of RKN are M. arenaria, M. incognita and M. javanica, and they reproduce parthenogenetically.

The life cycle of Meloidogyne spp. comprises 6 development stages: egg, 4 juvenile stages (J1 – J4) and the adult.

The life cycle begins when the second-stage juvenile (J2), the only infective and mobile stage, moves into the soil water phase and migrates within water films on soil particles searching for a plant host or is attracted by root exudates.

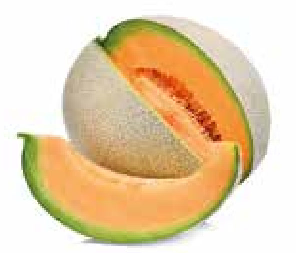
The J2 penetrates the roots just behind the root tip by use of a specialised mouth part called a stylet through which it secretes enzymes (cellulase and pectinase) that enable the nematode to establish an entry point to the root. It then migrates through the intercellular spaces of the cortex to the root tip where it then turns up at the meristem. From there it migrates back to the zone of cellular differentiation to establish a permanent feeding site.

This induces the abnormal differentiation of five to seven cells adjacent to its head in a characteristic way. These cells, named Giant Cells, suffer morphological, physiological and molecular changes caused by the J2 infection and it is the Giant Cells that supply food to the nematode.

This results in root tissue becoming distorted due to the hyperplasia (intense cell multiplication) around the site of infection, forming characteristic root 'galls'.

Once the nematode establishes the feeding site, it becomes sedentary going through two more moulting stages (J3 and J4) and finally becoming an adult. It is at this stage that sex differentiation occurs.

A male root-knot nematode is able to move about freely and can leave a root while the female root-knot nematode remains and feeds in a given location within a root. She now grows in length and width adopting a 'sausage like' shape. Eventually, a female enlarges to the point where a portion of her body extends to the root surface which allows her to lay her eggs in the soil.



Epidemiology

Soil temperature influences the length of the life cycle and is the main abiotic factor which determines development and survival in the absence of a host plant.

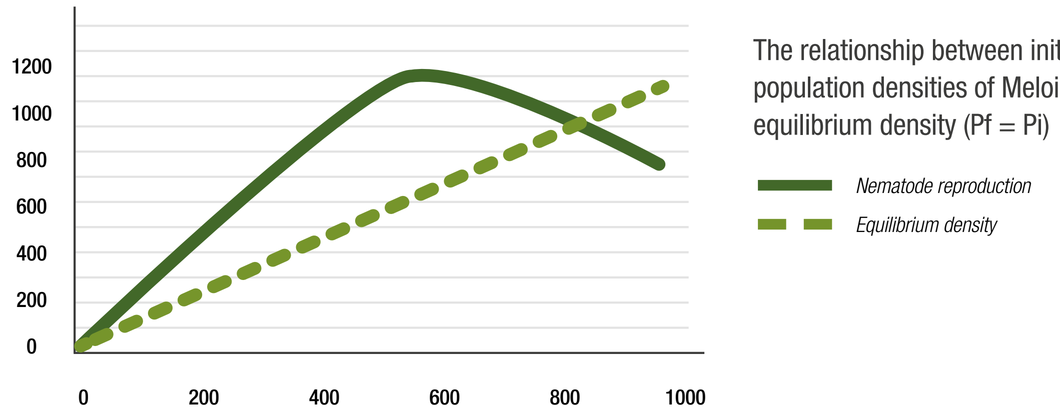
The optimum temperature for egg and J2 survival is around 10 °C. Egg hatching occurs at temperatures above 10 °C as does nematode development. Optimal temperatures for the completion of the life cycle of the most common RKN in vegetable crops are around 10 °C, 28-30 °C and 35 °C.

Besides temperature, the fluctuation of nematode densities over time (known as population dynamics) is conditioned by biotic factors, such as food availability, crop growth status, nematode population density at the beginning of the crop (Pi), intraspecific and interspecific competition and the presence of antagonists. The relationship between the final population density (Pf) and Pi is represented below by the Nicholson model (1935):

The relationship between initial (Pi) and final (Pf) population densities of Meloidogyne spp. and equilibrium density (Pf = Pi).

