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MicroLife
Research Centre

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The MicroLife Research Centre is Agri Technovation's newly established, privately-owned laboratory based in Wellington, in the Western Cape.

Soil Health services that were previously available exclusively to research and a few academic institutions, will now also be made accessible to the commercial sector. These services, which will include various soil microbial assays, statistical analyses on obtained results, and the compiling of easy-tounderstand reports, will be conducted by a well-trained and experienced research team, consisting of a senior researcher with more than 15 years' experience in soil microbiology in agriculture and his trained assistants.

As curators of our soils, it is our obligation to care for the only non-renewable natural resource that keeps nations alive.

Soil Microbiology

Background

Active and diverse soil microbial communities play vital roles in nutrient cycling, soil aggregation, maintenance of disease resistance, and various other essential processes that contribute to soil resilience and resistance, consequently supporting ecosystem stability. Soil microbiology research provides several indicators to determine soil structure, fertility and health. The resulting changes in biological status can be used as early indicators of deteriorating/improving soil health. Informed decisions regarding management practices could consequently be incorporated to improve cost-effective and environmentally-friendly sustainable crop production.

Methods

- Soil microbial diversity
  - EcoPro
- Soil microbial activity
  - DebriDeg
  - AlkPac
  - AcPac
  - UrAc
- Active Carbon
- Soil Organic Carbon

Details

Soil microbial diversity

This assay studies the changes in soil microbial community diversity and functioning as a result of changes in agricultural management practices such as soil disturbance, cropping systems, residue management, application of biological and/or chemical products etc.

Soil microbial activity

These assays provide insight into the maintenance of critical soil functions performed by soil microbial communities in response to changes in the soil environment. The assays provide an indication of the potential of soil microbial communities to release C, P and N from organically bound compounds, into the soil/root environment to be taken up by plant roots. Soil microbial activities are very sensitive to changes in agricultural practices such as soil disturbance, cropping systems, residue management, etc. This is an ideal indicator to evaluate soil fertility and to describe the functioning of an ecosystem.

Active Carbon

This assay acts as an indicator of the fraction of soil organic matter that is readily available as a carbon and energy source for soil microbial communities. Research has shown active carbon to be a good "leading indicator" of soils' responses to changes in crop and soil management. Active carbon responds much sooner to management practices, than total organic matter. Monitoring changes in active carbon can be particularly useful to farmers who are changing practices in an effort to build up soil organic matter.

Soil Organic Carbon

Soil organic carbon is the main component of soil organic matter. Decomposing plant and animal residues, root exudates, etc. release organic carbon into the soil. The organic carbon is mineralised by soil microorganisms and converted into inorganic carbon that can easily be taken up by plant roots. Organic carbon also serves as an energy source for soil microorganisms, consequently changing the type and function of microorganisms present in the soil ecosystem. Benefits of soils with high organic carbon content include increased fertility and productivity, water retention and purification, and resilience to impacts of climate change.

Long-term monitoring and consistent analyses of changes in the diversity and activity of soil microorganisms by the MicroLife Research Centre, will provide an interesting insight into the below-ground impact that various agricultural practices might have on the health status of any given soil.

Soil microbial diversity

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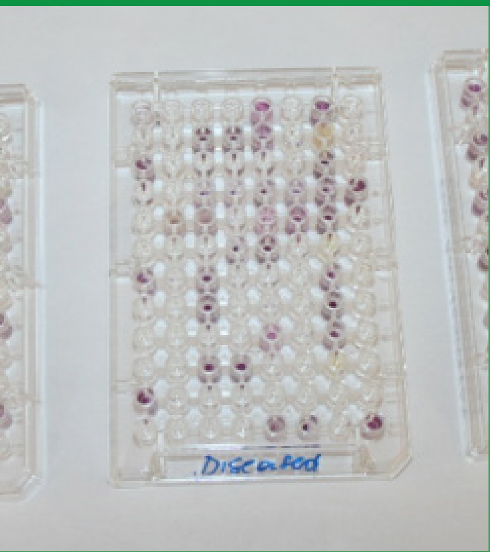


