Importance of SOIL MICROBE COMMUNITY COMPOSITION

The Soil Health Project - Central conducted a range of soil, sugarcane biomass and root system comparative testing between sites having a long-term (>10 years) history of different management practices.

The measurements taken aimed to determine how different practices may influence soil health. This included the following soil microbiology assays:

- **MICROBIAL BIOMASS**
  Indicates the size of the microbial community present, but not the composition of the community, which is important
- **GLUCOSAMINIDASE ACTIVITY**
  Glucosaminidase is responsible for catalysing three soil enzyme reactions which result in nitrogen (N) mineralisation in the soil, turning soil sources of N into a form that sugarcane can use. These sources may be the result of previous season N fertiliser applications that have become held up in the soil
- **GLUCOSIDASE ACTIVITY**
  Glucosidase is an enzyme involved in the C cycle, more specifically it breaks down cellobiose in glucose. It is highly sensitive to changes in soil C levels. It is used as an indicator of organic C levels
- **PACHYMETRA ROOT ROT**
  A fungus-like organism known as an oomycete which attacks the large primary roots of the sugarcane plant. Reduces yield and may lead to stool tipping which can result in gappy ratoons and increased soil in the cane supplied to the mill
- **NEMATODE CHANNEL RATIO**
  A high ratio indicates a higher population of bacterivores compared to fungivores. Bacterivores breakdown readily available sources of carbon (C) which is mostly respired as CO_2 and not retained in the soil. In comparison, a high proportion of C broken down by fungivores is retained in the soil and contributes to improved soil health
- **FREE LIVING AND PLANT PARASITIC NEMATODES**
  Free living nematodes (FLN) are beneficial, feeding on bacteria, fungi and other soil organisms and do not attack living plant roots. High diversity and populations of FLNs, relative to plant-parasitic nematodes, is a sign of a healthy soil. Plant parasitic nematodes (PPN) attack the roots of living plants, including sugarcane. Whilst there are many species of PPN, the two most important sugarcane pests are root knot nematode *(Meloidogyne spp.)* and root lesion nematode *(Pratylenchus zeae)*.

The results indicated growers who adopted the following practices not only have more soil microbiology present, but a better balance of communities within species:

- apply soil ameliorants such as mill mud and lime
- reduce number and aggressive types of tillage
- have permanent cane beds
- incorporate wider row spacing to facilitate controlled traffic farming
- incorporate legume break crops.

Balance within communities is important as they give a representation of the health of the soil and can assist in measuring the impact of certain management decisions, such as tillage.

Two sites in the Central region, consisting of the same soil type, variety, and crop class, but different farm management practices, are used to demonstrate how sampling results need to be interpreted holistically and in combination with recent management practices.

At quick glance, results provided in Table 1 indicate the total FLN population on site one is substantially higher (1551), compared to site two (162).

Site one also has a considerably lower PPN population (30%) than site two (80%).

It would be easy to assume from this information that site one had a 'healthier' soil. However, this is not necessarily the case. The fungal:bacterial ratio indicates that bacterivores are dominating the composition of the FLN population rather than fungivores. Bacterivores dominate and multiply quickly when readily available organic residue is present. This often occurs after soil disturbance or when large amounts of organic matter are incorporated into the soil (e.g., following break crops or applying mill mud). Certain FLN then feed on these. A few days before sampling occurred at site one, the ratoons were cultivated to control weeds. This disturbance in the soil is the likely cause in spike of FLN and dominance of bacterivores.

Incorporation of organic matter (e.g., weeds, cane tops and trash) during the tillage event may also be one of the factors leading to elevated glucosaminidase levels and populations in FLN, resulting in a reduction PPN percentage.

Pachymetra spore counts at both sites were below the damage threshold of 50,000 spores in ratoons, indicating both growers have followed a good variety rotation program.

Site two has a more balanced fungal:bacteria ratio (0.63), compared to site one (0.83), due to the presence of more fungivores. Fungivores have multiple roles in the soil, such as assisting in soil carbon sequestration, predation on parasitic nematodes and aggregation of soil particles.

Table 1: Comparison of microbiology between a paired site of the Central region

	SITE 1	SITE 2
NEMATODES		
Root lesion nematodes (Pratalenchus)	373	632
Root knot nematodes (Meloidogyne)	0	0
Total nematodes	2211	812
Total Plant Parasitic Nematodes (PPN)	660	650
Total Free-living Nematodes (FLN)	1551	162
% Parasitic Nematodes	30	80
Channel Ratio (Fungivore/Bacterivore)	0.83	0.63
PACHYMETRA		
Pachymetra (spores/kg soil)	1093	2094

Fungivores are particularly sensitive to tillage as they take time to rebuild their hyphal networks. The grower at site two has adopted a minimum tillage system and grows break crops over the fallow which may assist in building and maintaining the fungivore population.

Bacterivores and fungivores both play very important roles in the soil but need to be well-balanced to realise soil health benefits. It is common for sugarcane soils to have more bacterivores than fungivores due to monoculture cropping and high, sometimes aggressive, tillage practices. Ways to assist in rebalancing soil biology include:

- breaking the sugarcane monoculture with legumes and other break crops during the fallow period
- reducing compaction through increasing row spacing and/or implementing controlled traffic
- ensuring neutral soil pH (7), to provide a favourable environment for soil biology
- reducing the amount of tillage and limiting aggressive tillage practices (e.g., rotary hoe).

USEFUL RESOURCES

The impact of long-term practices on soil health (PDF)

The impact of fallow management on soil biology (PDF)

Soil Biology Sample Collection (Video)

Soil Biology - Testing (Video)

MORE INFORMATION

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