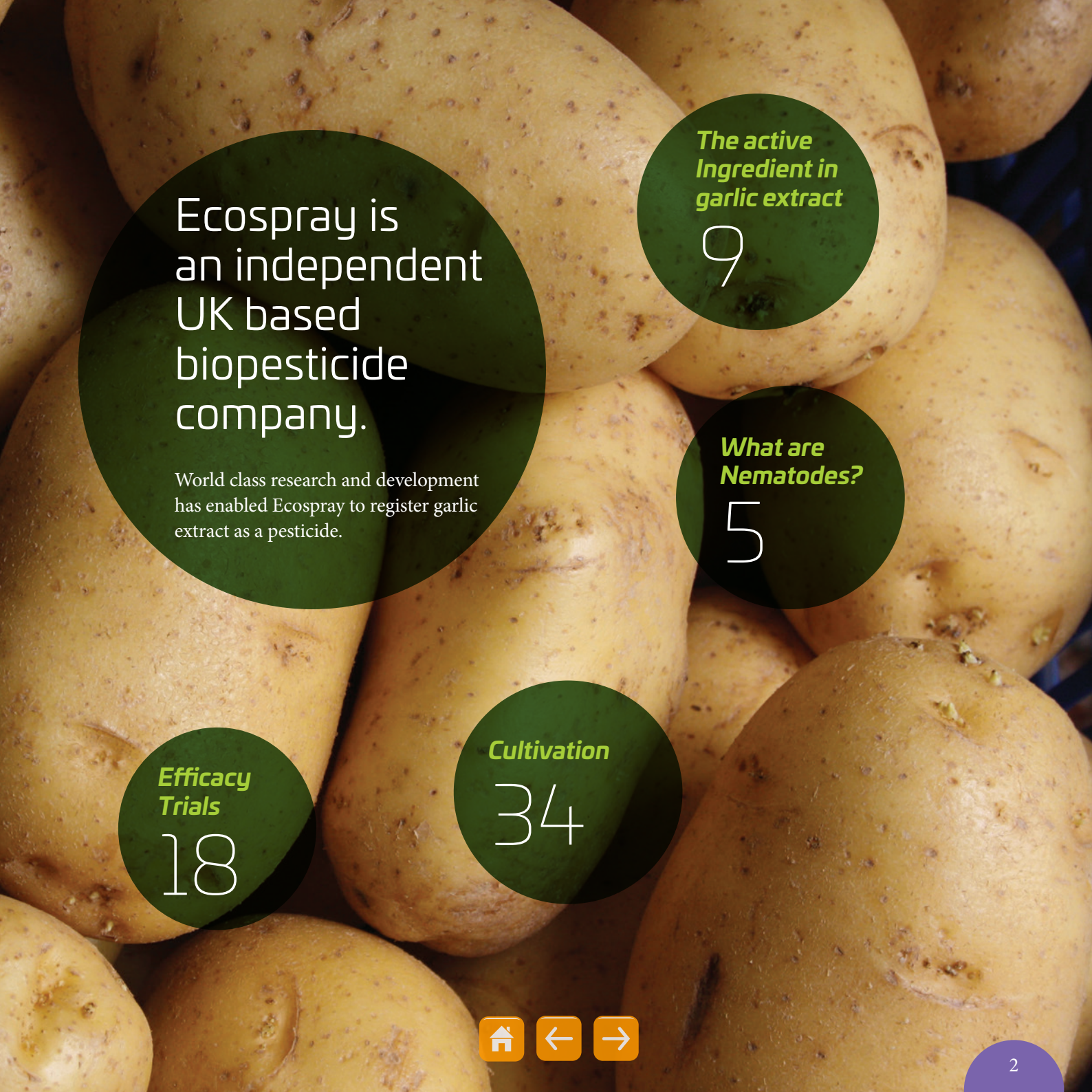
Ecospray

Granular nematicides for the reduction of free living, root knot and cyst nematodes in carrot, parsnip and potato crops

Nemguard® DE
Nemguard® PCN



Ecospray is an independent UK based biopesticide company.

World class research and development has enabled Ecospray to register garlic extract as a pesticide.

Contents

Introduction

Nematodes are the single most significant 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 nematodes. The society of Nematology and other organisations estimated in 2015 that crop losses due to nematodes were in excess of $100 billion annually.

Nematodes, free living and in particular cyst nematodes (PCN), are the biggest pest threat to the UK potato industry for example, costing in excess of £50m annually. PCN is currently present in much of the land used for growing potatoes in the UK and some other countries and there are increasingly limited nematicide options left available to growers.

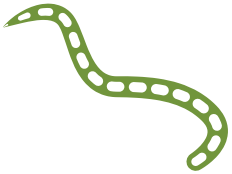
Free living nematodes are also an important pest of carrots and parsnips causing 'forking' or 'fanging' and other growth irregularities leading to reductions in marketable yields due to misshapen roots.

This handbook explains these pests and their lifecycle, the role of garlic extract and the active ingredient di-allyl polysulfides (DAS) found within it and the finished products containing DAS – Nemguard® PCN and Nemguard® DE.

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 toward their own growth. In so doing they can cause major irregularities to root morphology and functionality.

There are two types of plant parasitic nematodes. Ectoparasites feed from the outside of plant tissue and endoparasites 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.

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.

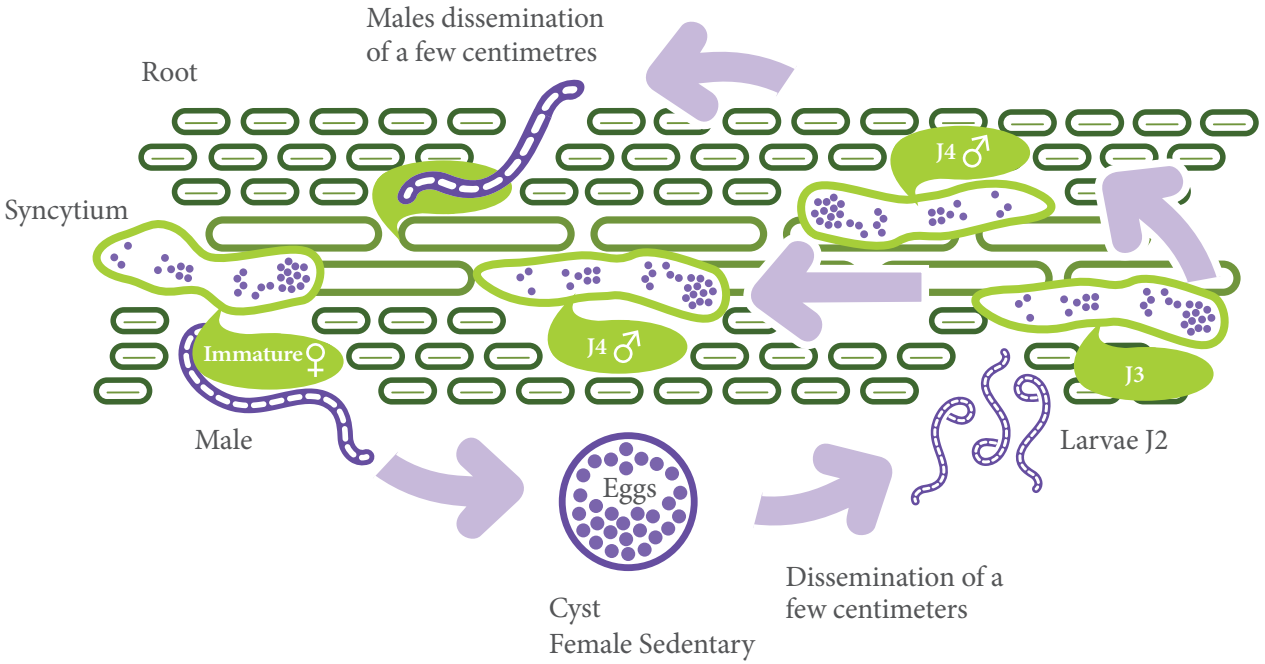
Potato Cyst Nematodes (PCN)

There are two main species of PCN, Globodera rostochiensis and Globodera pallida. The larvae feed on the plant roots of growing potatoes causing low vigour, plant stress and in some cases premature death. This means lower yields, adverse impact on size grades and an overall reduction in quality.

Eggs hatch in the spring, and in response to chemical exudates released by the roots of the developing potato over the growing season, females attach to roots and develop into cysts which can contain up to 500 eggs each. The newly hatched PCN attack developing stolons and tubers causing damage to the crop.