Background

Our farmers are increasingly realising the vital role that soil life plays in agriculture. Soil life consists of thousands of different nematodes, fungi, yeasts, and billions of bacteria. Considering that 50,000 bacteria can fit on a pinhead, it is easy to comprehend that a teaspoon of healthy soil might contain between 100 million and 1 billion bacteria, with approximately 25,000 different types of bacteria on the same teaspoon! Beneficial and harmful organisms are finely balanced in a healthy soil with its high microbial diversity. With this sensitive balance maintained, plant-pathogens are suppressed and vital soil processes are optimally executed. This attribute is highly beneficial, especially when external forces disrupt soil processes performed by specific species. These vital processes can immediately be re-initiated and maintained by other individual or groups of species, thus strengthening the soil's resilience (the ability to bounce back when faced with stress/pressure) and resistance (the ability to withstand stress/pressure) to disruptive forces. Due to the sensitivity of soil microorganisms to changes in the soil environment, they can be used as "early warning systems" to determine the deterioration or improvement of soil health. Soil microbiology research monitors and evaluates these changes in microbial diversity to determine a soil's resilience and stability. These analyses could be implemented by farmers to monitor the impact of agricultural practices on their soil microbiology, soil health and yield. Informed management practice decisions could consequently be incorporated to improve cost-effective and environmentally-friendly sustainable crop production.

Details

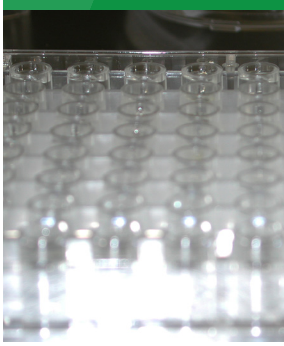
One approach to monitor the diversity and evaluate the functions performed by soil microorganisms, would be to profile the specific food sources they utilise. The utilisation of various food sources will give a characteristic reaction pattern, called a metabolic fingerprint, which represents the collective functional ability of the soil microbial community. Changes in soil microbial community diversity and functioning are studied to determine the influence of agricultural management practices such as soil disturbance, cropping systems, residue management, application of chemical and/or biological products, etc. Land management can consequently be improved to eventually provide healthy soils for sustainable agriculture. It is highly recommended that soil microbial analyses be conducted at least twice per season over a period of 3-5 years.

Data generated from the first sampling will serve as baseline data for all future data comparisons. To attain a reflection on the impact of different agricultural rehabilitation techniques on microbial diversity as an indicator of soil fertility and health, it is highly recommended that trends in microbial diversity be monitored over an extended period of time.

Turnaround time for services is approx. 1 month.

Method

Soil microbial functional assays



Soil sampling protocol

The following will be needed for soil sampling for microbial analyses:

- A clean soil auger/spade
- Clean water
- 70% ethanol (if available)
- Clear, clean plastic/ziplock bags
- Labels & marker pens

The goal of the soil sampling, e.g. assessment of management practices, identification or troubleshooting constraints in a problem area, or comparisons between different areas on the same land, etc. will determine the sampling times during a growth season which, in turn, will determine the number of samples to be collected. To determine changes in microbial communities under annual crops throughout a season, it is recommended that soil samples be collected shortly before planting, during the vegetative period, few weeks after flowering and finally very shortly before/after harvesting. The number of soil samples to be collected should be determined by the areas within a field with differences in yield, crop growth, management practices, soil type, etc. These samples could be split to enable comparisons, or a representative number of soil samples could be collected from similar areas under investigation, and combined to a bulk soil sample. For perennial crops/orchards, a soil sample from an orchard must not represent an area of more than 5 ha. Collected soil samples should be representative of an orchard or land as described by its soil type, management practice, crop growth, etc. Samples should be collected within a soil type or at the same cultivar – different soil types and cultivars should be sampled separately.

Identify at least 5 specific locations, within the plot/field that need to be analysed, that are most representative of the plot/field/treatment. Irregular areas in a plot/field/treatment should be avoided, unless samples are specifically collected from a problem area to identify problems/limitations. Before collecting a soil sample from a plot/field/treatment, wash the soil auger/spade with clean water, then spray the auger/spade with 70% ethanol (if available), and let dry.

1a. **Before actual soil sample collection:** In the corner of the plot/field/treatment, remove surface debris and take 2 fake soil samples to "clean" the soil auger/spade before the actual sampling. These samples will not be analysed.

1b. **During actual soil sample collection:** Remove any surface debris, and use the cleaned soil auger/spade to collect soil samples as close as possible to the root zone at a depth of 15-20cm for crops and up to 45cm for perennials, depending on the root depth and size.

