

As many livestock producers across Australia and New Zealand are reporting excellent results with the use of TM Ag on their pastures in terms of animal health and weight gain, as well as several independent trials indicating an increase in both dry matter and pasture quality, we decided to put together this document which may explain in plain English the reasons for the afore mentioned outcomes.

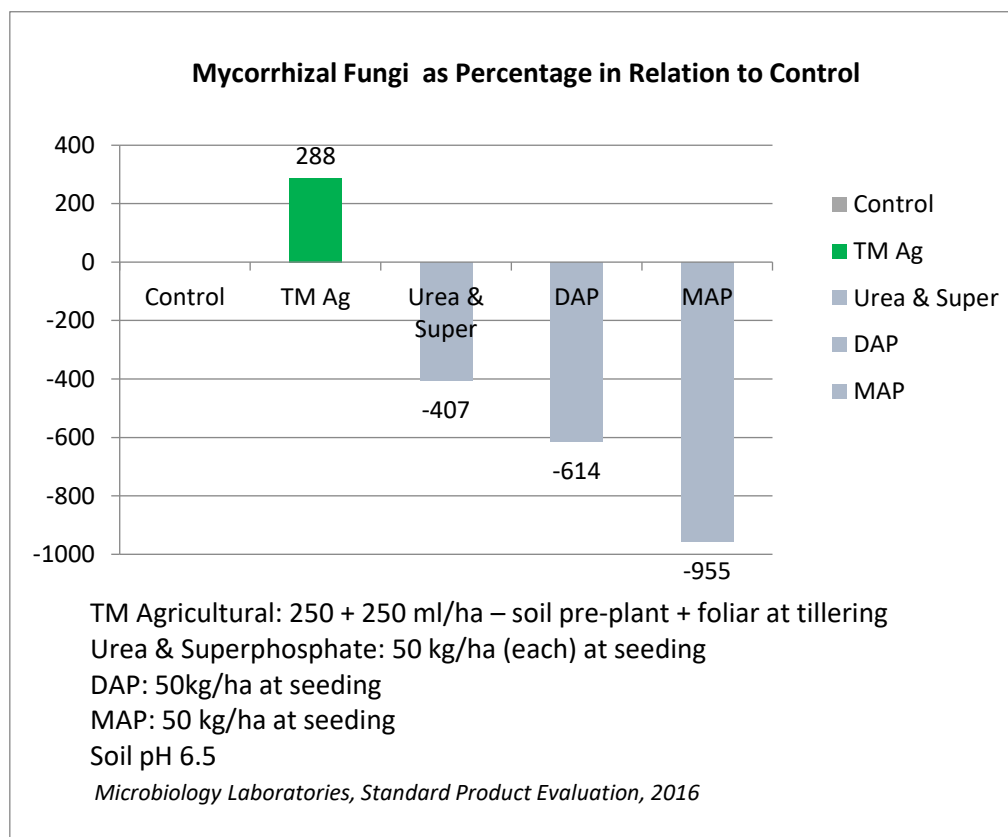


Attached is a slightly shortened and modified article originally published in the *Beef Producer* (<http://www.beefproducer.com/soil-health/fungus-keeps-giving>).

The graph below shows the summarised results from an independent Standard Product Evaluation Trial conducted by Microbiology Laboratories. Drs Ash Martin, Maria Manjarrez Martinez and staff go to great lengths to make sure that everything is done properly under standardised, controlled conditions. All treatments are replicated four times to help statistical validity. Together, this means scientifically valid results.

The negative effects of the commonly used acid/salt fertilisers, often written about in scientific papers and demonstrated here, should also be of some concern.

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Mycorrhizal fungi is the secret to healthy soil and regenerative agriculture, and you can have more of it.

Beef and fungi go together long before they can be steak and mushrooms on a plate.

If truth be told, efficient beef production is utterly dependent on an organism known as arbuscular mycorrhizal fungi (AMF) because 90% or more of all forage plants can't really survive, and certainly cannot thrive, without this curious symbiotic organism. **Put simply, your grass needs fungus.**

This relationship is well worth understanding because it can be managed and improved, thereby improving soil health, animal health, and the overall productivity of a livestock producer wise enough to make those improvements.