Biological cycle of Potato Cyst Nematode

Sexually reproducing diploid with one or more males



Free living Nematodes (FLN)

Free-living nematodes (FLN) are those nematodes which do not have a phase of their life cycle within a host and represent the majority of known nematode species/genera and are far more widely distributed in soils than cyst nematodes such as PCN.

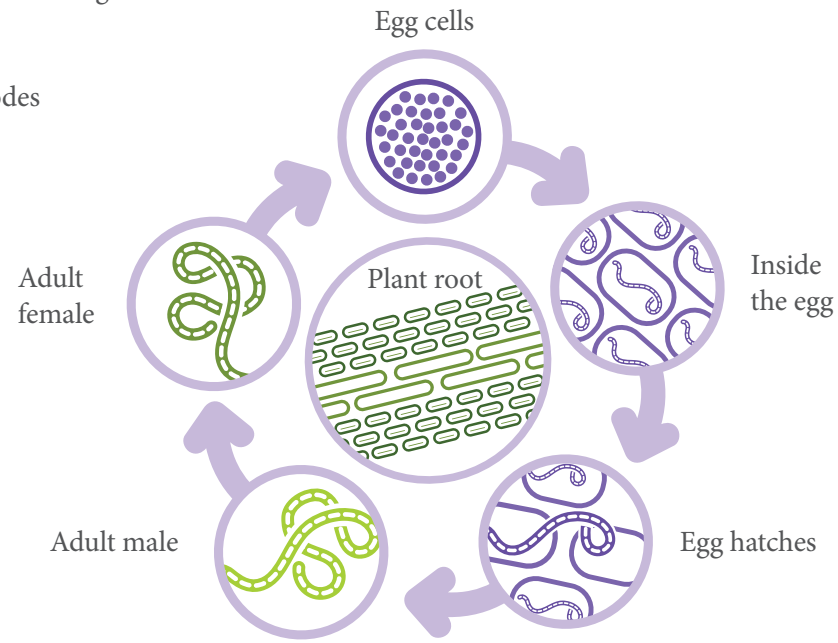
Frequently non-specialists refer to FLN as meaning plant-parasitic nematodes that are not Globodera pallida or Globodera rostochiensis, however, FLN is a global term with species/genera that represent the Trichodorus spp. and Paratrichodorus spp. Free living nematodes (FLN) live within the soil profile and are most mobile in light sandy soils which is where they are likely to cause most damage.

They are responsible in potatoes for example for transmitting Tobacco Rattle Virus (TRV) which causes brown internal cork like effects sometimes called 'Spraing', This condition can render a crop of potatoes almost worthless.

In carrots and parsnips FLN can cause 'fanging' or misshaping of the root where the main tap root splits into two or is malformed as a result of an attack by FLN making the resulting malformed carrot unsaleable. While overall yield is not particularly impacted, the number of saleable roots is reduced.

Life cycle of FLN

Ectoparasitic nematodes



Ecospray

Made from natural ingredients, formulated and stabilised into a unique crop protection product with proven efficacy compared to other conventional 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.

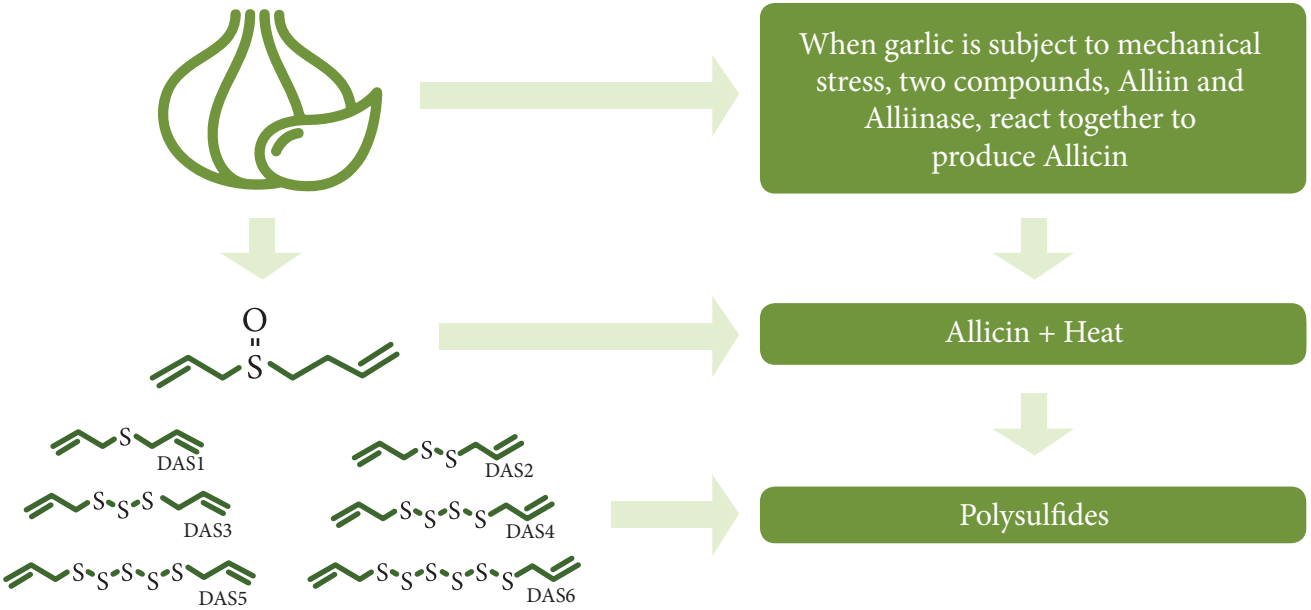
Each DAS is unique and dependent on the number of sulphur atoms in the chain, has different properties. For example, the one and two sulphur atom chains are largely responsible for the typical garlic odour but they are of limited biological activity.

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.

Ecospray garlic extract is an EU Annex I approved active substance, therefore products produced using it may be registered as plant protection products within the EU 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. Ecospray has an increasing number of approvals world wide.

Unlike unregistered garlic compounds, Ecospray 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 Ecospray 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

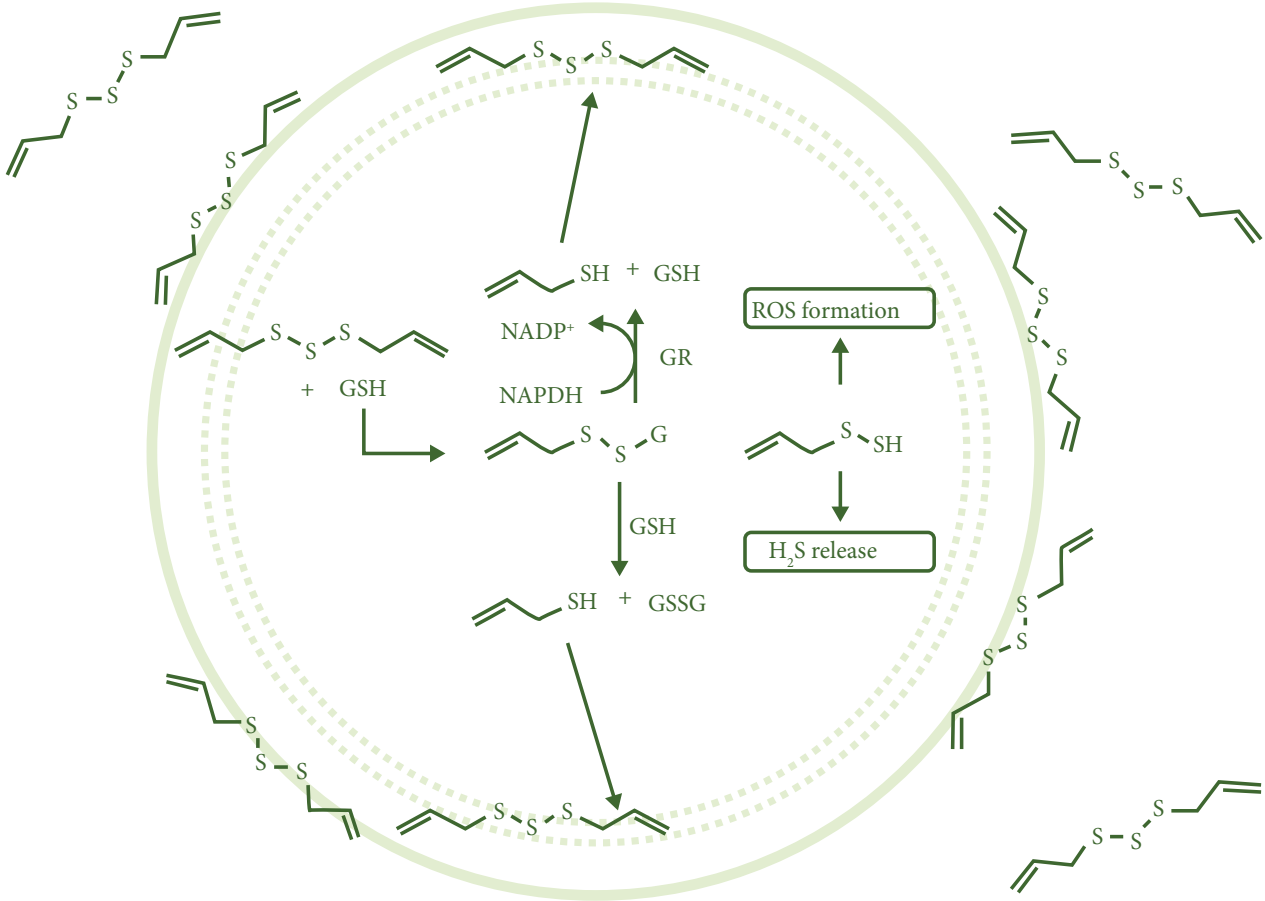
When a nematode encounters DAS molecules in the soil they penetrate through the skin, which is a semi-permeable membrane that allows the nematode to breathe and absorb water.

