Update

August 2009

Western Mineral Fertilisers

LEADERS IN BIOLOGY AND MINERAL FERTILISERS

Research & Results Driven Innovation

"*Mineral*" vs "*Acid Soluble*" Fertilisers:

(*Microbe Controlled-Release vs Chemical* Fertilisers)

The term "Mineral" fertiliser (sometimes called "Silicate based Mineral", "Biological Mineral", "Biologically-friendly Mineral", "Mineral RICH" or "Mineral EN-RICHED" fertiliser) is used *to differentiate from* **"artificial High Analysis" fertilisers** (which include "acid", "acidified", "soluble", "chemical", "synthetic", "conventional", "NPK", "macro-nutrient" or "inorganic" fertiliser).

Mineral fertilisers basically consist of a combination of fine mineral ores in their "natural state" (such as micas, alkali feldspars, soft rock phosphate, potassium silicate etc), which are rich in silica and can contain up to 65 essential multi-nutrients (P, K, Mg, Ca, Si, Trace Elements etc). These nutritionally important minerals can become bio-available through *microbial activity* on the "natural" ores by certain beneficial microbes. For example, Mycorrhizal fungi are highly efficient at solubilizing and extracting minerals from the ores, and exchange some of these nutrients with host plants, thereby forming a mutually beneficial symbiosis.

Acid soluble fertilisers are chemically treated to make the nutrients *soluble* in water, and tend to have a higher Salt Index. For example, rock phosphate is predominantly calcium phosphate $Ca(PO4)_2$ (which *is not sufficiently water-soluble* to be used as a "conventional" fertiliser). The addition of Sulphuric acid converts rock phosphate into a *water-soluble* "superphosphate" form - calcium dihydrogen phosphate $Ca(H_2PO_4)_2 + CaSO_4$. Similarly, rock phosphate can be reacted with orthophosphoric acid to produce water soluble "triple superphosphate" (P_2O_5 no S).

… **Hence - the term *"Acid fertiliser"*.**

Acid fertilisers rely on direct contact with the plant root system for uptake and because of their losses due to mobility, volatility and tie-up, higher analysis amounts are required to meet the plant requirements. On the other hand, the ***"Mineral fertilisers" are not treated with acid*** and therefore have a more neutral to alkaline pH (approx pH 7-8.5), generally with a lower Salt Index. Salt index (**SI**) is a measure of the salt concentration that fertiliser induces in the soil solution. When applied near the seed, fertilisers with lower **SI** values generally cause fewer problems in seed germination or seedling injury.

WMF consciously selects alkaline inputs to buffer the acid affects of the chemical fertilisers as well as various environmental constraints (such as low soil pH and Aluminium), subsequently they can be blended with acid fertilisers to produce a more neutral product *(for more details see our 'What is a Fertiliser' Tech sheet on the web site> wmf1.com)*.

WMF FERTILISERS

Visit us at DOWERIN and NEWDEGATE

Meet with our Technical staff, on hand to discuss:

- Latest Microbe & Soil Nutrition Technology
- Our Mineral / Biological Programs
  - Ideal for Cropping and Grazing
- Our Beneficial Microbe Seed Dressings
- Excellent on-Farm and Research Trial Results

Visit Our New Web Site
>> www.wmf1.com

WESTERN MINERAL FERTILISERS
Head Office Tenterden WA Ph: (08)-9851-7222 *Fax (08)-9851-7293*

Biological Farming is about Harnessing Beneficial Microbes

Gingin Lettuce grower examines the large and healthy roots systems of young lettuces on a Mineral / Microbe crop

Lettuce biomass (above and below ground) one week after planting out

Microbes are an Integral part of the Mineral Program

Biological farming methods present a viable way of producing high quality, nutritious produce and shifting to sustainable and less chemical dependent practices. It focuses on improving the beneficial microbiology as a way of increasing plant growth and harvest yield & quality.