"AMF are so important to the life of plants that a portion of most plants' genome is dedicated to monitoring and controlling the symbiosis of AMF," says Wendy Taheri, one of only a few authorities in the world on arbuscular mycorrhizal fungi.

The AMF can scavenge micronutrients from the soil which would otherwise be unavailable to the plants. It can help transfer water to the plants.

It can produce protective compounds against pests. It has the ability to share nutrients among plants and across species. It also produces soil structure by way of byproducts called glomalin.

In turn, the plants produce sugars by way of photosynthesis; this is the carbon-based currency they trade to the AMF for their magic potions in this intimate marriage.

Vital trading

The plant-AMF relationship is an extremely active one, usually with multiple species of AMF colonizing each individual plant. Taheri explains the plants can choose where to spend their carbon dollars and will trade more actively with arbuscules which are feeding them well, and cut back food from the arbuscules which are not. The arbuscules are the attachment points for the AMF, and are actually inside plant root systems.

In fact, Taheri says, "Arbuscules are ephemeral structures. They are formed, and when the hyphae they are attached to use up all the nutrients within reach, the arbuscule is dissolved. As new hyphae find new pockets of nutrients, new arbuscules are formed, and again dissolved when their usefulness ends. The symbiosis is dynamic!"

This relationship is beneficial to both organisms, a situation known as symbiosis, with the participants termed symbiots by scientists. The plants need the AMF, and the AMF cannot survive without the plants.

Extenders of everything

AMF are fungi, as are the organisms which produce mushrooms, but AMF are non-fruiting. They are an organism which produces miles and miles of underground hyphae cells. It's their version of roots, and they are so small you need a microscope to see them. AMF reproduce by way of spores released into the soil. Taheri likens spores with plant seeds. These are in fact the method by which Taheri and other AMF experts identify and count AMF species and content of soils.

One of the reasons AMF are so valuable is because **they effectively add 10 to 100 times the surface area to the root system of plants, and possibly more.** Taheri explains on average, AMF probably supply around 50% of a plant's nutrients, and likely more in natural ecosystems like native grasslands, forest and savannahs. They can double water availability.

Additionally, the plants themselves directly trade sugars for nutrients with soil microbes which colonize their roots, but as we've noted, the AMF dramatically increase the total area which can make these and other trades. Soil microbes colonize the entire structure of roots and the AMF, and their entire life cycle adds nutrients to the life cycles of the plants and AMF. This compounds the special abilities of the AMF at gathering materials such as phosphorus, which are largely unavailable to plants and their comparatively meager root systems.

Starting early

They begin to attach to a plant in the seedling stage, with a colonization technique so intimate it's at the cellular level. The fungi form a structure called an arbuscle inside the plant cells and then begin to trade signals with the plants as to desires and needs.

If you manage to improve AMF, everything else will come along with them, Taheri says.

Four big fungi payoffs

Ultimately, there are more reasons than we can list here to learn how to improve conditions for arbuscular mycorrhizal fungi in your pastures or farmland. However, from Wendy Taheri's list of 16 benefits, here are four that should be plainly obvious to beef producers.

1. Increased yield -- A meta-study (a review of 300 other studies) showed a 23% yield increase across all studies, including greenhouse culture. It can be less, but it can be 200% or more.

2. Free phosphorus -- Generally phosphorus is scarce in nature, because of too many forms and too many of them bound up, and yet it is absolutely critical. It is so critical, in fact, that plants actually base much of their "decision" about how much carbohydrate to pay to AMF based mostly on the flow of phosphorus.

3. Drought tolerance -- These fungi are so small you need a microscope to see them, so many people wonder how they could they provide much water and drought tolerance. But researchers have shown dramatically greater water uptake and usage through AMF hyphae than plant root systems alone.