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**.

Granule Carrier

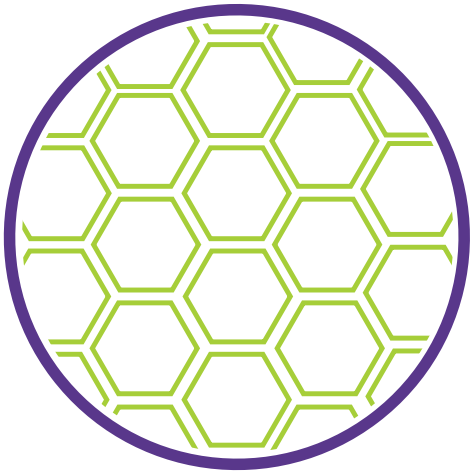
Diatomaceous earth is used as the carrier in the formulation of both products as it has the required characteristics for even release of the active ingredient in the soil.

Diatomaceous earth is made from the fossilized remains of tiny, aquatic organisms called diatoms.

Their skeletons are made of a natural substance called silica. Over a long period of time, diatoms accumulated in the sediment of rivers, streams, lakes, and oceans. Today, silica deposits are mined from these areas.

Diatomaceous earth is the second most abundant element in soils. It's a common component of rocks, sands, and clays. It is also abundant in plants and plays a role in their growth and development. Due to its chemical makeup, diatomaceous earth is not degraded by microbes or by sunlight. It is odourless and does not easily dissolve in water which increases the persistence and gives the desired release pattern of the product. A low dust grade of diatomaceous earth is used, which minimises operator exposure risks.

Structure of a DE Nemguard® granule



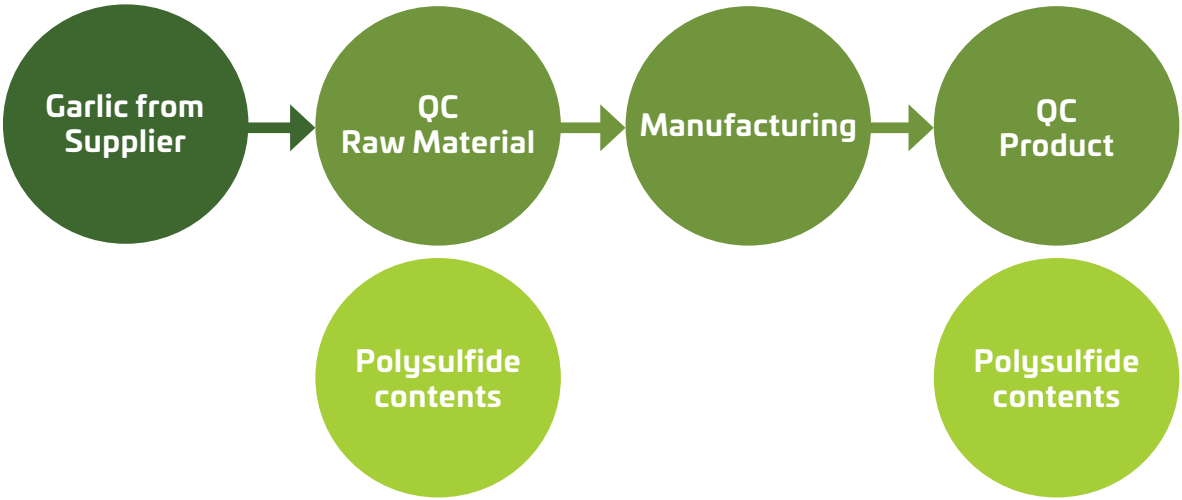
The Nemguard® DE granule contains a Honey-comb structure and acts as an effective carrier matrix for the active ingredient.

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 Nemguard® DE or PCN 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).



Ecospray

A granular nematicide, suitable for application to carrot and parsnip crops at sowing

Nemguard® DE (for carrots and parsnips)

Nemguard® DE

Nemguard® DE is granular non-systemic nematicide containing 45% garlic extract. Utilizing Ecospray's patented technology, it has a stabilized and recognized DAS fingerprint.

It is registered in a number of countries for use on carrots and parsnips with new territories and uses being added all the time. Current territories include the UK, Eire, Netherlands, Italy, France, Belgium, Spain and Israel.

Active Substance	450 g/kg of garlic extract
Formulation	Diatomaceous Earth (DE)
Crop	Carrots & Parsnips (DE)
Target	Endoparasitic and Ectoparasitic of the following Genera: Trichodorus spp. Longidorus spp. Pratylenchus spp. Meloidogyne spp. Tylenchus spp. Xiphinema spp.
Application Rate	Carrots and Parsnips 20kg/ha (UK), other territories may vary
Harvest Interval	7 Days
MRL	None
CLP	Attention: Handle with care
Number of applications	1
Application timing	At time of planting
Application method	Calibrated granule applicator
Application equipment	Horstine 'Microband' applicator or similar

Nemguard® DE (carrots and parsnips)

What are growers looking to achieve using a nematicide in the crop?

An attack by free living nematodes (FLN) will generally not affect gross yield, although an early attack of nematodes can wipe out young seedlings. It will largely affect marketable yield as a result of misshapen and fanged roots as well as diseased roots where damage to the plant's vascular system by a nematode can allow entry of diseases such as Pythium.

Gall and cyst nematodes on the other hand can have a major impact not only on total yield but also marketable numbers of roots where there can be disproportionate numbers of either oversized or undersized roots..

Untreated crop

Nemguard® treated crop

Trial Results
Nemguard® DE (carrots and parsnips)

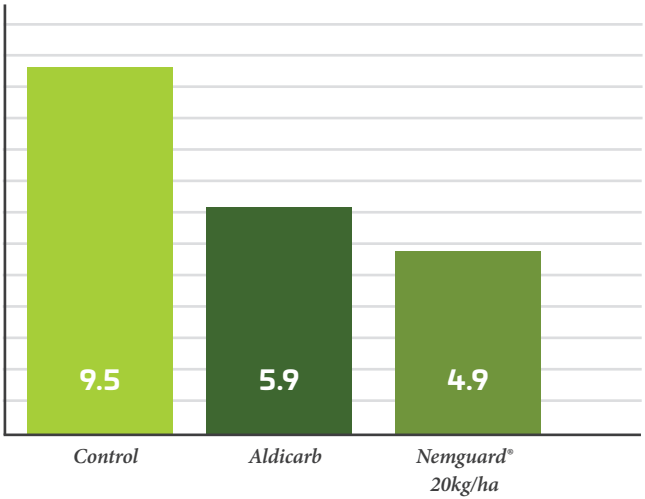
Nematicidal effects

Nemguard® treated crops have consistently shown improved plant numbers when compared to other treatments as well as seeing reductions in fanging equal to standard farm practice. The following are a selection of trials from the UK, Italy and Denmark that demonstrate this over the period 2003 to 2017.

The nematode pests involved include free living, gall and cyst types. Nemguard® is effective on all types of nematodes.