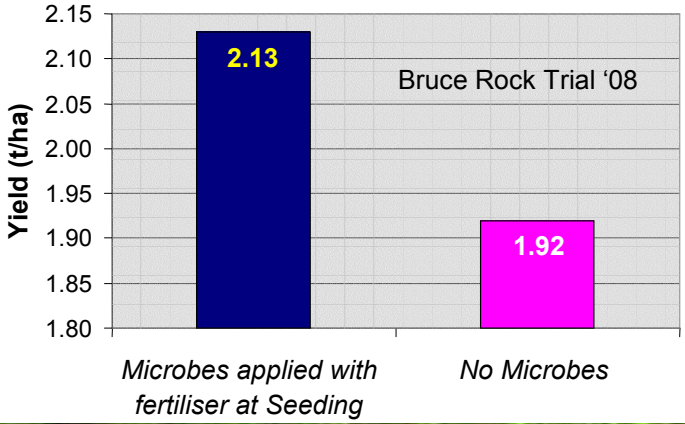
WMF microbe blends are a combination of beneficial soil microbes (that colonize plant root zones) and specially selected VAM Mycorrhizal fungi (that grow as minute hyphal filaments that attach to and penetrate the roots of most plants). The thin filaments absorb water and nutrients from mineral ores and the soil and deliver them to the plant – a bio-fertiliser role. In return the plant provides essential sugars and other nutrients to the fungus. VAM also produce compounds that stimulate the plant to produce additional roots on which the fungi can grow – thereby helping to increase the plants below ground biomass.

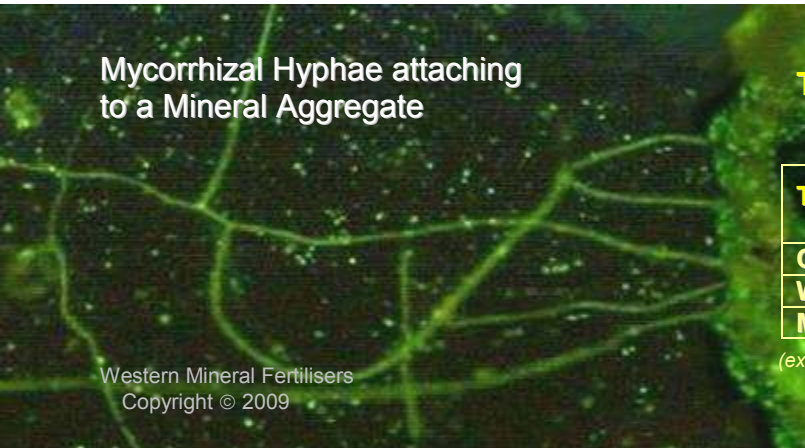
VAM also produce a glycoprotein called **Glomalin** – which stores high amounts of Carbon (30% to 40%). This Glomalin penetrates through organic matter, binding it to sand, silt and clay particles - forming clumps of soil aggregates. These add structure and tilth to soil, and can keep other stored soil carbon from escaping.

Seed coating with beneficial microbes is an efficient and cost effective way of precisely inoculating the root zone of plants (where these 'beneficials' are needed the most) - at the point where the seed germinates in the ground. This ensures that the beneficial bacteria, fungi and mycorrhiza are readily accessible to the root particularly at critical "early germination" stages, facilitating early, healthy and rapid development, and improved uptake of plant nutrients.

Seed inoculation of crops with WMF beneficial microbes has increased yields of WMF programs on average by 9.8%. For example in the Living Farms 2008 Bruce Rock trial (*see full trial report on WMF's website*), WMF microbes increased a 1.92 t/ha wheat crop by 210kg/ha (up 10.9%) = "statistically not significant" but worth **an increase of $68.25/ha** (based on APW2 @ $325/t).

Fig 1: Effect of Microbes on Wheat Yield (*Arrino* @ 70kg/ha)
Treatment 100kg/ha NPK Crop Plus *and* 30l/ha Liq-N Foliar





