PLANT AND SOIL NEMATODES

DEVELOPMENT OF NON-CHEMICAL CONTROLS FOR PLANT-PARASITIC NEMATODES ON TURFGRASS: RESEARCH REQUIREMENTS

Plant-parasitic nematodes sometimes cause problems on turfgrass (Fact sheet PSN 020), but chemical nematicides are currently the only control option available to turf practitioners in Australia (Fact sheet PSN 021). More sustainable control methods are badly needed and this fact sheet outlines the research required to develop a more active and diverse soil biological community that is capable of suppressing populations of key nematode pests.

Ecosystem services provided by soil organisms

Over the last two decades, scientists in many countries have undertaken research aimed at understanding the key factors that sustain the health of agricultural soils. As a result of that work, we now recognise that healthy soils contain a diverse range of organisms (Fig. 1) that benefit plants, the soil, and the environment in many ways.

- Transform plant residues into organic materials that improve soil structure, increase water infiltration, and improve drainage
- Provide plants with water and nutrients and minimise losses of nutrients to the environment
- Protect plants from damage caused by pests and pathogens
- Reduce soil erosion, degrade pesticides and other pollutants, and mitigate against climate change by sequestering carbon

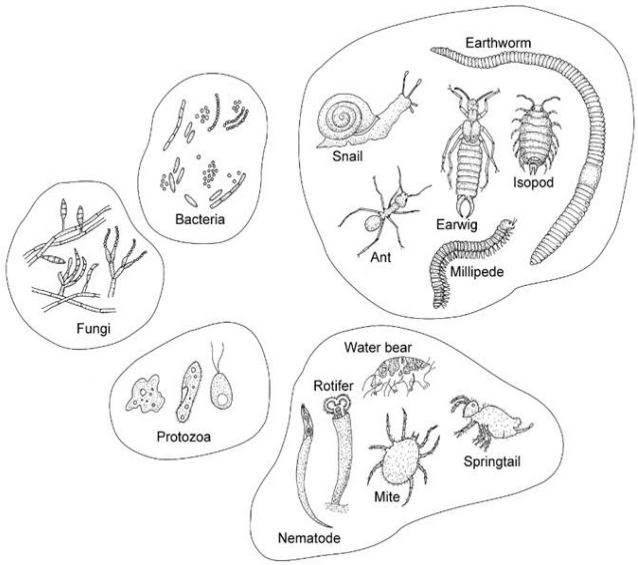

Fig. 1. A pictorial view of some of the organism found in a healthy soil (grouped according to their size)

The findings listed above have largely been ignored by the turf industry, particularly the components where the turf is intensively managed (e.g. golf courses, bowling greens and major sports stadiums). In such situations, fertilisers and pesticides are regularly applied and this will almost certainly be having a detrimental effect on the soil biological community. The biology of turfgrass soils is rarely assessed but many soils will be in poor condition, particularly those that are managed intensively. The management practices typically used to grow turfgrass favour some organisms and are detrimental to others, and so turfgrass soils tend to be dominated by bacteria and will have lost some of the fungi, microarthropods, and other organisms that provide the ecosystem services listed above.

Improving the biological health of turfgrass soils

As many turfgrass soils are in poor condition from a biological perspective, research is required to improve the situation. There are many issues that warrant attention, but an initial research program would have the following objectives.

- Develop methods of assessing the biological status of turfgrass soils
- Assess the impact of fertilisers and pesticides on the biology of intensively managed turfgrass soils
- Determine whether plant health can be maintained by relying on the nutrient cycling capacities of the soil biota rather than regular inputs of nutrients from fertilisers

If a project aimed at improving soil biological health was undertaken, some of the resources should be directed towards determining whether arbuscular mycorrhizal fungi (often referred to as AM fungi) play a role in improving soil and plant health in turfgrass systems. Detailed information on these fungi can be found in Fact sheet PSN 009, but they warrant attention because scientists have shown that AM fungi benefit plants and soil in the following ways.