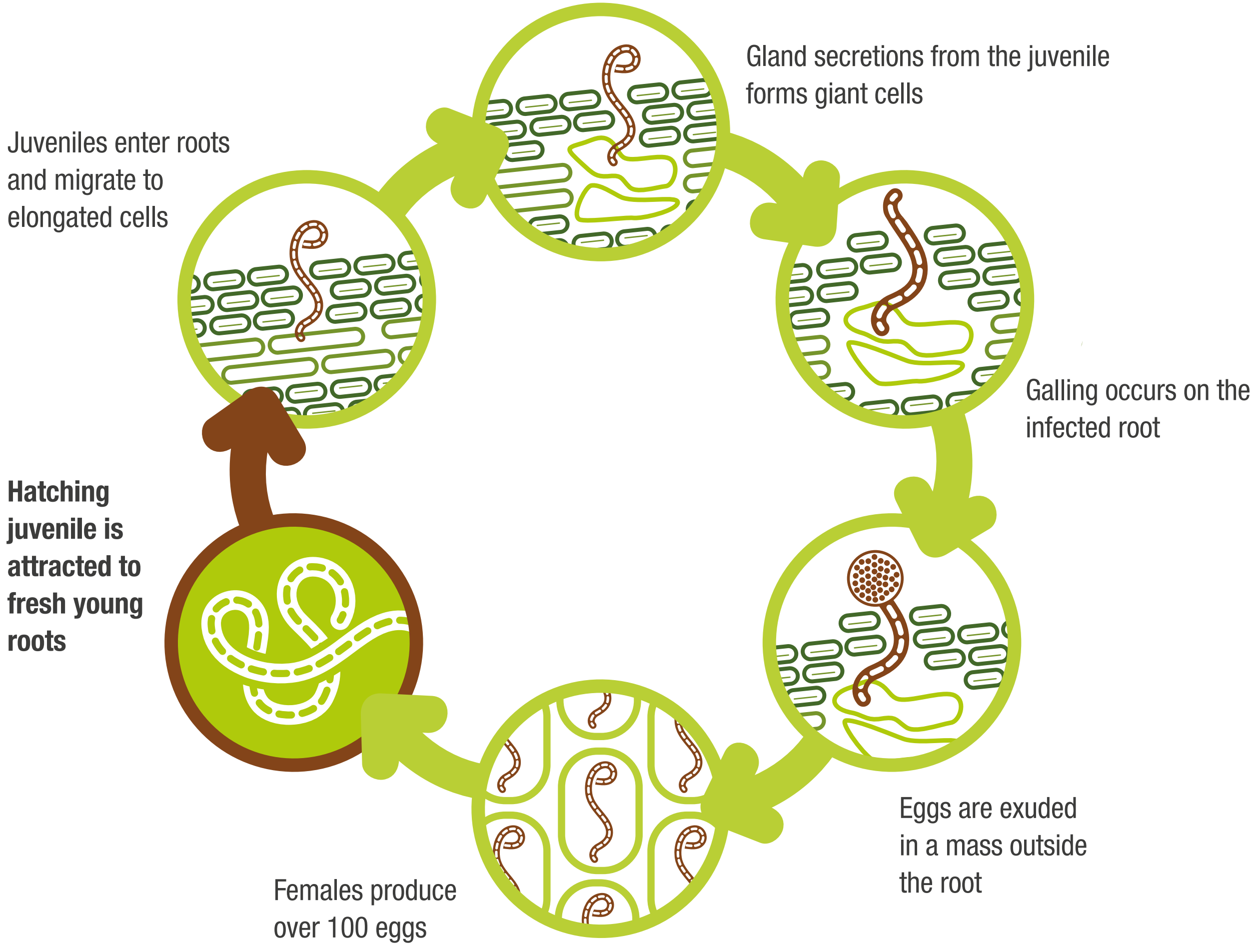
Under favourable conditions for the development of the RKN populations, such as when there is enough food and low nematode inoculum pressure at planting, the nematode density at the end of the crop will be proportionally related to Pi.

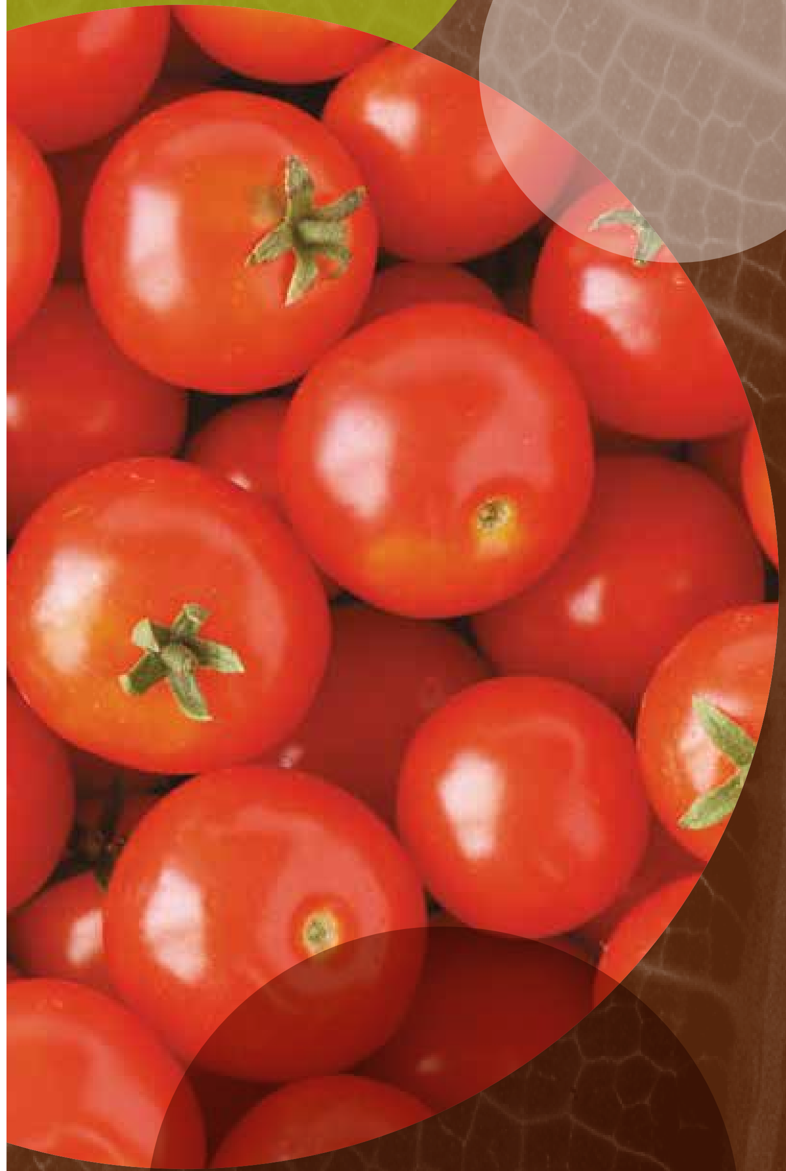
Population Densities



The relationship between initial (Pi) and final (Pf) population densities of Meloidogyne spp. and equilibrium density (Pf = Pi)

Life cycle of RKN





MADE FROM NATURAL INGREDIENTS, FORMULATED AND STABILISED INTO A UNIQUE CROP PROTECTION PRODUCT WITH PROVEN EFFICACY COMPARED WITH CONVENTIONAL SYNTHETIC NEMATICIDES

DIALLYL POLYSULFIDES (DAS)

The active ingredient contained within the garlic extract

Garlic (Allium sativum) contains a wide range of organosulfur compounds which show a variety of biological effects including broad spectrum insecticidal, antibacterial, antifungal and antiviral activity.