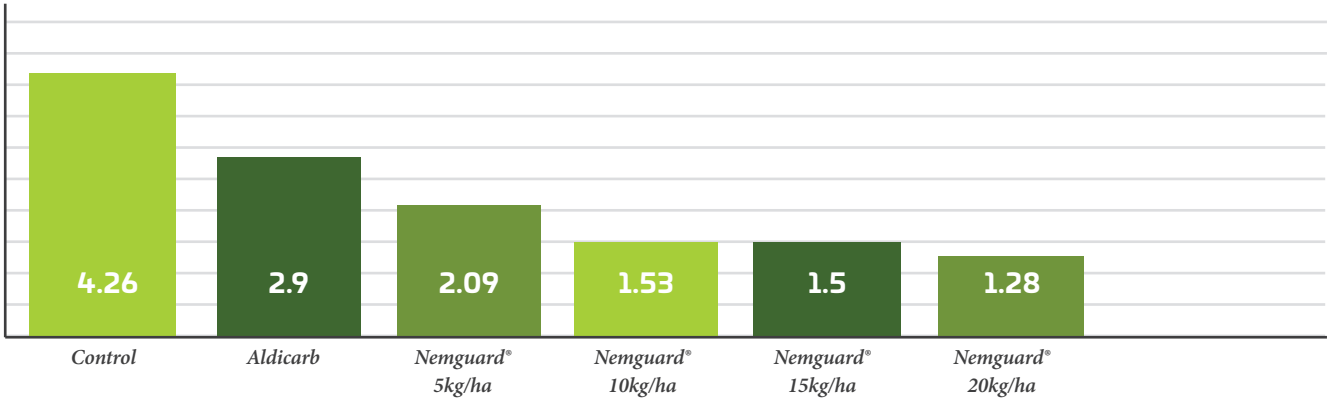
UK Field Trial FLN 2003

Carrots Mean % Fanging



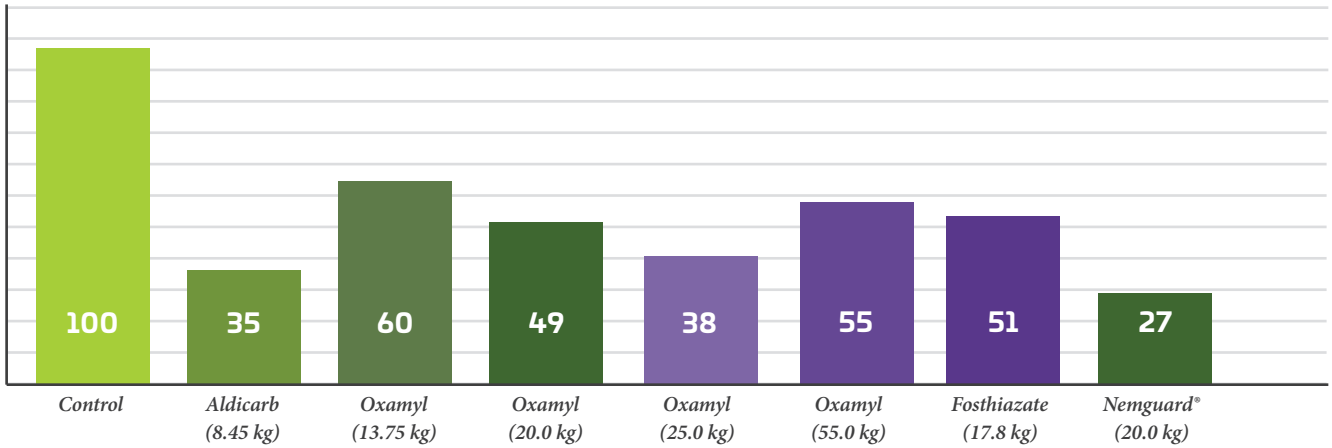
UK Field Trial FLN 2003

Parsnips Mean % Fanging



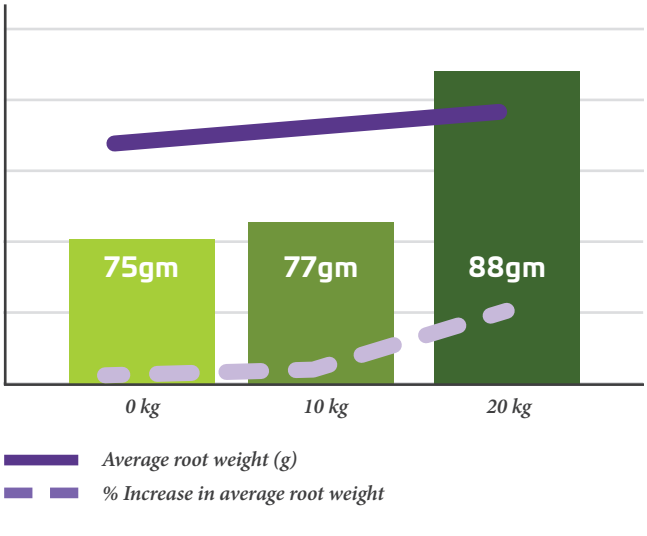
UK Field Trial FLN 2004

Carrots % Fanging (Mean of 3 trials)



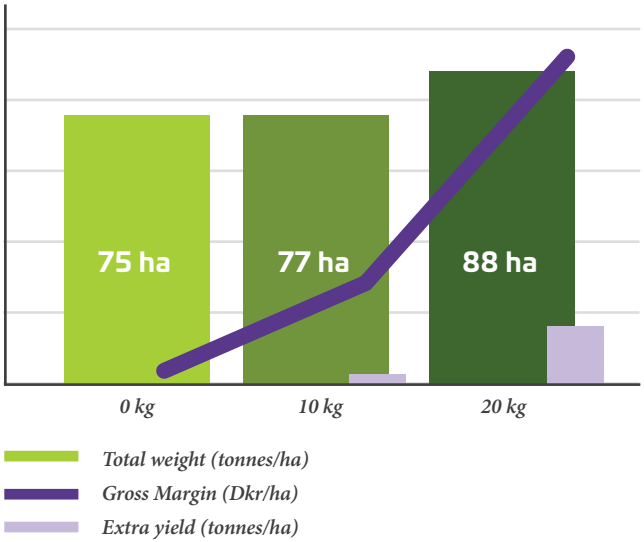
Denmark Field Trial 2004

Carrot Cyst Nematode Weight of Roots/plot



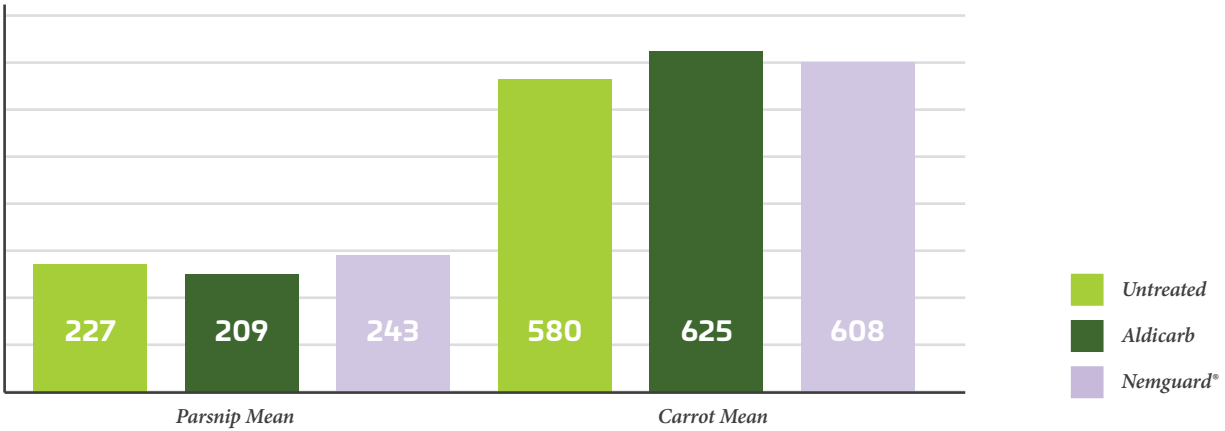
Denmark Field Trial 2004

Carrot Cyst Nematode Grower Return



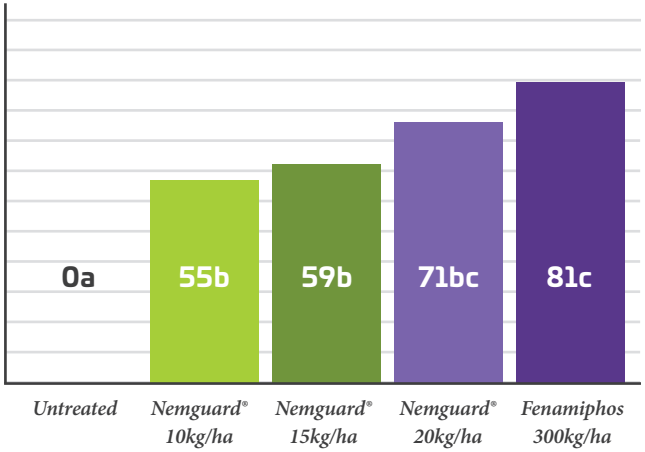
UK Field Trial FLN 2006

Marketable Quality Indicator (Total No. marketable roots x quality score)