Mycorrhizal Hyphae attaching to a Mineral Aggregate

Table A: Growth, Mycorrhizal Colonization & shoot P uptake in Clover

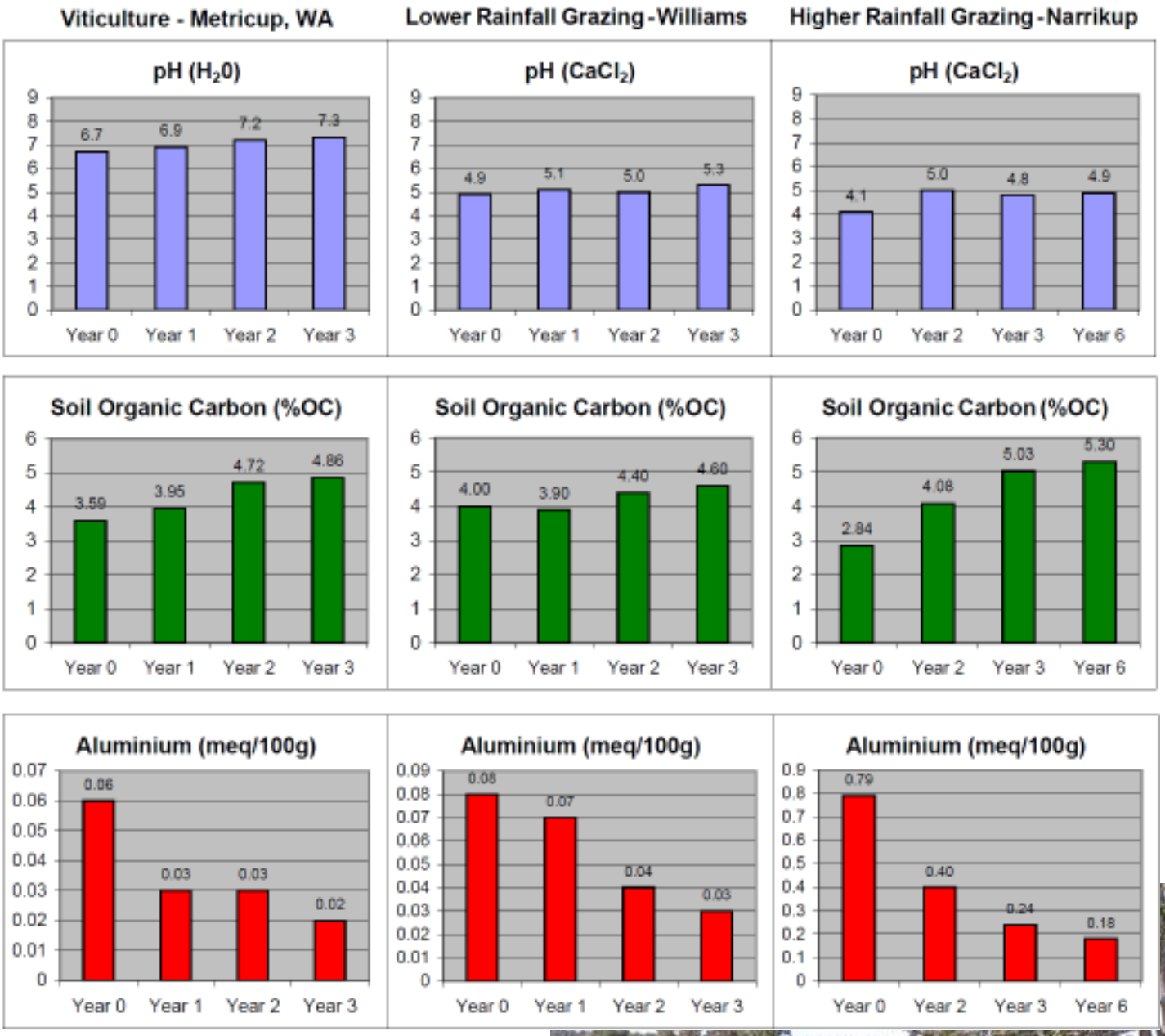
Treatment	Mycorrhizal colonization	Root Dwt (mg/plant)	Shoot P conc (%)	Shoot P (µg/plant)
Control	5.8%	57.2	0.21	70.5
WMF	17.5%	114.8	0.29	157.9
MAP	7.1%	73.7	0.19	63.3

(extracted from Solaiman et al 2008 – for complete data set & details see WMF website)
Rates WMF @100kg/ha + microbes, MAP @ 30kg/ha

BIOLOGICAL FARMING = CARBON FARMING

- Mineral / Microbe Programs & their effect on %OC & Aluminium

Fig 2: The Long Term Effect of Minerals + Microbes on Soil parameters:

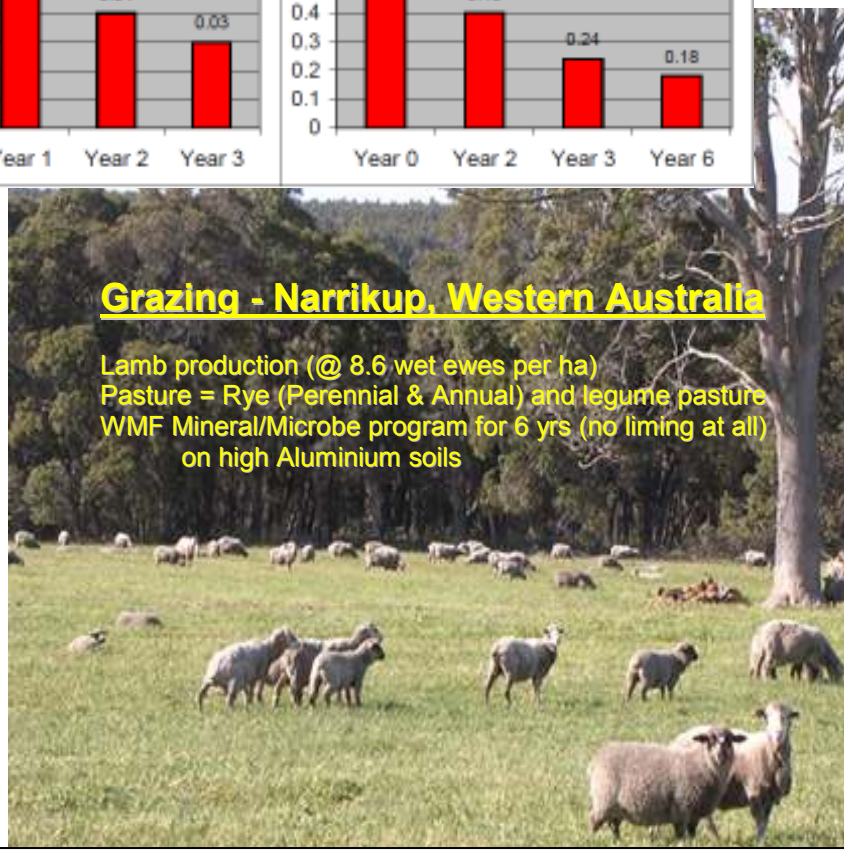


Minerals & Microbes - beneficial to soil health:

It is now becoming widely recognised that Soil health is of fundamental importance to prosperity and sustainability across agriculture. **A key ingredient for soil health is organic Carbon, its sequestration and its management.** Most conventional farming practices burn up the pool of Carbon in the soil. Biological farming techniques not only are building more productive and sustainable farms, but WMF Mineral + Microbe programs have shown that soil Carbon *can be increased* in the same paddocks over a number of years, particularly by increasing the below ground root and microbial biomass. Strong evidence is now emerging that the addition of Biochar may further enhance this process.

Results of WMF Mineral Microbe Carbon Farming:

- Increase in soil fertility, pasture & harvest quality.
- %'age increases in soil Organic Carbon observed in a few years.
- Decrease in Aluminium levels.
- Noted improvement in animal health…



BIOLOGICAL FARMING = CARBON FARMING

- Mineral / Microbe Programs and Root : Shoot Biomass Ratios

Below ground (Root + Microbial) Biomass vs Shoots (above ground biomass)

The two dominant modes of plant biomass partitioning are between root and shoot. In conventional farming systems, the root biomass is poorly understood and is all but ignored (mainly because the roots are out of sight and aren't encouraged to grow). In Biological farming, the opposite is the case. Beneficial soil microbes tend to stimulate root development and growth, along with the bio-availability of minerals and trace elements (e.g. Zinc promotes the cell growth needed for increasing root development).

Numerous independent trials have demonstrated that significantly larger root systems grow on WMF mineral/microbe programs compared to those grown on conventional/district practice. As a typical example (**see Fig 3**), in a 2008 Ferti-Tech/WMF trial at Tincurrin (see website for full trial details) the WMF treatments had significantly higher Root : Shoot ratios (ie much larger roots) than the conventional (MAP + liq N) program - *hence increased %OC*.

Tissue tests collected during the season generally tended to show no significant differences in Total Nitrogen levels. The highest Nitrogen values were seen in WMF mineral+microbes where no extra N was applied, and conventional MAP program *PLUS 30L/ha Liq-N* (injected).

Despite the lower analysis of the WMF mineral program (P = 9%, applied 0.72) compared to the conventional Practice fertiliser (P = 14%, applied 0.91), **Phosphorus tissue levels were significantly higher** (0.35%) in WMF compared to (0.20%) in the conventional. **Similar tissue data was seen in the majority of the essential minerals & trace elements.**