One highly bioactive class of compounds from garlic are the diallyl polysulfides (DAS), containing one to six sulphur atoms in a linear chain. These compounds form the active ingredient (ai) found within the garlic extract.

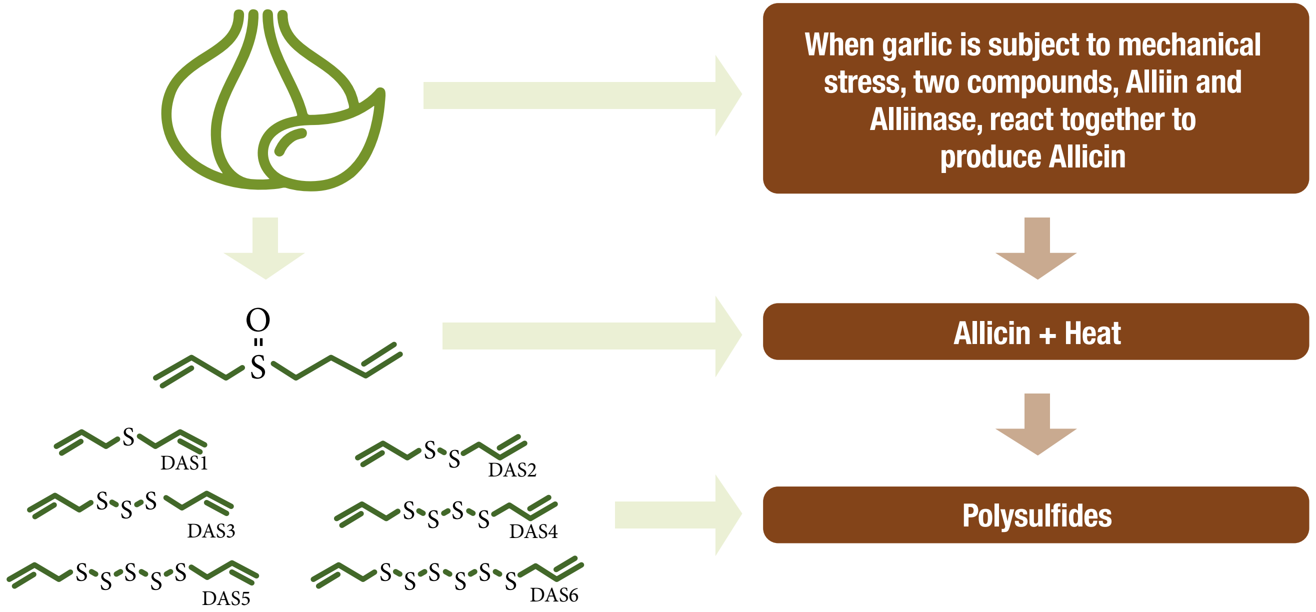
Each DAS is unique and dependent on the number of sulphur atoms in the chain, has different properties. For example, the one and two sulphur atom chains are largely responsible for the typical garlic odour but they are of limited biological activity.

On the other hand the three, four, five and six sulphur molecules are orders of magnitude more biologically active each to the other. This means that in order to have an effective active substance the garlic extract has to contain them in sufficient quantities.

Eco-nemguard™ garlic extract (known as CLAIL0021) is an EU Annex I approved active substance, therefore products produced using it may be registered as plant protection products and following individual national or zonal registration, can make appropriate pesticidal claims.

Similarly in non-EU territories regulatory approval is also required in order to make pesticidal claims. Eco-nemguard™ has an increasing number of approvals world wide.

Unlike unregistered garlic compounds Eco-nemguard™ patented technology has enabled a stabilized form of garlic extract to be produced that delivers the same DAS profile each and every time.



Extensive testing and development by OCP has shown that DAS derived nematicides form an effective alternative compared to synthetic nematicides with the additional advantages of a low operator risk profile and effectively a zero harvest interval as there is no residue definition.

This knowledge, understanding and consistent active ingredient has resulted in a range of approvals as a registered pesticide in a number of countries for nematode control in a variety of crops using either the Granule (GR) or Suspension Concentrate (SC) formulations.