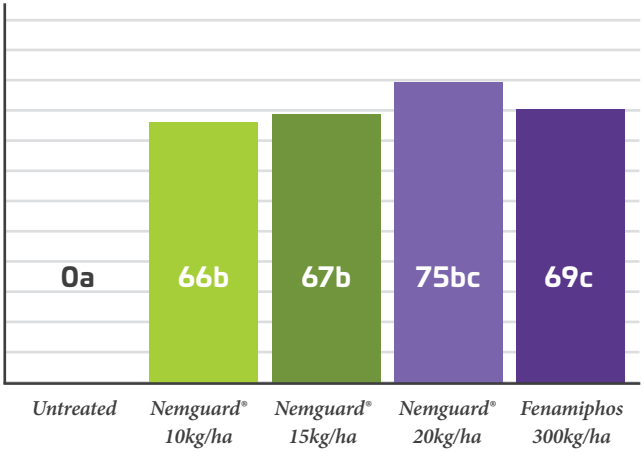
Italy Field Trial 2007

RKN (Meloidogne Spp) Carrots % Control



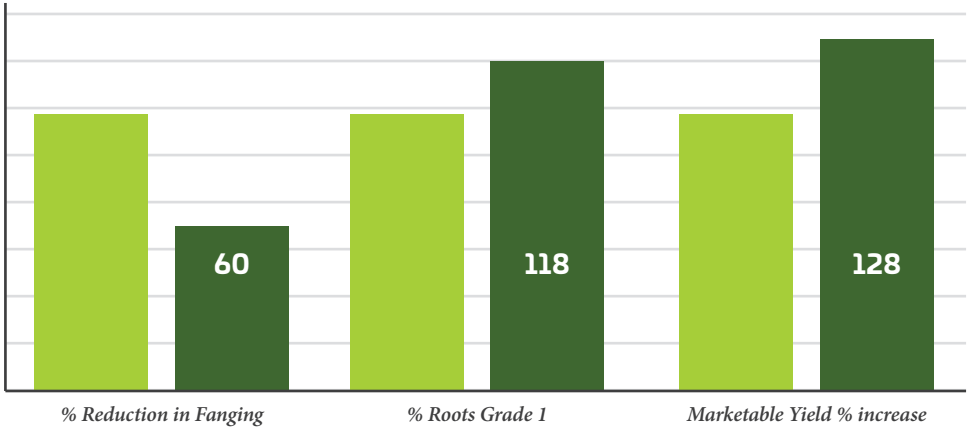
Italy Field Trial 2008

RKN (Meloidogne Spp) Carrots % Control



UK Field Trial FLN 2016

Mean of 8 Replicates



Soil Type: Sandy
Drilling: 2/5/2016
Irrigation: None
Rainfall: May – Sept 372mm

Control
Nemguard® 20kg

UK Field Trial 2016 – Early nematode attack in an untreated plot

Effects on Pythium spp.

Pythium is a disease that affects carrot and parsnip crops in two ways. Firstly, at crop establishment where the young germinating seedlings are affected by 'damping off' disease. This is caused by Pythium and possibly some other soil fungal species as well. This results in a reduction in plant stand (plant numbers).

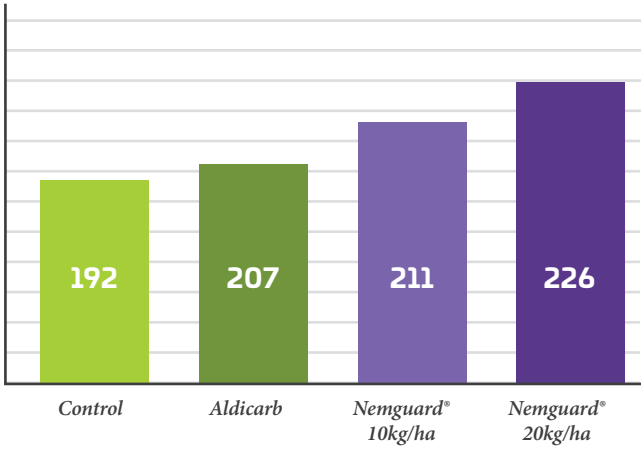
Nemguard® affects the same cellular processes within certain fungal pathogens as it does with nematodes and so helps to suppress impact of these fungal pathogens on the developing seedling.

Plant Stand

In trials over a number of years consistent improvements in plant stands have been noticed.

