

NEMATODES

A detailed microscopic photograph of soil. The soil is dark brown and crumbly. Several plant roots are visible, appearing as thin, light-colored lines. Numerous small, white, thread-like organisms, which are nematodes, are scattered throughout the soil. Some of these nematodes are attached to the roots. There are also several larger, pale, spherical structures, which are cysts, attached to the roots. The overall scene depicts a soil environment heavily infested with nematodes and cysts.

Fig 1: Cyst nematodes on roots (courtesy of CSL)

THE UNSEEN TERROR

Dr Ruth Mann and Sue Hockland look at nematodes and the damage they can cause

Nematodes (or eelworms) are non-segmented colourless microscopic worms, found in almost all environments worldwide. More than 18,000 species of nematode have been described. Every type of life form will have at least one nematode species that can feed on it. Most nematodes associated with soil are beneficial, feeding on fungi or microscopic life and thus helping to return nutrients to the soil. Others are predators or parasites of insects and their eggs. We may even use entomopathogenic species to try and control other pests in our turf, such as *Heterohabditis megidis*, which may control chafer grub infestations. However, there are 'terror' species that feed on our turf causing unseen problems until significant damage has been done.

Thousands of plant-parasitic nematode species exist but, fortunately, relatively few species parasitise turf grass. The species found on grass can have one of two appearances; long thin worms (such as stunt nematodes and root-lesion nematodes) or sac-like organisms (such as cyst nematodes (Fig 1) or root-knot nematodes). Plant-feeding nematodes feed with a stylet, which is a needle-like appendage used to pierce cells and inject enzymes that digest the cell contents. The resultant material is then sucked back into the nematode. They are obligate parasites, needing the host plant for multiplication but capable of limited movement away from the plant roots. They can either burrow into the plant (endoparasitic nematodes) or they may browse on roots and root hairs (ectoparasitic nematodes). Such feeding often results in lesions, nodules or galls being produced on the roots (Fig 2). Some species are also vectors of virus disease.

Nematodes can multiply quickly under ideal conditions. The life cycle can be as short as 17 days or as long

as 2-3 years, with often hundreds of eggs being produced. Each species has its own peak of activity during the year, with some species active at temperatures as low as 1°C. They survive adverse periods as eggs, juveniles, or in a dormant state.

Large nematode populations are associated with easily-draining sandy soils at field capacity (the same irrigation point as that preferred by grass), but nematodes will exist in all soil types and parasitise all of our grass species. However, we believe that the numbers are usually in equilibrium, with healthy turf being able to withstand a certain amount of attack. Symptoms of nematode damage tend to occur during periods of active plant growth, when infested areas appear as irregular patches of stunted growth, usually showing signs of nutrient deficiency. This is an indirect result of the nematodes destroying the amount of roots available for water and nutrient uptake. The turf may appear yellow due to an apparent lack of nitrogen, but when fertiliser is applied no effect is seen. The turf may become thin with individual plants dying prematurely. In a few cases greenkeepers have reported that the grass takes on the appearance of anthracnose symptoms without the black stem bases, as the leaves turn yellow through to orange/red.

Plants under stress for other reasons are also more susceptible to nematode attack; a slight moisture deficit may cause drought symptoms as the infested roots cannot absorb enough water, and hot weather, low height of cut and low fertility all exacerbate the problem. Greens and tees are not usually uniformly affected and 'hot spots' of nematode activity occur as a result of the patchy nature of their distribution. The edge of the symptom patch is diffuse compared to the rather sharp lines associated with

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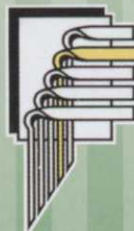


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NEMATODES

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Fig 2: Galls at the root tips of smooth stalked meadow grass caused by grass root-gall nematode (*Ditylenchus radicum*) (courtesy of CSL)

some fungal diseases, or inappropriate application of fertilisers / herbicides. Nematode activity may also be revealed for other reasons, for example, where tractor wheelings have consolidated the soil, preventing nematode activity and thus allowing better growth of grass (Fig 3).

We are noticing an increase in nematode problems on golf courses and sports turf in the UK and Ireland. It is possible that these have been overlooked in the past, or perhaps we are becoming more adept at recognising them, but increasing emphasis on the production of quality turf for professional use has heightened the need to investigate problems. Environmental conditions over the past few years (above average rainfall, cool springs and mild winters) have allowed a slow increase in nematode populations to occur and we are now seeing the resultant symptoms expressed. Perhaps some of the new grass varieties are more susceptible to nematode damage than was previously the case.

Nematode activity can lead to other problems. Nematode-induced damage to the grass root system allows other pathogens easier access.