MODE OF ACTION OF POLYSULFIDES

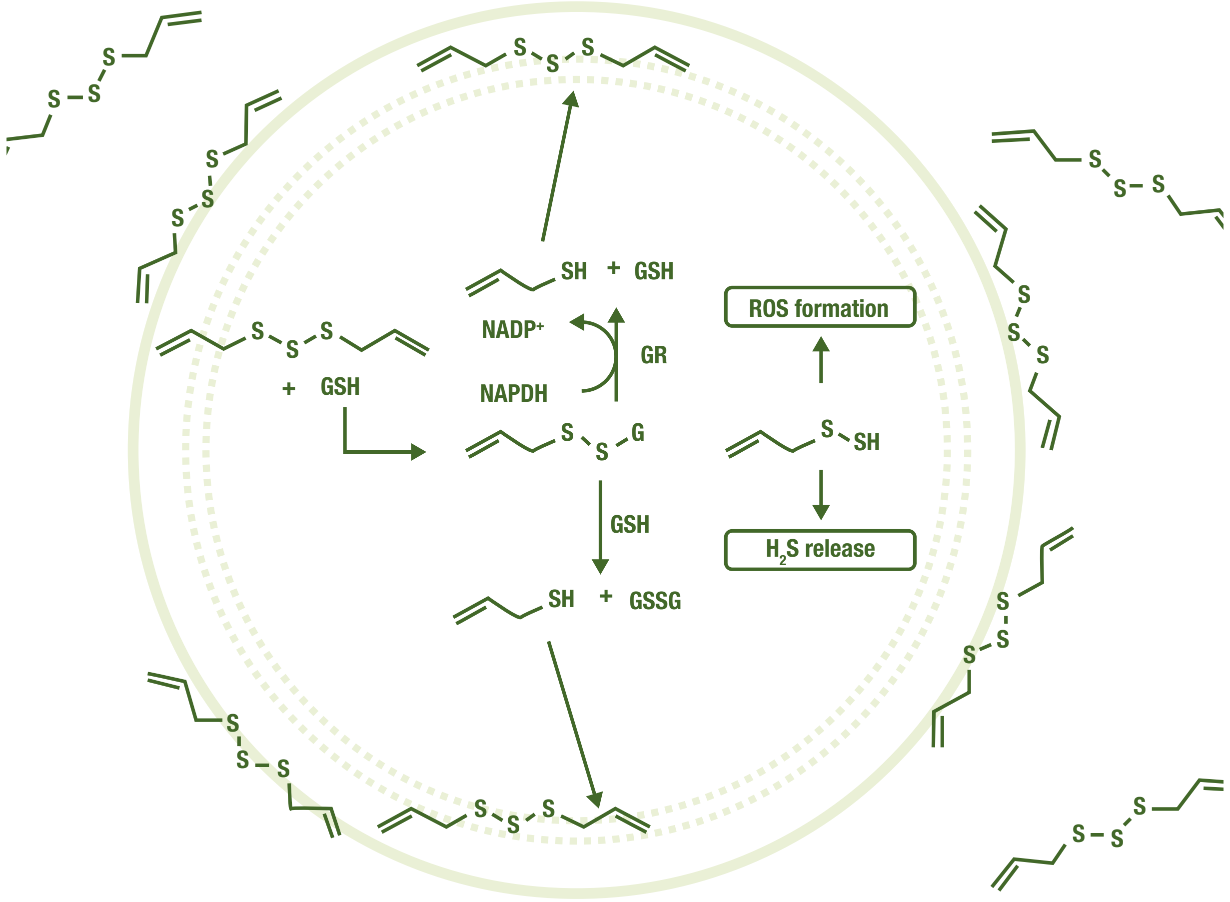
When a nematode encounters DAS molecules in the soil they penetrate through the skin, which is a semi-permeable membrane that allows the nematode to breathe and absorb water.

Rate of passage through the cuticle is dependent on sulphur chain length. Once the DAS dissolves through the cuticle of the nematode the lethal biochemistry starts. The action of DAS is initiated following a reaction with intracellular low molecular weight thiols (LMT's) and protein thiols in the target organism.

This leads to a cascade chain reaction within the nematode which it cannot regulate causing it to die due to overwhelming oxidative stress – a situation where the cell is desperately trying to negate the effects of the reaction caused by the DAS but rapidly runs out of capacity to deal with it.

Roots with galls produced by Root Knot Nematode

How Polysulfides work



The schematic above demonstrates a cross section of a typical nematode. Over 70 different processes within individual cells are compromised by the DAS contained within the active ingredient. As a consequence the development of resistance to this ai is **extremely unlikely.**

ECO-NEMGUARD™

Eco-nemguard™ is a suspension concentrate containing 99% garlic extract (CLAIL 0021). Utilising OCP's patented technology it has a stabilised and recognised DAS fingerprint.

It is registered in a number of countries for use on a variety of speciality crops with new territories and uses being added all the time.

Territories include the EU Southern Zone - Bulgaria, Greece, Spain, France, Italy, Cyprus, Malta, Portugal, Croatia, Turkey, Israel, Morocco, and Zimbabwe.

Active Substance	99% Garlic Extract
Formulation	Suspension Concentrate
Crop	Tomatoes, Sweet Peppers, Cucumbers, Aubergines, Melons, Water Melons, Curcubits
Target	Endoparasitic and Ectoparasitic of the following Genera: Trichodorus spp. Longidorus spp. Pratylenchus spp. Meloidogyne spp. Tylenchus spp. Xiphinema spp. Heterodera spp. Globodera spp.
Application Rate	2 - 4 litres/ha
Harvest Interval	7 Days
MRL	None
CLP	Attention handle with care
Number of applications	6
Application timing	According to crop, risk profile and growth stage
Application method	Drip/Trickle irrigation
Application equipment	Through calibrated irrigation system

ECO-NEMGUARD™ EFFICACY TRIALS

To support the label claims a total of 21 GEP efficacy trials have been performed in Italy (19 trials), Spain (1 trial) and France (1 trial) to evaluate the efficacy of Eco-nemguard™ at different rates against plant parasitic nematodes.

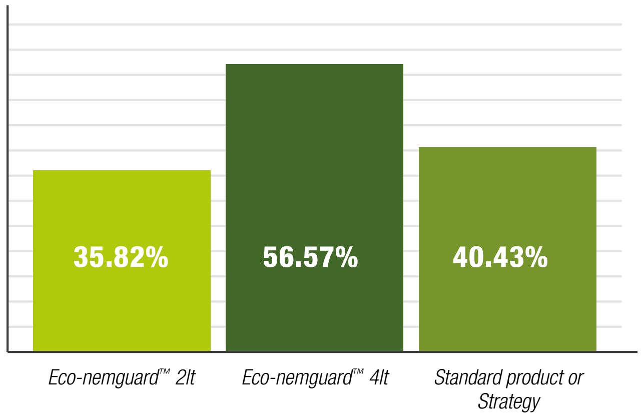
Of these 21 trials, 8 were performed in tomato (4 outdoor field trials + 4 greenhouse trials), 3 on greenhouse bell pepper, 4 on greenhouse cucumber, and 6 on greenhouse melon. The efficacy of Eco-nemguard™ was evaluated for all cropping cycles ranging from March to October.