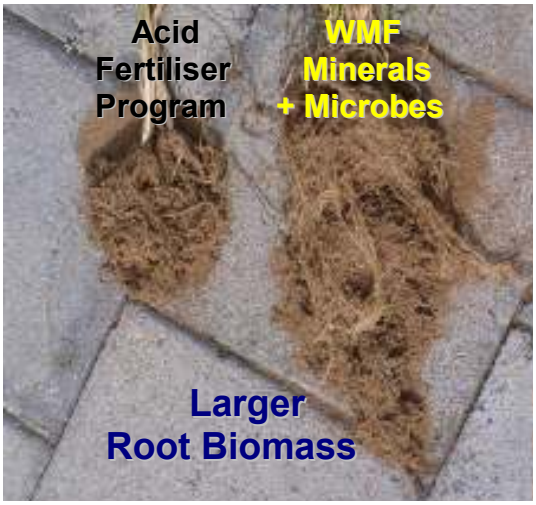
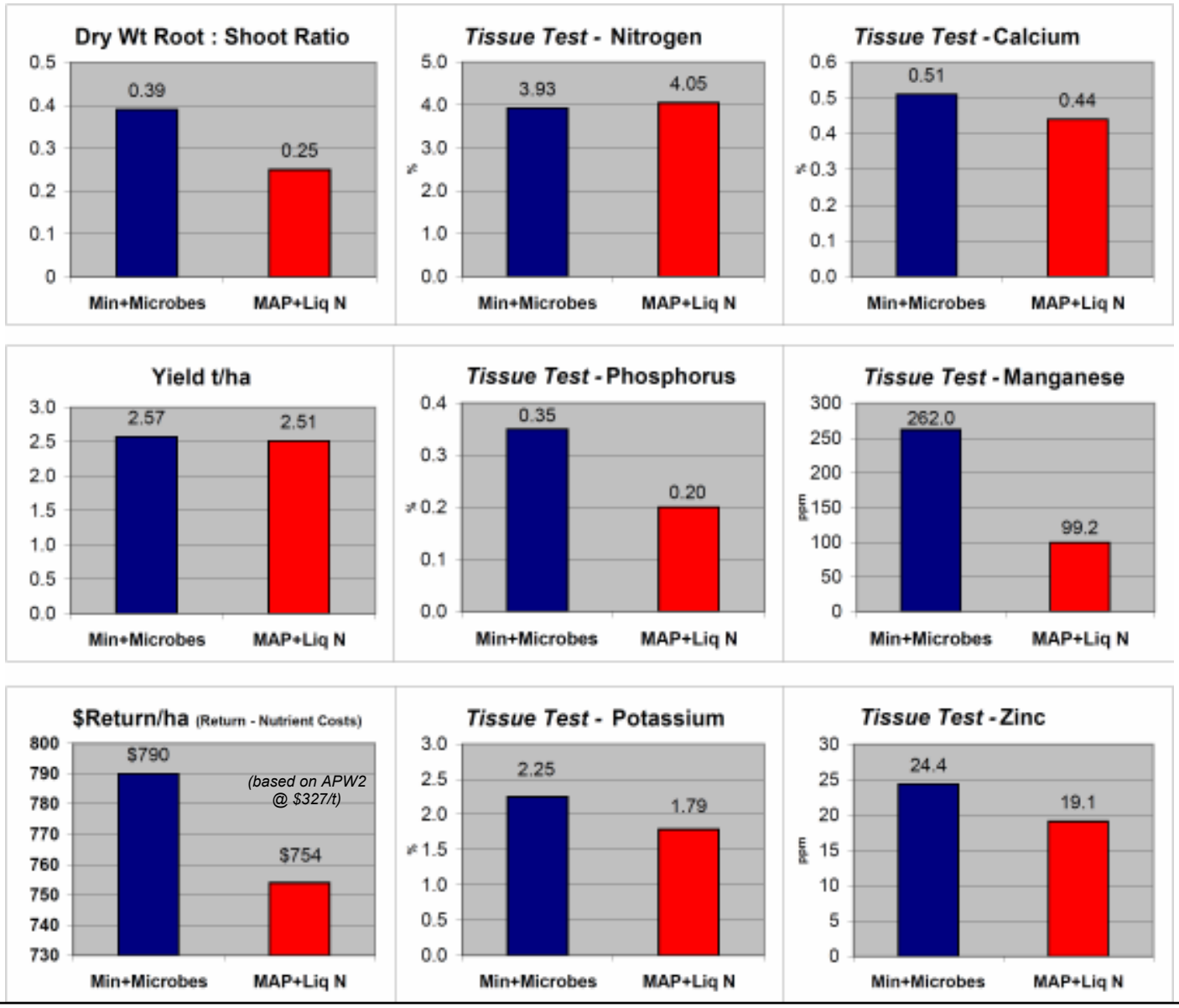