2. When sampling WITHIN a plot/field/treatment, there is no need to clean the auger after each sampling. As soon as samples have to be collected in a section of the plot/field/treatment with a change in soil type or chemistry, or in a NEW plot/field/treatment, the auger/spade needs to be cleaned again.
3. Place the collected soil samples in a clearly marked plastic bag. The weight of a composite soil sample to be analysed should be approximately 750g.
4. Keep the collected soil samples away from direct sunlight, and cool in a coolbox.
5. Please plan soil sampling carefully. It is recommended that soil samples be collected on Monday to Wednesday in order to have the freshly collected soil samples delivered to the Agri Technovation labs as soon as possible. If soil samples are collected on Thursday or Friday, the soil samples should be stored and kept cool in a coldroom or a fridge at approx 6-8°C, before couriering to Agri Technovation on Monday morning. Please DO NOT freeze or dry the soil samples.
6. The clearly marked soil sample bags should be placed in a suitable container together with ice packs/cooler blocks, and couriered to Agri Technovation in the shortest possible time.

Please reconsider

- **It might not be worth all the trouble (and money) to send extremely wet/muddy soils for analyses, since the microbial populations would have changed significantly. Rather wait for the soil to drain properly before collecting and sending the soil samples.**
- **Be careful not to take soil samples directly after herbicide/pesticide application – rather collect soil samples approx. 2 weeks after application.**

We were appointed as curators of our soils. Let's act accordingly, because when our soils collapse, it will take all living beings with it. No soil, no agriculture, no producers, no life.

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Soil microbial activity

Background

The main aim of soil microorganisms is to, directly or indirectly, cycle nutrients in the soil. Organic matter decomposition in soil systems is facilitated by the activities of different enzymes produced by soil microorganisms. Microbial activity in relation to the cycling of carbon, nitrogen or phosphorus in soil, has been used to evaluate soil fertility and ecosystem functioning. This provides an indication of soil microbial communities' potential to release C, P and N from organically bound compounds, to be taken up by plant roots. Changes in soil microbial activity are considered biological indicators and "early warning systems" of ecosystem stress, soil degradation and fertility. Due to the sensitivity of microbial activities to changes in soil properties and agricultural practices such as soil disturbance, cropping systems, residue management, etc., informed management practice decisions could be incorporated to improve cost-effective and environmentally-friendly sustainable crop production.

Methods

1. **DebriDeg**
   This assay is a useful indicator of soil quality due to the important role it plays in the biodegradation of plant debris in order to release carbon in the soil ecosystem. The rate of biodegradation depends agricultural management practices as well as the C:N ratio of plant debris. In healthy soils, a higher diversity of microbial populations will contribute to faster and more efficient degradation of a higher variety of plant debris, thus enhancing nutrient cycling in the soil environment.
2. **AlkPac**
   Variable amounts of this enzyme is present in agricultural soils, depending on the microbial diversity, activity, and management practices. Due to the sensitivity of this assay to high pH, this assay is derived solely from the activity of soil microorganisms and plays a critical role in the P cycle and soil fertility. Microbial activities are responsible for the solubilisation of various kinds of rock phosphate and conversion of inorganic and organic phosphates from decomposing organic material into available forms that are readily available in the soil and plant system as a nutrient source. Increased microbial diversity through farming practices, conducive to healthy soils, will contribute to higher microbial activity and P availability.
3. **AcPac**
   This assay is classified based on its sensitivity for its optimal performance in low pH soil. This assay is based on a substance excreted by soil microorganisms and plant roots in cases of phosphorous deficiency to increase availability of phosphate in soils surrounding the root zone.
4. **UrAc**
   This assay is an important indicator of nitrogen mineralisation as performed by bacteria, yeasts, fungi, and algae playing a vital role in the regulation of N supply to plants, especially after urea fertilisation. Nitrogen mineralisation is affected by soil microbial diversity, organic matter content and factors such as the rate of urea input, soil moisture, pH, temperature, locality, and type of soil. The addition of urea to soil activates UrAc to convert urea to NH_4, whereafter other groups of soil microorganisms, responsible for the conversion of NH_4 to NO_2 and NO_3, are stimulated. Consequently, a higher UrAc might stimulate a more diverse microbial population to mineralise N at a faster rate. This will contribute to more efficient use of N-fertilisers with a less negative environmental impact.

Data generated from the first sampling will serve as baseline data for all future data comparisons. To monitor the impact of different agricultural rehabilitation techniques on microbial activity as an indicator of soil fertility and health, it is highly recommended that trends in microbial activity be monitored over an extended period of time.

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