A randomized complete block design (RCBD) with 4-6 replications per treatment was used in all trials.
The efficacy of the product in reducing crop damage was evaluated several times throughout the study period by assessing Root Galling Severity (RGS) according to Zeck's scale ranging from 0 (0 = complete and healthy root system, no infestation) to 10 (=completely galled root system, plant dead).

In all trials, Eco-nemguard™ was applied using the irrigation system calibrated to apply a water volume from 933 to 30,000 L/ha.

The soil type was primarily sandy (soil type: sand in 10 trials, sandy loam in 3 trials, loamy sand in 2 trials, sandy clay loam in 2 trials, sandy clay in 2 trials, not reported in 2 trials).

Reducing Root Galling Severity % Control



Efficacy of Eco-nemguard™ in reducing Root Galling Severity (RGS) on Tomato, Eggplant, Bell Pepper at 2 and 4 Lt/Ha

Average of 11 trials, 8 Tomato and 3 in Bell Pepper. Field and Greenhouse

RGS in the Untreated Control 4.87 Zecks scale

*% control= (RGS(C)-RGS(T))/RGS(C)*100*
RGS(C)= mean RGS in untreated control
RGS(T)= mean RGS in Treatments

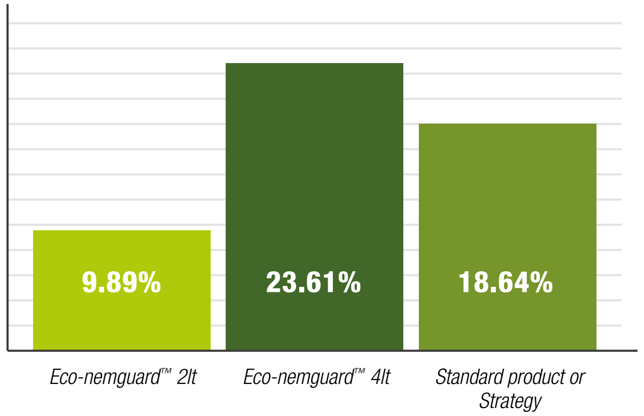
The data demonstrated that the efficacy of Eco-nemguard™ in reducing RGS at the proposed full label rate of 4 L/ha was superior in 2 out of 7 trials and equal in 5 out of 7 trials to standard farm practice. Overall mean efficacy of Eco-nemguard™ at 4 L/ha was 56.57%, higher than that of the standard farm practice at 40.43%.

Based on the efficacy data of Eco-nemguard™ in tomato and bell pepper against root-knot nematodes (1MELGG) and on the preliminary tests, it can be expected that the product will be also effective against free-living stages of plant parasitic nematodes belonging to the genera Tylenchus (1TYLNG), Trichodorus (1TRIHG), Longidorus (1LONGG), Pratylenchus (1PRATG), Xiphinema (1XIPHG), Globodera (1GLOBG), Heterodera (1HETG) in the same crops (tomato, bell pepper) as well as against the same and other nematode genera in eggplant in both greenhouse and the open field.

The data demonstrated that the efficacy of Eco-nemguard™ in reducing RGS at the proposed full rate of 4 L/ha was equivalent to the efficacy of standard farm practice in 3 out of 3 trials. Overall mean efficacy of Eco-nemguard™ at 4 L/ha was 23.61%, slightly higher than that of the standard farm practice at 18.64%.

Efficacy of Eco-nemguard™ in reducing Root Galling Severity (RGS) on cucurbits with inedible peel at 2 and 4 Lt/ha.

Reducing Root Galling Severity % Control



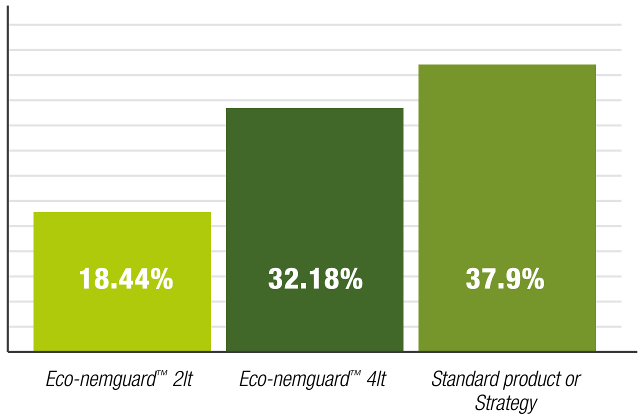
Efficacy of Eco-nemguard™ in reducing Root Galling Severity (RGS) on cucurbits with edible peel (Zucchini) at 2 and 4 Lt/ha

Average of 4 trials done in Cucumber and Zucchini in Greenhouse

RGS in the Untreated Control 8.23 Zecks scale

*% control= (RGS(C)-RGS(T))/RGS(C)*100*
RGS(C)= mean RGS in untreated control
RGS(T)= mean RGS in Treatments

Reducing Root Galling Severity - % Control



Efficacy of Eco-nemguard™ in reducing Root Galling Severity (RGS) on cucurbits with inedible peel at 2 and 4 Lt/ha.

Average of 6 trials done in Melon and Watermelon

RGS in the Untreated Control 7.26 Zecks scale

*% control= (RGS(C)-RGS(T))/RGS(C)*100*
RGS(C)= mean RGS in untreated control
RGS(T)= mean RGS in Treatments

Chemical Standards used in the trials

Cucumber	Melon	Tomato	Pepper
1 x fenamiphos 240 SC + 2 x fluopyram	1 x oxamyl 10 L + 3-5 x iprodione 500 SC	2 x oxamyl 10 SL+ 4 x iprodione 500 SC	2 x oxamyl 10 L + 4 x iprodione 500 SC
4 x iprodione 500 SC	2 x Bacillus firmus (strain I-1582)	3 x oxamyl 10 L 1 x fosthiazate 10 G 1 x oxamyl 10 G	2 x oxamyl 10 L + 1 x iprodione 500 SC + 3 x Paecilomyces lilacinus WG *(synonym Purpureocilium lilacinum strain 251)*

Conclusion of Efficacy trials

Based on the results of the efficacy data for Eco-nemguard™, the following label claim has been approved* in the EU southern zone for the control of plant parasitic nematodes in field and greenhouse:

- Recommended rate 2-4 L/ha;
- Application via any type of drip, handheld, or other irrigation system before, at transplanting/sowing and post-planting/sowing;
- Maximum number of applications: 6 per crop cycle;
- Time interval between applications of 10-14 days.

