Can biomineral fertilisers improve soil carbon sequestration?

Soil carbon sequestration is very quickly becoming a key focus of agriculture, both for the productivity benefits of increased soil carbon levels and in many cases the opportunity to generate and sell Australian Carbon Credit Units (ACCU's). Strategies and operational practices which are required to increase soil carbon include:

- growing more biomass
- maintaining ground cover
- increasing longevity of living roots in the soil through perennials
- reducing tillage.

These practices are largely proven through long term research and evidence based outcomes of commercial practices. However, there is a need to quantify through independent research whether certain products (as opposed to practices) can aid in sequestering carbon in conjunction with the current best practices. Biomineral fertilisers with a microbe coating, an alternative to synthetic fertilisers, are promoted as having the ability to increase soil carbon at a rate beyond that of conventional fertilisers.

What is a biomineral fertiliser?

A biomineral fertiliser is a mineral based fertiliser which consists of a combination of fine mineral ores, such as micas, alkali feldspars, soft rock phosphate, dolomite, basalt, granite and crystalline silica, that are blended with various sulphates (ammonium, potassium, manganese, copper and zinc).

This mineral component is then blended further with a suite of microbes including various bacteria and fungi, along with a macrocote polymer. The microbe blend applied to the biomineral fertiliser is reported to carry out a wide range of biological activities within the soil such as:

- nutrient fixation and mobilisation
- production of plant growth hormones
- decomposition of organic matter
- promotion of beneficial soil micro-organisms.

This results in an overall soil conditioning effect through the improvement of soil structure and increase in soil carbon and nutrient availability.

Project overview and objectives

Pedaga Investments, a producer and ag research organisation, and Meat & Livestock Australia have developed a project to examine the ability of biomineral fertilisers to sequester soil carbon in pasture systems in the south western region of WA. This project will run for three years, through to 2025.

This project aims to determine the ability of Troforte Cropping Plus, a type of biomineral fertiliser with a microbe coating, to increase soil carbon sequestration in comparison to synthetic fertilisers. Productivity and profitability of the two fertiliser regimes will also be assessed as it is critical these outcomes can be at least maintained.

It will be explored through an integrated R&D producer demonstration site model and is relevant to all livestock producers currently implementing a fertiliser regime. Of particular relevance are livestock producers in the high rainfall south western region of WA.

The trials will be completed in conjunction with best practice operational strategies including:

- maintaining ground cover
- reduced tillage
- incorporation of perennials
- time controlled grazing.

Reducing carbon emissions

It is proposed that biomineral fertilisers will reduce carbon emission through two pathways:

1. By increasing the formation of permanent humus compounds and through an increase in the soil organic matter stability. Consequently, the contribution of the organic matter fractions that are more resistant to decomposition are crucial for increasing soil carbon sequestration.

   This is achieved by:

   - Microbes in biomineral fertiliser colonise roots and drain more carbon to the rhizosphere soil to increase soil carbon pool.
   - Biomineral fertiliser increases root biomass which are the sources of carbon locked up in the soil over time.
2. Biomineral fertilisers will improve soil biological fertility and subsequently plant nutrition. Carbon emissions from livestock will be reduced by increasing nutrient density of pastures and subsequently, increasing weight gain efficiency of livestock. Possible anti-methanogenic impacts will also be assessed.

Project progress

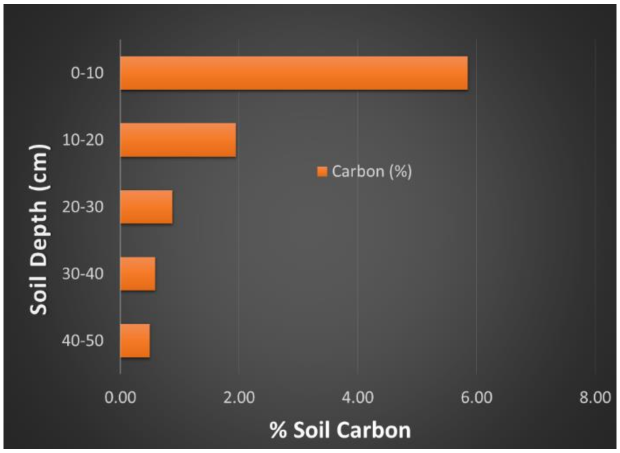
The project commenced in February 2022 with the baseline soil samples taken in April 2022. The image below shows the typical soil type on the main trial site in Bridgetown which is a duplex sand over clay. The site is under surface irrigation and has been growing a kikuyu, ryegrass and clover pasture mix for the past 40 years. There are two trials and three demonstrations within the overall project.

Soil core sample to 500mm at main trial site in Bridgetown

Each soil core was divided into five sections (0–10 cm, 10–20 cm, 20–30 cm, 30–40 cm and 40–50 cm) for testing, to better understand the dynamics of soil health, fertility and carbon/organic matter through the soil profile.

As seen in Figure 1 the majority of the soil carbon at the main trial site is held within the top 10cm and then it progressively declines down to depth.

Figure 1: Soil carbon % throughout the profile to 50cm at the main trial site



This is as expected as the site has been using synthetic fertilisers for at least 40 years. The readily available nutrients applied, result in the plants roots only needing to grow in the top section of the soil and not work deeper into the profile.

Typical dryland growing conditions within the region are from May through to October. Soil microbes are active during the wet growing season and become dormant during the summer dry seasons, limiting the potential rate of soil carbon sequestration.

By holding the main trial site on an irrigated pasture, the project will have the ability to essentially speed up the process or impact of biomineral fertilisers on soil carbon sequestration. There will be green pasture and live roots within the soil for the duration of the trial (36 months). This should enable the soil microbes and fertiliser to colonise roots and drain more carbon to the rhizosphere and increase the overall root biomass, in particular the root biomass at depth.

Three dryland demonstration sites are being carried out in conjunction with the main trial site to validate the irrigated results under dryland conditions. This will assist producers to understand the impact of these alternative type fertilisers on their own operations. The three dryland demonstration sites are being held at Bridgetown, Benger and Witchcliffe which are all in the south western region of WA.

Acknowledgement

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