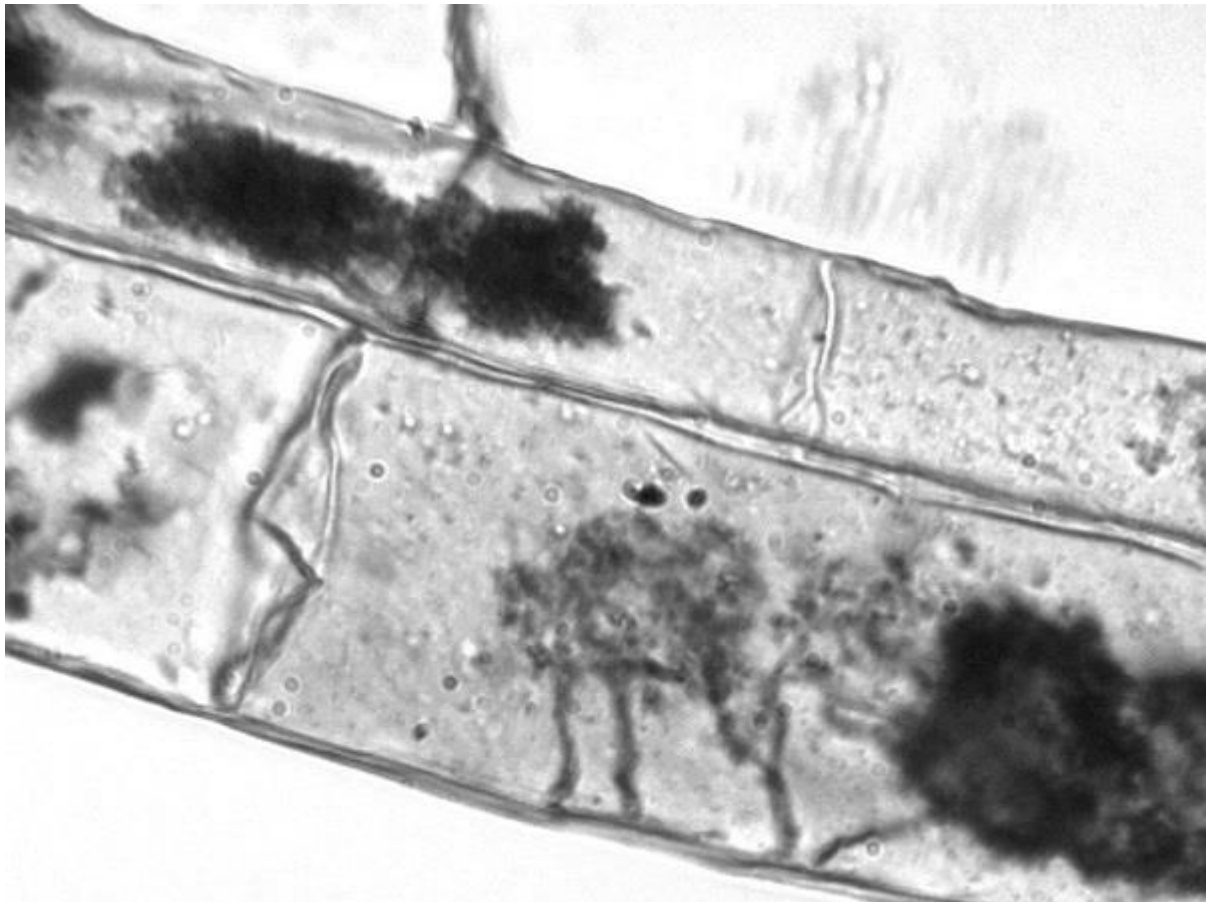
4. Biocontrol -- AMF protect plants from a wide variety of diseases, such as root rot, stem rot, anthracnose, verticillium, fusarium and many more. Taheri says there are 75,000 known plant pathogens in the soil, which is less than 1% of all the known soil organisms, so a healthy soil will have many more "predators" or benefactors than pests. Also, the interconnected nature of the AMF with their host plants lets them warn other plants of invasions, giving them opportunity to mount defences ahead of the problem.

Why is it called arbuscular?

Arbuscules are the attachment point for arbuscular mycorrhizal fungi, formed only inside the cells of plant roots. They are not found outside the plant.

Hyphae, which are long fungal filaments with a branching structure similar to roots, will grow out from the roots, becoming an extension of the plants' root systems. The arbuscules themselves are an organ of the fungus.

Inside the root cells, the plant forms a membrane that surrounds the arbuscule and this becomes the interface between plant and fungus through which nutrients and other chemicals are exchanged between plant and fungi.



This microscopic picture of corn roots shows how arbuscular mycorrhizal fungi actually attach inside the cells of plant roots to share nutrients.