- Enhance the uptake of phosphorus and other nutrients
- Increase water uptake and improve drought tolerance
- Improve soil structure
- Improve a plant's resistance to soilborne pathogens

The University of Minnesota is undertaking research on AM fungi in turfgrasses and a similar program in Australia could aim to answer the following questions

- What species of AM fungi occur on turfgrasses in Australia?
- As phosphate fertilisers are detrimental to AM fungi, have these fungi disappeared from situations where the grass is heavily fertilised (e.g. golf and bowling greens)?
- In situations where AM fungi have declined, is it possible to reinstate them by reducing phosphate inputs or applying products that contain these fungi?
- Are nematodes and soilborne pathogens causing problems on turfgrasses because their roots are no longer colonised by AM fungi?

Organic amendments to improve soil health and reduce the damage caused by plant-parasitic nematodes

Composts, manures, organic wastes, and a range of organic products are used on many crops to provide nutrient inputs, promote root growth, and improve soil health. They are also known to reduce nematode damage, either by producing toxic decomposition products or stimulating the activity of natural enemies.

From a nematode management perspective, recent observations in Western Australia by Ken Johnston and Peter Ruscoe (Sports Turf Technology) showed that compost reduced the damage caused by southern sting nematode (Fig 2.). This suggests that follow-on research should be undertaken to determine which amendments provide the best nematode control, what application rates are needed to substantially reduce the nematode population, and what is the longevity of the effects obtained. As many organic products and biostimulants are now being marketed in Australia, some of these products should be included in such a research program.

Fig 2. Response when kikuyu was planted on a 5 cm layer of compost at a site infested with *Ibipora lolii*

Naturally occurring biocontrol agents and bionematicides for control of plant-parasitic nematodes

Healthy soils have a huge range of organisms that parasitise or prey on nematodes (e.g. nematophagous fungi, predatory nematodes, predatory microarthropods, tardigrades and *Pasteuria*), but their biocontrol activity has never been assessed in turfgrass soils. Consequently, research is required to answer the following questions.

- What natural enemies of nematodes occur on turfgrass in Australia, and are they playing a role in reducing populations of key nematode pests?
- Do fertiliser or pesticide inputs limit the capacity of naturally occurring biocontrol agents to regulate nematode populations?

Endospores of *Pasteuria*, a bacterial parasite of nematodes, have been observed on several nematode pests of turfgrass, including the most damaging nematode, *Ibipora lolii*. We know that this parasite can increase to levels capable of reducing populations of some plant-parasitic nematodes, but research is required to determine how widespread it is on turfgrass in Australia, what nematodes are parasitised, why it occurs at high levels in some locations and not others, and whether it reaches levels capable of providing reasonable levels of nematode control.

A range of bacterial and fungal bionematicides are now available in the marketplace and species in the bacterial genus *Bacillus* are constituents of some of these products. Overseas evidence indicates that a product containing *Bacillus firmus* provides some protection against nematode damage on turfgrass, which suggests that similar products should be tested in Australia.

The role of turf practitioners

It is most unlikely that a comprehensive research program such as the one outlined above will ever be undertaken in Australia. Consequently, turf practitioners will need to be innovative and do their own research. The following are examples of the type of work that could be done if a manager is prepared to modify management practices or set up field trials and observe the results.

- Reduce the use of inorganic fertilisers, particularly nitrogen, and determine whether the turf remains healthy when fertilised with combinations of organic materials such as compost, worm castings, humic and fulvic acids, and products derived from seaweed or kelp.
- Check whether the biopesticides available in the marketplace can replace the fungicides, insecticides and miticides currently in use, and assess their efficacy.
- Assess organic amendments, organic products, and bionematicides at a site where plant-parasitic nematodes are causing problems, and check whether they reduce nematode populations or improve plant health.

A turfgrass manager who would like to move away from chemical nematicides and control plant-parasitic nematodes in a more sustainable way may be surprised by the type of research that was suggested above. However, it is important to recognise that the ultimate aim of the work is to modify the soil biological community in ways that improve soil health, enhance the plant's capacity to cope with damage caused by plant-parasitic nematodes, and increase the activity and diversity of organisms that parasitise or prey on nematodes. As high inputs of inorganic nutrients and the regular use of chemical pesticides are detrimental to the organisms that regulate nematode populations, they are the first management practices that require attention.

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