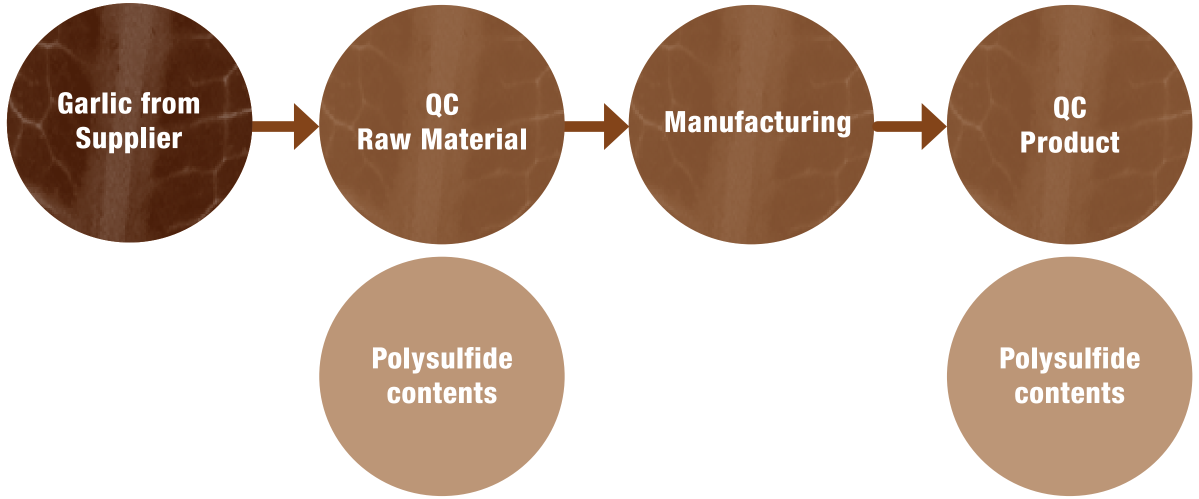
** Subject to regulatory approval in individual countries*

QUALITY CONTROL

Variable quality is always a concern with a product produced from a botanical extract. It is therefore vital to ensure that the finished product has the same analytical profile each and every time.

Consequently there is a strict QC programme that ensures this is the case for every batch of Eco-nemguard™ that is produced.

There is a two stage QC process. First on the Raw Material to analyse the polysulfide content and ensure that the range of DAS is in line with the product specification. Second analysis of the finished product again measuring the Polysulfide contents, assessment of the Elution profile (speed of polysulfide release) and the biological activity on laboratory nematodes (Steinernema feltiae).



GETTING THE BEST OUT OF ECO-NEMGUARD™

Application where it is needed

Contact and systemic nematicides must be uniformly applied to soil, with application targeted towards the rooting zone of the plant.

Placement within the top 5 – 10cm (2 to 4 inches) of soil provides a zone of protection for both seed and transplant establishment.

As the roots extend downward, nematicides are leached in soil solution with additional irrigation or rainfall, thus protecting new roots. Protecting outward, lateral root growth depends on the band width in which nematicides are applied. In general, band widths of 20 – 38cm (8 to 15 inches) are recommended for vegetable crops.

Irrigation

There are many different types of irrigation systems. As a general rule it is recommended that the amount and timing of irrigation must be based on crop evapotranspiration and soil water depletion.

Maximising retention of soil applied nematicides within the crop rooting zone is a primary consideration. The apparent failure to control nematodes in the field is often as a result of excessive irrigation or rainfall soon after application leading to poor retention in the rooting zone of the crop.

On sandy soils nematicide efficacy is related to the depth of water movement and distribution of the product within the wetted zone. Factors which affect water infiltration will also affect the location of the nematicide.

All of the nematicides currently available are subject to the problems of early root zone leaching.

Regardless of the nematicide or irrigation system, maximum depth of nematicide penetration in soils increases with the amount of irrigation. More importantly, the time in which total nematicide residues are contained entirely within the crop rooting zone generally decreases with the amount and frequency of irrigation.

Most non-fumigant nematicides applied at label rates will kill all target nematodes immediately on contact. However, as nematicide concentrations decrease in soil or roots (due to dilution, leaching, chemical and microbial degradation) the ability of many nematodes to resume a normal lifecycle can be restored once the nematicide is flushed from the environment surrounding the nematode.

Waiting periods for subsequent irrigation cycles following nematicide application may therefore be critical for adequate nematode control if maximum contact activity is expected.

Concentration x Time

The lethal effect of nematicides is determined by two components. The first is concentration (C) of the nematicide in the soil solution, usually expressed as parts per million (PPM).

The second is the length of time (T) the nematode is exposed, expressed in minutes, hours or days. The level of nematode control is then related to dosage, the amount of pesticide placed in the environment of the nematode for a known length of exposure time (Concentration x Time).

Total exposure is the product of C x T. For most organisms, nematodes included, there is a concentration level below which kill is not obtained regardless of the length of exposure.

Soil Type and Organic Matter

Apply Eco-nemguard™ to light, sandy and free draining mineral soils, it is not recommended for use on soils with a high silt content and clay soils.

When it comes to irrigation many growers question how much, how long, how fast and how often they need to irrigate. The answers usually involve a combination of soil characteristics, plant growth stage and weather. However, how fast to apply water is based solely on soil type.