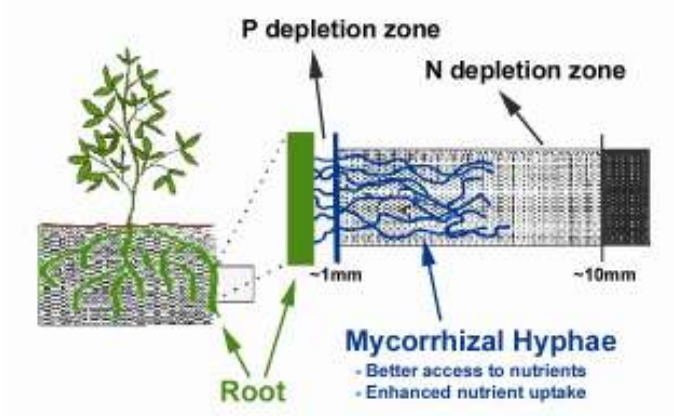
Figure 3 – 2008 Tincurrin Trial (*Yipti wheat* @ 65kg/ha):



Biological Farming is about Nutrient Bio-AVAILABILITY - NOT FERTILISER ANALYSIS

Biological farming works to maintain production levels and quality by using natural systems and methods that mineralise depleted soils and build optimum soil, plant and animal health, while incorporating the best of conventional farming methods.

Soil nutrient availability to plants is not necessarily determined by **the amount of the nutrient** that is present in the soil (unless it is deficient), ***but* more by how the nutrients *are released*** by the soil to the plant. Micro-organism mediated processes (such as by Mycorrhizal fungi) can enhance the release of essential nutrients tied-up in the soil. In addition, the VAM Mycorrhiza form an extensive filament system within the soil that is many times larger than the plant root system, and therefore can access nutrients and water that may not normally be accessible by a smaller root system (for more details see WMF VAM Plus Tech Sheet).



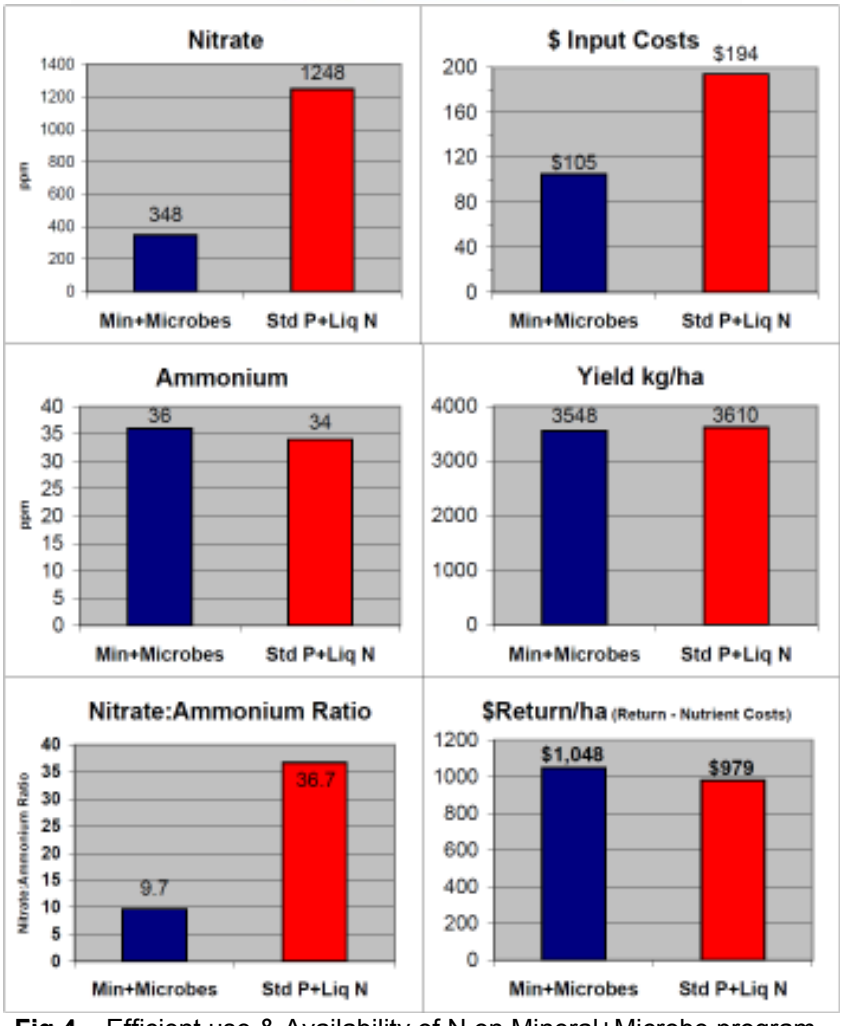
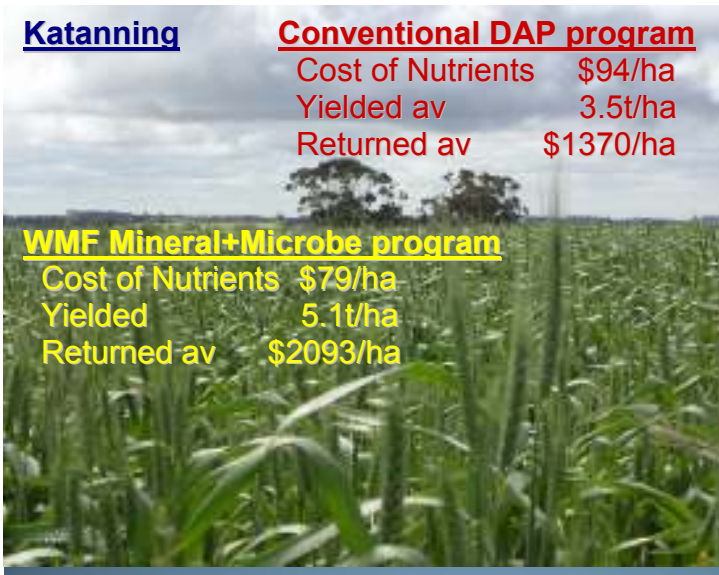