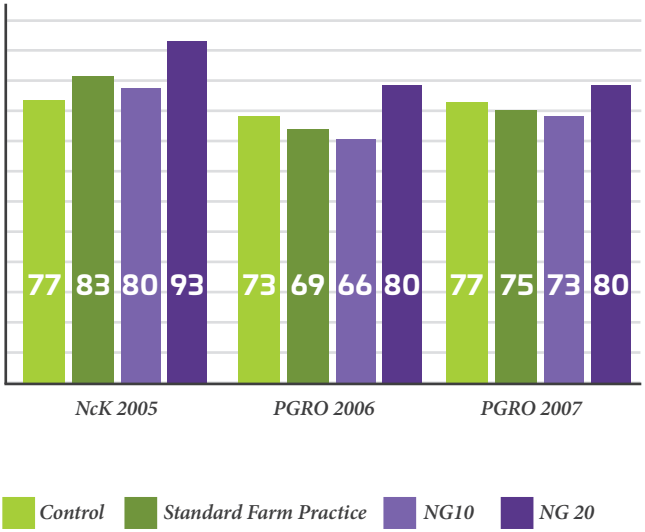
PGRO 2006 Carrots

Plant stand in 4m strips, 5 replicates



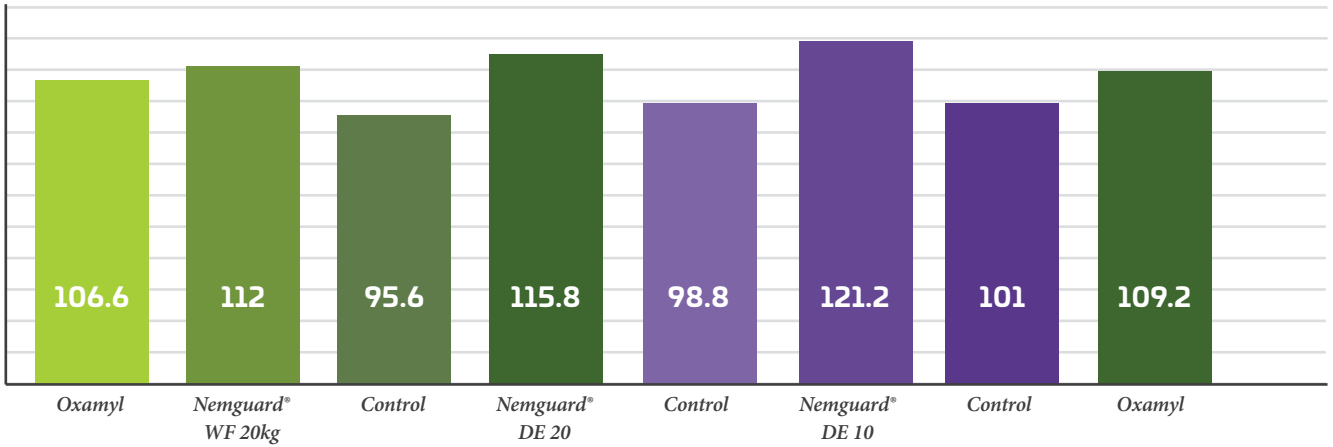
Parsnips 2005-7

Plant stand in 4m strips, 5 replicates



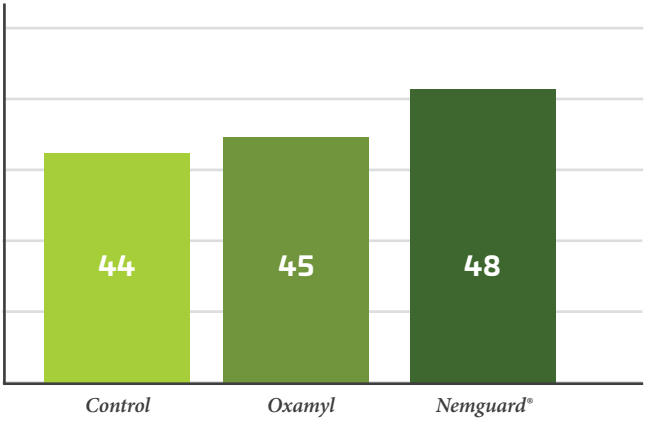
Plant stand populations BCGA trial 2012

Plant numbers

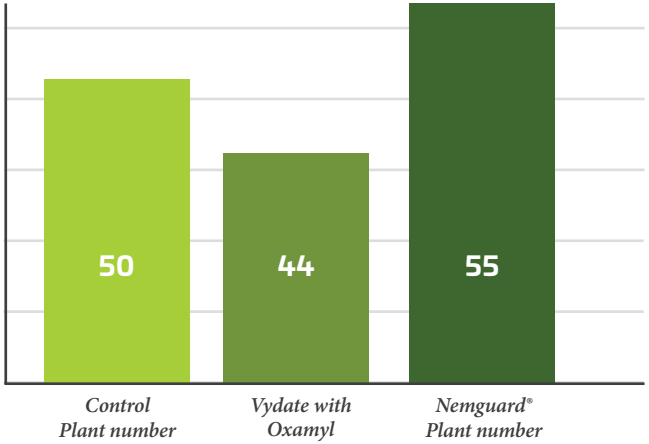


Plant Stand populations UK trial 2017

Plant numbers from first assessment
7/6/17 - 6 weeks post drilling



Plant numbers from fourth assessment
4/8/17 - 15 weeks post drilling



Plant stand and crop evenness comparison trial 2016 70 DAT

Nemguard®

Oxamyl

Untreated

Cavity Spot

This disease is caused mostly by *Pythium violae* and results in depressed lesions on the carrot root.

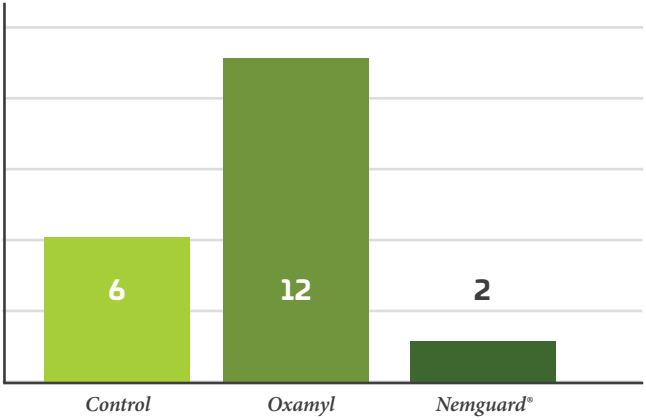
The disease while not particularly impacting yield can severely damage crop quality to the point that if the attack is severe enough the crop can become unmarketable.

Conventional treatments utilise application of metalaxyl-m to help control the disease.

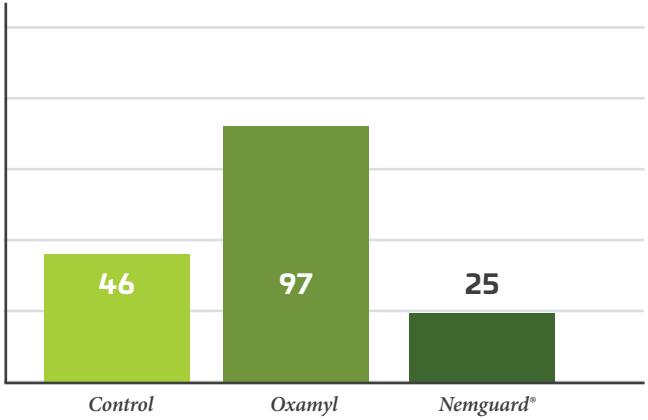
Trials have demonstrated that Nemguard® DE can help suppress the effects of Pythium violae and can therefore be a useful tool in managing this unpredictable disease both in terms of total numbers of roots affected and numbers of lesions per root. It is not designed as a replacement for a fungicide treatment, rather as an additional incidental benefit resulting from use as a nematicide.

Fifth Assessment 9/10/17

Mean percentage roots with cavity spot



Total Number of Lesions/Treatment



Getting the best out of Nemguard® DE

It is recommended that the product is applied in furrow at the same time as planting through appropriate granular application machinery.

Apply Nemguard® DE granules if prior to cropping, soil samples reveal that damaging free-living nematodes have reached or exceeded known risk thresholds. Nematodes of particular importance are those from the sub-orders *Dorylaimina* and *Tylenchina*. If appropriate consult an expert for interpretation of nematode population data.

Best conditions for use

Soils should be considered damp enough to support crop establishment at the time of a Nemguard® DE application. Percolation of water down the soil horizon is required to disperse the active ingredient in the granules and loss of continuous hydraulic contact down the soil profile after application may adversely affect efficacy.

Nemguard® DE is not recommended for use in soils with a high silt content.

Apply beneath the soil surface in bands at the same time as drilling as near to the seed as possible.

Moisture will be required to activate the release of the active substance from the granules as efficacy of the product may be reduced in prolonged dry conditions. If conditions are dry at application, 20 mm of irrigation should be applied as soon as possible after application. If dry conditions persist, additional regular irrigation should be applied.

Ecospray

A specially formulated granule suitable for application to potato crops at planting

Nemguard® PCN Ideally suited to short term harvest crops such as first early or salad potatoes

Nemguard® PCN

Nemguard® PCN is granular non-systemic nematicide containing 45% garlic extract. Utilizing Ecospray's patented technology it has a stabilized and recognized DAS fingerprint. It is currently registered in the UK.

It is a different formulation from Nemguard® DE as it is required to behave differently in soils where it is broadcast incorporated into the ridge at planting rather than placed around the surface of drilled seed as in a carrot or parsnip crop at sowing.

Active Substance	450 g/kg of garlic extract
Formulation	Diatomaceous Earth (DE)
Crop	Potato
Target	Endoparasitic and Ectoparasitic of the following Genera: Globodera spp., Trichodorus spp., Longidorus spp., Pratylenchus spp., Meloidogyne spp., Tylenchus spp.
Application Rate	60 Kg/Ha (UK)
Harvest Interval	7 Days
MRL	None
CLP	Attention: Handle with care
Number of applications	1
Application timing	At time of planting
Application method	Calibrated granule applicator
Application equipment	Horstine 'Microband' applicator or similar

Nemguard® PCN (potatoes)

Potato growers use nematicides to protect both yield and quality as well as the land.

Availability of suitable land for growing the crop near to where it is being processed is often an issue. The ability to return to the same field in a 6 or 7 year rotation is key to profitable production.

Target Crop Sector

As Nemguard® PCN does not have an MRL (maximum residue level) and in practice has a zero harvest interval (7 days in the UK) it is ideally suited to short term harvest crops such as first early or salad potatoes where residue management may be a concern with some other conventional granular nematicides. Many of these crops are grown on light sandy mineral soils where irrigation is already in place meaning that both soil type and water availability are optimal to get the best out of the product.

Salad Potatoes

Salad crop types tend to be grown in fields where PCN populations are low to moderate. This reduces the burden on the nematicide to protect gross yield and any impact from PCN will tend to restrict tuber enlargements which in turn may produce a more favourable return due to the increased value of small tuber size grades in the salad crop type. It is a 'numbers game' where yield although important is not the only factor – tuber numbers of the right sizes are key to profitability. Growers are seeking at least 1 million marketable tubers/ha and higher.

Against this, it is important to protect tuber initiation and set, and early attack by PCN can often affect vigour, that in turn disturbs the initial tuber populations. In the situation where initial tuber set is low due to an attack by PCN, the tubers formed in this phase of the crop development may then divert nutrients to sustain their enlargement and produce a disproportionate population of larger tubers with a consequent lower sales value as the tubers may be unmarketable as salad potatoes.

