Can nematodes indicate the health of the soil?

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Soil nematodes

Nematodes are the most abundant multicellular animals on earth. They are found everywhere, as parasites in animals and plants, or as free living organisms feeding on microbes in water and soil. Research has primarily concentrated on plant parasitic nematodes as these are the nematodes which cause damage to plants and, reduce the yields of crops. Of particular importance to bananas is the "burrowing nematode" (*Radopholus similis*) which produces large reddish-black lesions in the roots of bananas reducing production, quality of fruit and sometimes cause banana plants to topple.

A relatively new part of nematology research involves studying all the nematodes in the soil; the nematodes that feed on plants as well as free living nematodes which feed on fungi, bacteria and even on other nematodes. Changes in the soil will affect the food that the different groups of nematodes feed on and then affect the abundance of the different types of nematodes. In each nematode food group there are nematodes that respond quickly to changes and nematodes which are slow to adapt to changes. By looking at the whole nematode ecology and diversity in the soil it is possible to get an idea of the health of the soil, something like a blood test when you are feeling sick.

Comparing plant growing systems

At a recent nematode ecology workshop held at the Centre for Wet Tropics Agriculture, Dr Gregor Yeates, compared two banana growing soils with different management practices. One soil was taken from a farm which has low inputs, retains banana trash around the base of the plants (labelled sustainable

bananas), while the other was much more intensively managed with higher levels of fertfliser and trash placed in the interrow between bananas (labelled intensive bananas). The soil from the banana farms were compared with soil taken from a nearby rain forest, a bowling green and around trees on the beach foreshore.

The plant growing system with the most abundant nematodes was the intensively managed banana system. This had over 9 million nematodes per square metre. The second most abundant system with nematodes was the bowling green with over 5 million nematodes per square metre. It appears that the more intensively managed the plant system the more abundant the soil nematodes. The sustainable banana system had the least number of nematodes with just under 2 million nematodes per square metre (Figure 1).

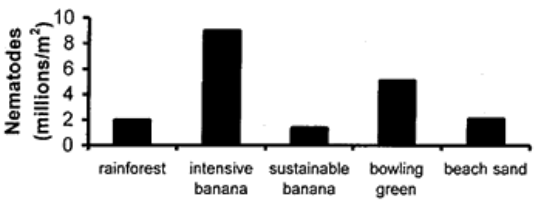

Figure 1. Abundance of nematodes in soil of five different plant growing systems.

While, the number of nematodes gives some indication of how many nematodes are present in the soil, it is the proportion of the different feeding types of nematodes that gives a better indication of the sustainability of the different plant growing systems (Table 1).

Table 1. Proportion of nematode feeding types found in five different plant systems.

Plant system	Proportion of nematodes in each feeding group (%)					
	Bacterial feeding	Fungal feeding	Predatory	Plant feeding	Plant associated	Omnivores
Rainforest	2	18	0	13	51	16
Intensive banana	2	0	0	93	4	1
Sustainable banana	26	1	2	56	1	14
Bowling green	20	5	10	51	10	4
Beach sand	19	14	3	25	9	30

In the systems where plants were grown as a monoculture, bananas and the bowling green, over half of the nematodes found in the soil feed on plant roots. However, in the intensive banana system 93% of the nematodes are feeding on

roots as parasites of plants. this leaves only 7% of the nematodes to feed on microbes in the soil.

Compare this to the rainforest soil where 87% of the nematodes feed on microbes. It is the nematodes which feed on microbes that help to recycle nutrients making them available for plants to reuse. It has been suggested that half of the soil nitrogen made available to plants is recycled through nematodes, with a low proportion of free living nematodes in the intensively managed banana soil there is very little nutrient recycling.

Plants rely on fertilisers for their nutrients and losses of nutrients from the soil are more likely. The more sustainable growing system has a lower proportion of plant feeding nematodes with more nutrient recycling occurring.

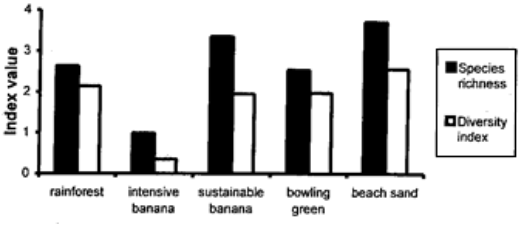

Figure 2. Diversity of nematodes in the soil in five plant growing systems

The diversity index and species richness can be used to give an indication of the nematode types that are present in the soil (Figure 2). The lower the index value the less diversity it the soil which suggests a more disrupted plant growing system relying on inputs to keep the plant system working. Again the intensively managed banana growing system had the lowest nematode diversity, due to the high proportion of plant feeding nematodes. The sustainable banana system and the bowling green had nematode diversity similar to the two natural ecosystems.

What does it all mean?

It is difficult to derive any firm conclusions from these results as the use of nematodes as indicators of soil management practices needs to be more thoroughly investigated.

However, it appears:

1. The more intensively managed the plant growing system the more nematodes present in the soil.
2. Where ever plants are grown in a monoculture there is a greater proportion of nematodes feeding on the roots of the plants.
3. In an intensively managed banana cropping system there is less recycling of nutrients than the more sustainable cropping system.

By altering soil management practices it may be possible to increase the amount of nutrient recycling and increasing the diversity of nematodes. This may lead to a decrease in the inputs applied to the soil and an increase in suppression of diseases in the soil, due to increased interactions occurring between microorganisms. The management practices that reduce the need for farming inputs must be identified due to increasing pressures to maintain the clean

environment in north Queensland.

Proportions of nematode feeding types in five plant systems