Fig 4 – Efficient use & Availability of N on Mineral+Microbe program vs excessive Nitrogen Application on Std Practice program
2008 Esperance trial - *Carnamah wheat @ 70kg/ha*



WMF's Mineral and Microbe cropping programs have basically performed well on **relatively low** applications of Nitrogen and Phosphorus.

Independently conducted trials have shown that the **WMF mineral + microbe programs** have generally **increased nutrient bioavailability** (as measured by tissue testing) **compared to higher analysis acid soluble fertiliser programs**. Typical examples (see **Fig 4)** show differences in Nitrate & Ammonium N status; or mineral nutrient status (see **Fig 3** on page 4).

Data extracted from the MEAG Soil Consultancy 2008 Esperance trials (*see full data set and report on WMF's website*) shows trends against the use of Nitrogen ***in excess*** (note – this does not mean no Nitrogen!).The 2008 Esperance trials show that the basic WMF program yielded 3548kg/ha, cost $105/ha for input, & returned $1048/ha; whereas the Standard Practice program yielded 3610kg/ha, cost $194/ha for input & returned $979/ha (based on APW2 @ $325/t) = no significant difference but +***$69/ha more return on the WMF program***. In the RAIN 2007 fertiliser comparison trial *(see WMF's website)* the basic WMF program yielded an average 1952kg/ha, cost $69.66/ha for input, & returned an av. $518/ha; whereas the Standard Practice program yielded 1686kg/ha, cost $65.68/ha for input, and returned an average $433/ha (based on APW @ $419/t in '07) = no significant difference but +***$84.72/ha more return on the WMF program***.

Biological Farming is about Results
- "Mineral" vs "Acid Soluble" Fertilisers

Over many years, independent FARM TRIALS show that the Western Mineral Fertiliser programs have generally equalled or out-performed conventional and district practice programs - with increased quality; protein (up to 1.3% higher), better screenings; highest yields; and improved net returns (from $18.00/ha to $724.00/ha), *and* often with cheaper inputs.

WMF Managing Director Stephen Frost says that 'the *consistent top trial results* throughout WA simply *backup the on-farm results* that WMF have been achieving for many years. It is time for many Agronomists and Farm advisors to broaden their knowledge base and objectively assess the new science in soil fertility and biological management. These programs result in overall reduced input costs and perform exceptionally well, particularly under environmental stresses (such as low rainfall events)'.

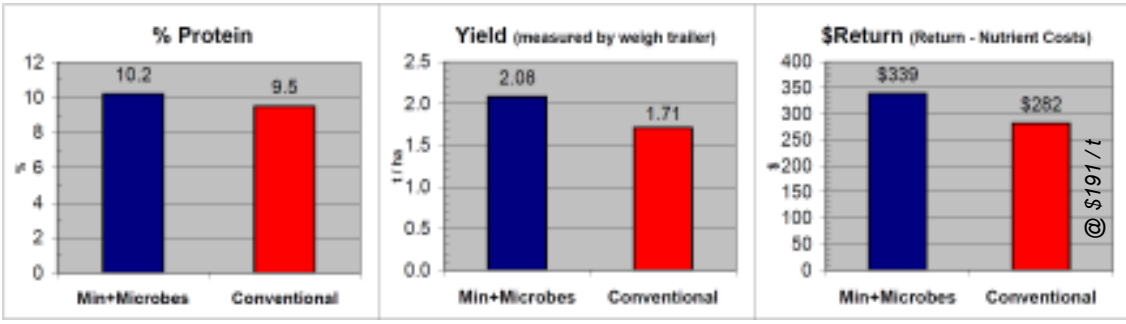
Trial sites over the years have included Agriculture Department trials in the northern wheatbelt through to Vasse in the Southwest, Liebe, RAIN and FACEY trials and on-farm trials across the state including Goomalling, Bruce Rock, Hyden, Narembeen, Lake Grace, Lake King, Mukinbudin, Ravensthorpe and Esperance.