For example, *Colletotrichum graminicola*, the pathogen that causes anthracnose, needs a senescent area of roots of the annual meadow grass plant for infection. The damaged areas left by nematodes may provide entry points for *C. graminicola* and the resultant anthracnose symptoms are a secondary infection which we see and treat without realising we have not discovered the original culprit.

Identification of nematodes is important but difficult due to the numerous different species found in the soil, most of which do not have a detrimental effect on turf grass growth. In fact some species encourage growth by helping to break down organic matter found in the soil thus releasing nutrients back to the plants. In cases where high numbers of nematodes have been observed in samples sent to STRI we have recommended that a test for nematodes is carried out. This can be done at the Central Science Laboratory (CSL) near York by the Invertebrate Identification Service. CSL is one of the few institutions in the UK that can identify nematodes to species level as part of a commercial service. If nematodes are suspected, the method

of taking samples is important, as any isolations, counting and identifications can only be as good as the sample provided. Samples should consist of at least 200g of turf and soil from the top 6 inches or so of the area showing symptoms. If plants are dead, then a sample from the edge of the affected area is also recommended. A further identical sample should be taken from a healthy area so that the numbers of nematode species can be compared. Stem or leaf nematodes (*Ditylenchus* or *Aphelenchoides* spp.) and cyst or root-knot nematodes (*Heterodera* or *Meloidogyne* species) concentrate in the turf itself, whilst many other pathogenic species are found at varying depths in the soil. The samples should be wrapped in damp newspaper or placed in a polythene bag which is then sealed. Each bag should be placed in another bag, together with an appropriate label and sent by overnight delivery.

Research

Some research is being carried out on nematodes in the UK but not specifically on the problems of nematodes in turfgrass. We need more data on the species causing problems so that environmentally sound control

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programmes can be devised and economic losses avoided. Thresholds for the number of nematodes that grass species can support before symptoms appear are available in the USA. However, it should be borne in mind that we need more evidence of the pathogenic importance of some nematode species in the UK. Thresholds for action have to be treated with caution; the effect of different species varies according to environmental conditions and on the tolerance or resistance of the host species. In addition, the total number and types of plant-parasitic nematodes present in turf may have more influence on growth and on the prevalence of disease than the presence of one particular pathogenic species. Associations between nematodes and other plant pathogens are also being investigated by CSL.

There are no chemical control measures available for turf in the UK, emphasising the need for management programmes. Frequent observations are important to introduce measures before the problem gets too serious. Infested turf should be treated as if it has a reduced root system, as the nematodes interfere with water and nutrient uptake due to their physical presence and the death of surrounding root tissue. Therefore, we need to reduce stress to the plants as much as possible. Ensure that the turf does not dry and the grass die from drought when, with a normal root system, it would not have

been affected. Fertilisers also need to be applied frequently and in smaller doses to allow the grass to take up available nutrients, but prevent the loss of excess nutrients that the grass plant cannot absorb. Mowing height should be increased to reduce the stress to the plants.

Various biological control agents, including plant extracts, are being investigated for the control of nematodes worldwide. Some work in the USA has shown that seaweed extract can significantly reduce the infection of roots of tomato plants by juvenile *Meloidogyne incognita* and *M. javanica*. This reduction was shown to be caused by certain chemicals in the extract called betaines. Although the effect of extract will vary with nematode species, it is possible that seaweed extract may help improve grass recovery by reducing further attack by the nematodes. There is also interest in nematode trapping fungi that 'catch' nematodes and eat them, other parasitic fungi and bacteria, and the use of predatory and parasitic nematodes, but research is required to establish whether these types of biological control could be adapted for easy application and effectively control nematodes that parasitise turf.

We also clearly need more research to determine the extent to which nematodes parasitise our turf. We must determine the efficacy of possible control measures on each nematode species individually to be able to devise effective control measures for mixed

populations. The interaction of other nematode species and external environmental conditions may affect control and so efficacy needs to be established in the field. It is possible that grass species vary in their susceptibility to the different nematode species. Therefore, we need to establish any grass species that can withstand higher populations of nematodes. These could then be oversown on areas with known nematode problems.

So! If your turf struggles to recover after winter or seems to always be 'off-colour' without any definite reason, or doesn't seem to respond to your loving care, it may be that parasitic nematodes are the problem and a more detailed look at the roots and soil may be required. However, until further research is done, new turf should always be tested routinely to ensure it is not infested with known pathogenic species and you should develop a management programme just in case.

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Fig 3: Patchy appearance of a ryegrass ley attacked by stubby-root nematodes (*Trichodorus* spp.). Better growth is visible in the consolidated tractor wheelings (courtesy of CSL)