Clay-based soils have small, flat, compact particles with large surface to volume ratios. Sand-based soils are at the other end of the spectrum having comparatively large particles with small surface to volume ratios. There are good and bad points for each soil type.

Characteristics of sand, silt and clay soils

For irrigation purposes, it is important to remember water is absorbed and moves slowly through clay soils, but once wet, they retain significant amounts of moisture. On the other hand water is absorbed and moves quickly through sandy soils, but they retain very little of it.

This means water applied quickly to clay soil has a tendency to run off rather than move into the soil. Therefore, when irrigating clay soils, water should be applied slowly over a long period but then the site may not need irrigation for several days.

Irrigation on sandy soils should be applied quickly but for short periods. Irrigation times on sandy soils should be shorter, otherwise water moves beyond the root zone, becoming unavailable to the plant and contributing to soil leaching. For efficient water use under certain weather conditions, sandy sites may need daily irrigation for short periods.

Property / Behaviour	Sand	Silt	Clay
Surface area to volume ratio	Low	Medium	High
Water holding capacity	Low	Medium - High	High
Aeration	Good	Medium	Poor
Internal Drainage	High	Slow - Medium	Very Slow
Organic Matter	Low	Medium - High	High - Medium

Clay soils have greater capillary (sideways and upward) movement than sandy soils (Figure 1). Quick water application on sandy soils will contribute to a broader wetting area, providing more soil volume for roots to exploit.

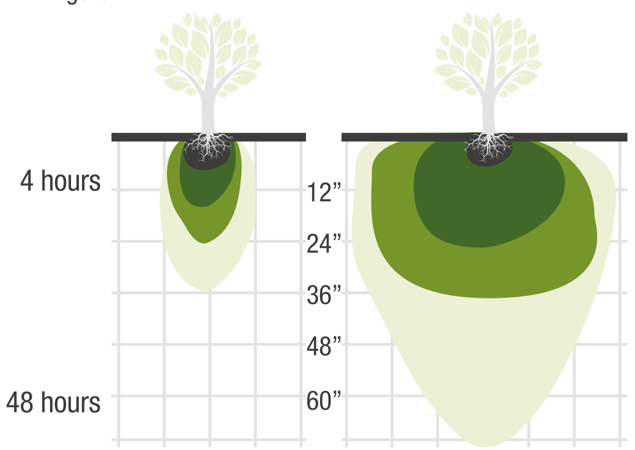
Nematicide dispersion (spreading) in soil following application occurs with water movement. Nematicide dispersal in sandy soils is generally very poor, usually less than 15cm (6 inches). In these sandy soils, increases in chemical application rates will generally not provide control to a greater soil volume although the nematicide may be leached to layers below the root zone. If dispersal is good (as in some of the heavier, sandy loam soils), increases in application rates may provide control to a larger soil volume within the crop root zone. The risk for surface run off and erosion is however, much greater for these soils.

Soil organic matter content is generally low and it declines rapidly with soil depth. The highest levels occur within the top 30cm (12 inches) of soil. Organic matter content has a major influence on soil water holding capacity as well as nematicide dispersal.

Nematicide dispersal may be severely restricted due to the reversible and irreversible binding (adsorption) of nematicide molecules onto organic matter surfaces. As the nematicide moves through the soil, many toxic molecules disappear on soil particles through both chemical and biological degradation.

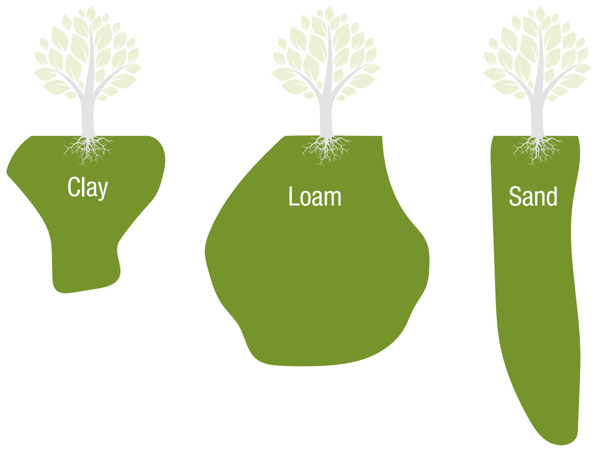
In conclusion therefore, soil water content and temperature are the two major soil environmental factors that control pesticide degradation rates. As binding of nematicide molecules to organic matter increases, toxic concentrations present in soil water become lower.