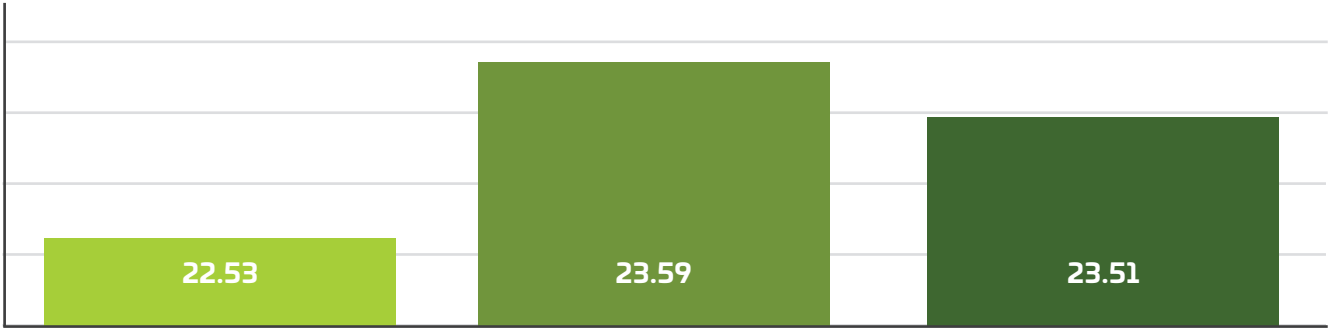
Granular nematicides in salad crops are therefore primarily used to ensure an even tuber set in the early stages of tuber initiation and at a population density that grows out to the most valuable size grades. The risk from low PCN initial populations is that this favours conversion of individuals from male to female to exploit low competition for feeding sites and once the initial impact of the nematicide has diminished to the point that emerging J2's can attack ab libitum, PCN populations (cysts and eggs) can increase very rapidly in the root mass of the crop. This has two effects:

- Net PCN reproduction as determined by Pf values can be very substantial from a low starting point. However, by the time the field is used to grow potatoes again (say in 7 years) population numbers will have declined to acceptable levels
- Final yield values across all the commercial size grades can be diminished, although these differences tend not to be significant due to the lower intensity of attack in the first 2-3 weeks of crop establishment

Trials over 5 years comparing to Standard Farm Practice (SFP), which was either oxamyl or ethoprophos, demonstrated that Nemguard® PCN is as good as SFP

Marketable Yield of salad potatoes

Mean Marketable Yields T/Ha 12 Trials 2014-18 Variety: M Peer



Commercial Trial 2017 – Salad potatoes Variety: Maris Peer

	Gross Yield T/Ha	Saleable Yield T/Ha	Mean Pi	Mean Pf/Pi	Saleable Tubers/ha
Nemguard® PCN	27.114	25.966	9.33	123.35	1,006,530
Ethoprophos	25.980	25.485	1.6	103.75	863,364

Nemguard® PCN

Ethoprophos

Getting the best out of Nemguard® PCN

Best Practice – ICM and IPM

It is more than just the use of a nematicide at planting. Effective PCN management requires:

1. Integrated crop management: Cultivation, Variety, Rotation
2. Integrated pest management: soil sampling to quantify the PCN population and use of an appropriate nematicide if necessary
3. Good agricultural practice: Adherence to the label recommendations

Soil

Apply to light, sandy mineral soils, it is not currently recommended for use on soils with a high silt content and clay soils

Moisture

Efficacy of the product may be reduced in prolonged dry conditions. If conditions are dry at application, 20 mm of irrigation should be applied as soon as possible after application. If dry conditions persist, additional regular irrigation should be applied.

Best conditions for Use

Soils should be considered damp enough to support crop establishment at the time of application. Percolation of water down the soil horizon is required to disperse the actives ingredient contained on the granules and loss of continuous hydraulic contact down the ridge after application of the product may adversely affect efficacy, especially if this event occurs at the time when PCN juveniles are migrating to the root zone to attack the root system.

Soil preparation

Soil must be properly prepared, preferably down to a depth of 25-30 cm. It must be free of clumps and non-decomposed plant material throughout the profile being treated. The structure of the soil must be fine and aerated. Cloddy soils and excess organic material in the soil can negatively affect the performance of Nemguard®.

Soil Type

Clay soils tend to restrict movement of all types of products. In fine-textured clay soils, pore spaces are much smaller than those in sandy or sandy loam soils. Small pores are likely to be blocked by excess moisture or compaction, making it more difficult for the polysulfides contained within the garlic extract to distribute evenly. Silty soils should also be avoided as they stop the effective movement of the polysulfides around the seed and early root system resulting in poor control.

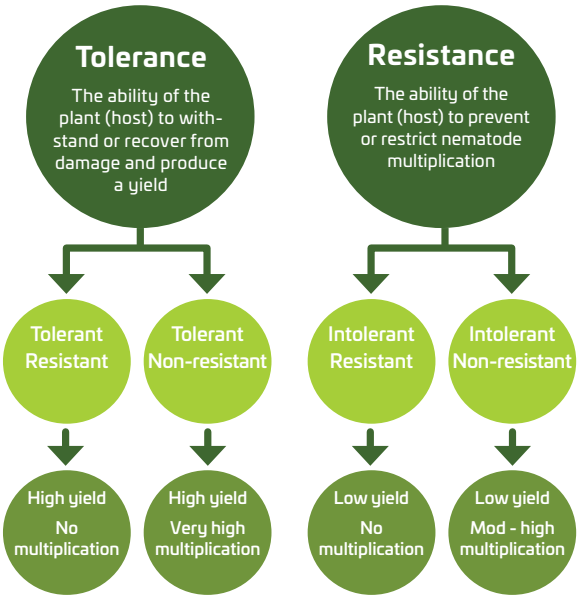
Light, sandy soils however, contain large pores that are less likely to be blocked by excess moisture or compaction.

Soil Temperature

Do not apply Nemguard® if the soil temperature is below 8°C at the depth of incorporation. The mobility and volatility of the various DAS compounds are related to temperature. If early root growth is impeded by environmental conditions (low temperatures and lack of moisture) then the stimulation of egg hatch will not occur at the most optimum time for control and overall performance can be impacted adversely.

Tolerant and resistant varieties

Growers should check with their seed supplier/breeder as to the relative tolerance of a chosen variety. If no information on the varietal tolerance to PCN is available growers should assume that the variety is intolerant.



Rotation

A field which is known to have high PCN/FLN populations is likely to cause reduced efficacy of any nematicide. Close rotations cause PCN populations to build very rapidly.
Soil sampling is crucial to identify the density of the population and so decide if the field should be used to grow potatoes and/or which varieties it is better to use.

Soil Sampling:

Unlike FLN which are ubiquitous in most soils and can be more easily found Potato Cyst Nematodes are never evenly distributed across a field, so some parts of the field may have higher than average numbers present resulting in 'hot spots'. This is as a result of PCN being imported into many countries relatively recently.

Consequently some areas of a field may have low counts, and the results shown refer only to the sample received in the laboratory. It is essential therefore to follow a recognised sampling procedure.

The whole field can be tested as one unit, or in a number and size of units into which fields will be sub-divided:

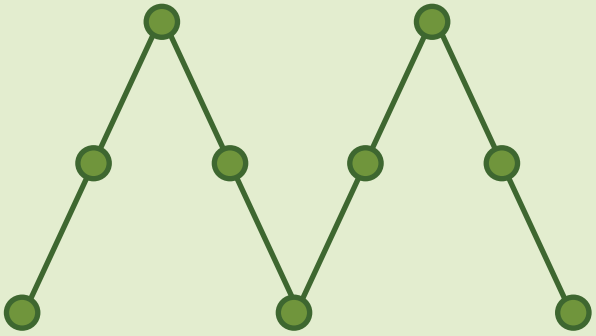
In general, sampled units should not be smaller than 4ha. Fields smaller than 4ha should not be divided. Sub-samples of soil should be taken using the T handled tool with a blade of half- tubular section at least 20 cm long.

A single sample unit should consist of 40 sub-samples (cores) taken from a uniform area.

The location of the 40 sub-samples must be selected systematically with an even distribution over the whole area. This can be achieved by following a 'W' shaped pattern - see figure 2 below. The sample unit must contain at least 500g of soil.

It should be noted that due to the varied distribution of cyst nematodes within the field and the inherent inaccuracy of soil sampling hot spots may still occur. There are more mechanised sampling systems available utilising GPS and mechanized samplers to enable even greater accuracy and traceability to be achieved.

*Figure 2 T Tube sampler and W sampling configuration



Sub-samples of soil should be taken using the T handled tool

The sample unit must contain at least 500g of soil

PCN Result Categories

Property / Behaviour	Sand
Nil Count	No cyst found in the sample analysed. Due to the nature of PCN distribution, an absence in the sample cannot guarantee that no PCN is present in the field
Low (1-10 eggs/g)	Low numbers of eggs found in the sample. PCN is present. Due to uneven distribution absence of PCN related problems cannot be guaranteed and so the use of a nematicide is recommended. The use of a resistant variety may limit the impact of a PCN attack
Moderate (11-60 eggs/g)	Moderate number of eggs found. There may be visible signs of PCN present and a loss of yield if cropped with potatoes next season. The use of nematicide is highly recommended along with a resistant variety
High (60+ eggs/g)	High numbers of eggs found. There is likely to be a severe yield loss. Consider growing on other ground.