*Figure 1



Large Pore Space
Gravitational Pull
Sandy Soil

Small Pore Space
Capillary Action
Clay Soil

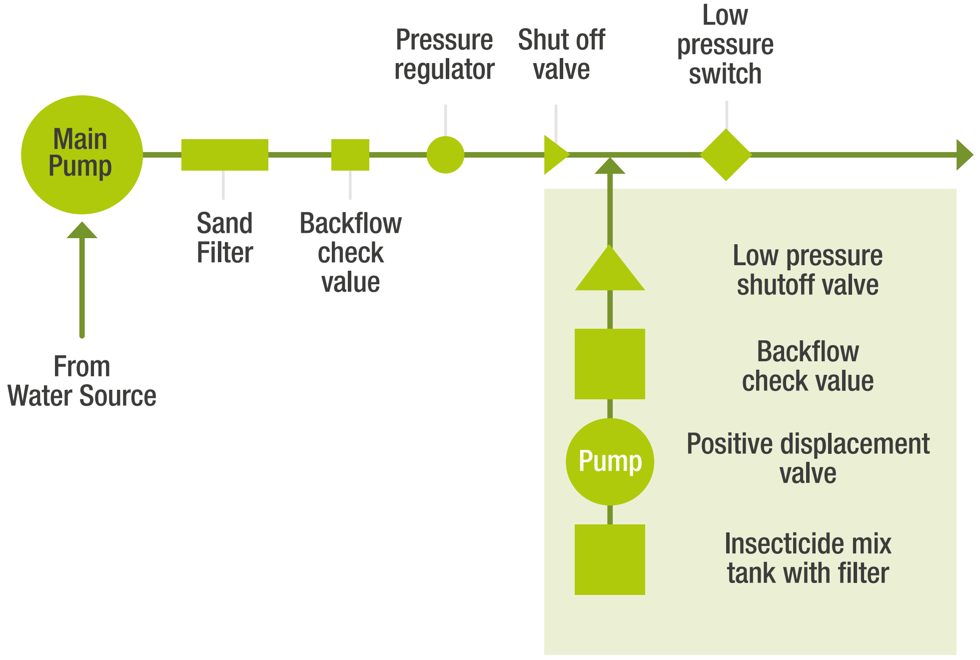


DRIP IRRIGATION

Drip, or trickle, irrigation can be defined as a method of uniformly delivering water to a plant’s root zone through point or line sources (emitters) on or below the soil surface at a small operating pressure.

Many agricultural chemicals are approved for application through various irrigation systems, including overhead, sprinkler, and drip/trickle, in vegetable and other crops.

Drip Irrigation systems that are to have a nematicide injected into them must be properly engineered, installed, and maintained over the season to ensure a uniform distribution of outflow.



Basic drip irrigation system using a positive displacement injection metering pump:

The injection pump must be properly installed and maintained to ensure an even flow of the chemical solution to every emitter in the irrigation system. Injection should be on the downflow side of the main pump filters to avoid potential site contamination as a result of the filter back-flush operation.

a) Water Management

Underwatering during injection will prevent the nematicide from uniformly reaching the root zone of all plants.

Overwatering (excessive watering during or after injection) increases the potential of the injected product to leach or move away from the root zone. The best results are obtained when the product is applied at the end of the irrigation cycle, minimising flush time to prevent the loss of efficacy.

Uniform applications of the nematicide solution are necessary for consistent, effective control. Uniformity of application is controlled primarily by the duration of the injection period. Too short an injection period will result in non-uniform distribution of the Nematicide, and not all plants will receive the treatment evenly. For very large fields, it may be best to establish irrigation blocks to reduce the size of the irrigated field which may result in a more uniform distribution of the injected material.

After application is complete, thoroughly rinse the irrigation system with clean water for the minimum injection time to ensure clog-free operation. It may take a considerable amount of time to completely remove all of the injected chemical from the drip/trickle irrigation system.

b) Timing of product injection

As a general rule, pest control is usually obtained within 24 hours after injection, depending on factors such as emitter spacing, length of time of injection and plant growth stage.

The overall objective of the application is to have an equal amount of Eco-nemguard™ released through every emitter in the system in order to have a uniform application to the root zone of all plants.

It is recommended that the injection of Eco-nemguard™ be targeted to the middle third of an irrigation cycle. For example, if the irrigation cycle is 180 minutes, injection of Eco-nemguard™ should commence after the first 60 minutes. Run the drip/trickle irrigation system at the correct operating pressure for at least 30–60 minutes before injecting anything else. This will prime the system, wet the root zone of the plants, and ensure rapid, even distribution of the injected product.

c) Calculating the Rate

To calculate the rate or amount of Eco-nemguard™ to inject in a drip/trickle irrigation system, it is necessary to first determine the effective wetting zone. The wetting zone can be modified by changing the placement of the drip tape, the drip tape emitter spacing, the drip tape flow rate, or the frequency of water applications …….

The amount of product injected is always based on the area of the irrigation wetting zone, and not on the crop width or number of rows per bed.

It is important that the Eco-nemguard™ injection pump be completely interlocked with the irrigation system so that it will quickly shut down if the main irrigation pump were to stop, or if there were a loss of pressure in the irrigation system. This will prevent a free flow of the solution if there is a pressure drop or loss (resulting from a power loss, a break or hole in the drip lines, etc), and it will also prevent the irrigation and drip lines from filling up with the solution if the main water pump stops for any reason.

A flow sensor installed downflow from both the injection pump and the main pump should be interlocked with the shutoff valves of both the main pump and the injection pump to shut down both the irrigation system and the product injection system if water pressure at any point in the system drops or ceases.

Example of Threshold of M. Incognita on Tomato (Greco and Di Vito 2001)

Nematodes per cm^3	10	20	30	40	50	70	100
Loss of production %	1.0	3.0	3.5	5.0	8.0	13.0	64

Tolerance Threshold 0.5

THE POLYSULFIDES CONTAINED WITHIN THE GARLIC EXTRACT AFFECT THE SAME BIOCHEMICAL PROCESSES IN NEMATODES, INSECT PESTS AND FUNGAL PATHOGENS

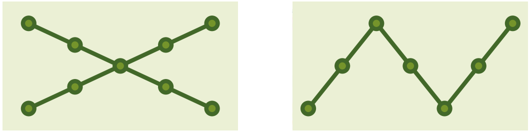
SOIL SAMPLING

a) Equipment

Soil corer, bucket, plastic bags, recording sheet and pen, labels or permanent felt tip marker pen.

b) Method

- Sample when soil is damp but not too wet, preferably after rain or irrigation.
- A composite soil sample of 15-20 cores should be collected from about 0.5 ha. Proceed to zig-zag or X across the entire surface.



- Discard the surface soil to minimise the influence of dried topsoil, weeds and cover crop.
- For root knot nematodes, collect soil samples from about 10 cm to a depth of 30 cm;
- Place each sample in a separate labelled bag and seal.
- Store bags in a refrigerator at about 4°C until they can be sent for testing. Samples need to be assessed within two weeks, however as soon as possible after collection is preferable.
- Soil samples should be re-taken from the same position each time, to avoid sampling error.

Organic Crop Protectants

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