Good agricultural practice

Application

Correct application is critical to success. Always comply with the label recommendations and it should be noted that application is at or immediately prior to sowing or planting.

Choice of application equipment will depend on local availability of appropriate equipment. In the UK Ecospray recommends either Horstine Farmery or Techneat applicators. Other territories may differ so consult your local distributor as to which system they recommend.

Whatever the equipment used to apply either Nemguard® DE or Nemguard® PCN always ensure that it is correctly calibrated to apply the recommended dose. Just because another granular product goes through the applicator on a given setting does not mean that it is an appropriate setting for Nemguard® as granular products differ from each other in terms of hardness, granule size range and specific weight. '

Nemguard® DE (carrots and parsnips)

Apply the granules in furrow at the same time as planting through appropriate granular application machinery.

Nemguard® PCN (potatoes)

Apply the granules during final seedbed preparation just before planting. Apply to the soil surface evenly and incorporate to the required depth (usually 10-15cm) immediately and ensure even distribution of the granules. Deeper incorporation may reduce efficacy. One pass with a powered rotary cultivator is preferred. Where incorporation is made with stone separating equipment, efficacy will be reduced and is not recommended

Microband Air is used for in furrow applications and can be mounted onto a wide range of planters

The system is conveniently mounted at the back of the planter to aid filling and calibration

Environmental Precautions

To safeguard the public, wildlife and pets, it is essential that all nematicide granules are well incorporated within the soil and none are left lying on the surface. Particular areas of risk are at the ends of rows when machinery is lifted, and at the point of hopper filling.

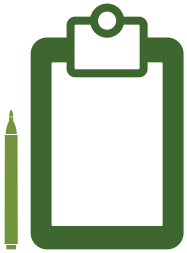
It is good practice to rotavate all headlands following planting to ensure that any granules that may be left on the surface are fully incorporated. All nematicides should be stored and transported in line with current codes of practice. Empty packaging must be collected and returned to safe storage ready for disposal on a daily basis.

Always fill hoppers with the nematicide in fields where they are being used. Transport of product in hoppers from field to field where the journey involves using the public highway is to be avoided, where possible.

Plan to fill the hoppers with the appropriate volume of product to treat the field. Ensure that all hoppers and hopper lids are secure. It's good practice to use a single site for filling hoppers in each field, one which can easily be checked for spillages. Small spillages should be buried so that no granules are left on the surface.

Stewardship Check List

- [ ] READ the label first: Even if you have used the product before, always read the label before using the product as requirements may have changed since you last used the product.
- [ ] Application equipment: Calibrate application equipment prior to use.
- [ ] Check applicator rotors regularly during application to ensure product is flowing freely.
- [ ] Aim to have applicators set up so that there is minimal distance between the applicator outlet and soil surface. AVOID granules being deflected by linkage arms or any other part of the equipment.
- [ ] ENSURE lids of hoppers are properly closed.
- [ ] MONITOR product application rate and adjust as necessary.
- [ ] Personal Equipment: BE AWARE of wind direction when filling applicator hoppers, to reduce the chance of inadvertent operator exposure.
- [ ] ALWAYS follow the requirements for Protective Personal Equipment (PPE), which are stated on the label.
- [ ] Always ensure tractor cab air filters are working properly, and check them regularly during planting.
- [ ] ALWAYS wear full PPE when cleaning down, and treat any dust as a pesticide.
- [ ] Cleaning and disposal: DO NOT attempt to clean any machinery which is contaminated by dust in farm yards, on roadways, or near open drains or ditches. Wash machinery after treatment in the field with water, so that contaminated water is collected in the field and will not contaminate surface water. Brush inside hoppers and rotor areas: avoid using water inside hopper/dispensing units.
- [ ] Application equipment cleaning procedure: ENSURE that no or only a minimal quantity of product remains in the hopper after field application. Upon completion, place suitable receptacles over the delivery tubes, crank the applicator, and collect the remaining granules. Comply with operator safety measures during these manipulations. The granules collected should be disposed of as pesticide chemical waste.



Ecospray Authorisations

New registrations are being added all the time. For an up to date list please visit: www.ecospray.com or contact the territory marketing company.

Product	Country	Primary Crops	Use	Status	Marketing Company
Nemguard® GR	Bulgaria	As Italy	Nematicide	Registered	CBC
Nemguard® GR	Cyprus	As Italy	Nematicide	Registered	CBC
Nemguard® GR	France	Carrot, Parsnip, Tomato, Sweet pepper, Aubergine Melon, Cucumber, Lettuce,	Nematicide	Registered	Certis FR
Nemguard® GR	Greece	Carrot	Nematicide	Registered	CBC
Nemguard® DE	IE	Bulb onion, Shallot, Garlic	Nematicide	Registered	Unichem
Nemguard® DE	IE	Fodder beet, Red Beet	Nematicide	Registered	Unichem
Nemguard® DE	IE	Carrot, Parsnips	Nematicide	Registered	Unichem
Nemguard® GR	Italy	Carrot	Nematicide	Registered	CBC
Nemguard® GR	Italy	Tomato, Pepper, Aubergine (F+G)	Nematicide	Registered	CBC
Nemguard® GR	Italy	Melon, Water melon (F+G)	Nematicide	Registered	CBC
Nemguard® GR	Italy	Lettuce (F+G)	Nematicide	Registered	CBC
Nemguard® °GR	Morocco	Tomato (F+G)	Nematicide	Registered	CBC
Nemguard® DE	Netherlands	Carrot, Parsnip	Nematicide	Registered	Certis NL
Nemguard® GR	Portugal	As Italy	Nematicide	Awaiting registration	CBC
Nemguard® GR	Senegal	Banana, Vegetables	Nematicide	Awaiting registration	Savana
Nemguard® GR	Spain	Carrot	Nematicide	Registered	CBC
Nemguard® GR	Spain	Tomato, Pepper, Aubergine (F+G)	Nematicide	Registered	CBC
Nemguard® GR	Spain	Melon, Water melon (F+G)	Nematicide	Registered	CBC
Nemguard® GR	Spain	Lettuce (F+G)	Nematicide	Registered	CBC
Nemguard® GR	Turkey	Tomato	Nematicide	Registered	Boyut
Nemguard® DE	UK	Carrot, Parsnips	Nematicide	Registered	Certis UK
Nemguard® DE	UK	Carrot, Parsnips	Fungicide	Registered	Certis UK
Nemguard® DE	UK	Fodder beet, Red Beet	Nematicide	Registered	Certis UK
Nemguard® DE	UK	Bulb onion, Shallot, Garlic	Nematicide	Registered	Certis UK
Nemguard® PCN GR	UK	Potatoes	Nematicide	Registered	Certis UK

Glossary

Endoparasitic nematodes:
Live and feed from within the plant host

Ectoparasitic nematodes:
Live and feed from outside the plant host

Stylet:
Specialised mouthpart that is used to pierce the surface of the plant

Cyst nematodes:
Eggs are contained within a hard case for protection until conditions are right for hatching

Free living nematodes:
Eggs are laid in the soil with no protective barrier

Abiotic factors:
Physical rather than biological factors

Biotic factors:
Biological rather than physical factors

Diallyl polysulfides:
Organosulphur molecules containing one or more sulphur atoms

Epidemiology:
The incidence, distribution, and other factors (including control) relating to a particular pest or pathogen

Pi:
Nematode population at the start (i = initial)

Pf:
Nematode population at the end (f = final)

Giant Cells:
Vascular cells that are stimulated by the nematode to turn into feeding cells so called because they are more than 100 times larger than surrounding cells

Galls:
Physical external evidence of RKN infection caused by root vascular cells proliferating as a result of Giant Cells forming in turn causing cortex cells to hypertrophy forming a root-knot structure known as a gall

Always check the label for the country/territory concerned before use and abide by any label restrictions.

Primary crops only are listed. In some countries/territories there are many additional minor uses approved. Check the label for details.

Nemguard® is approved in some countries for use in organic cropping systems. Check first with the relevant certification authority that it is approved.

Ecospray Limited
Park Farm Business Centre
Fornham St. Genevieve
Bury St. Edmunds
Suffolk
IP28 6TS

+44 (0)1603 561305

www.ecospray.com