The following is extracted data simply comparing basic "Mineral" vs "Conventional" programs from a number of larger trials. For further detailed information on extensive Cropping and Grazing Programs and complete Trial results, please visit our website: www.wmf1.com.

2005 Mukinbudin Trial
(*wheat* @ 60kg/ha):

WMF 80kg/ha NPK Crop + Microbes
65kg/ha Post em $AmSO_4$
Total units P 6.0 N 18.2
Total cost $57.85/ha

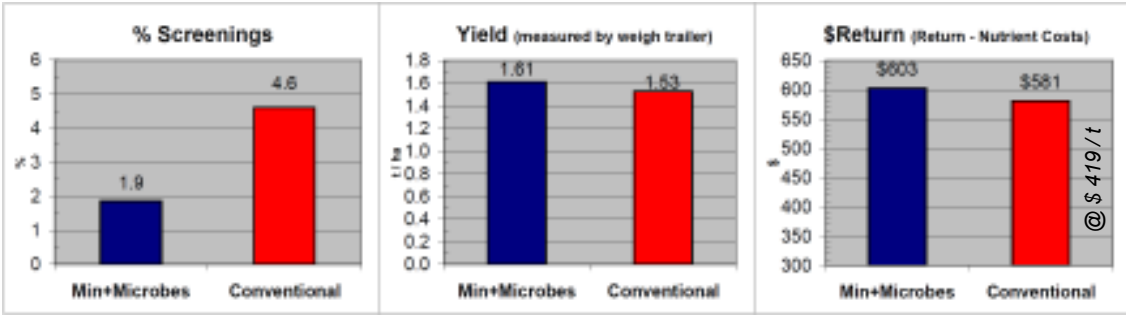
Conventional 40kg/ha MAP+Fungicide
40kg/ha Post em Urea
Total units P 9.0 N 23.0
Total cost $43.74/ha



2007 Kalgarin Trial
(*wheat* @ 70kg/ha):

WMF 80kg/ha NPK Crop Plus+Microbes
FSE, 100kg/ha Preplant $AmSO_4$
Total units P 7.2 N 27.4
Total cost $72.40/ha

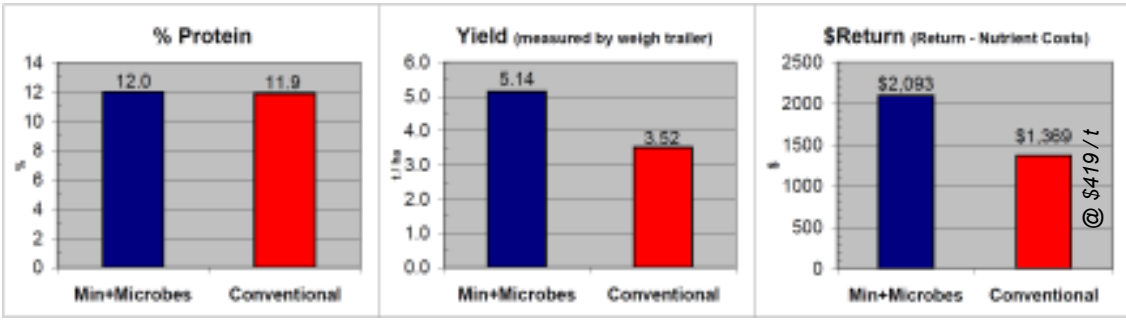
Conventional 55kg/ha TSP+Fungicide
FSE, 100kg/ha Preplant $AmSO_4$
Total units P 11.3 N 21.0
Total cost $58.68/ha



2007 Katanning Trial
(*wheat* @ 70kg/ha):

WMF 100kg/ha NPK Crop Plus+Microbes
60kg/ha Post em Urea
Total units P 9.0 N 35.6
Total cost $78.94/ha

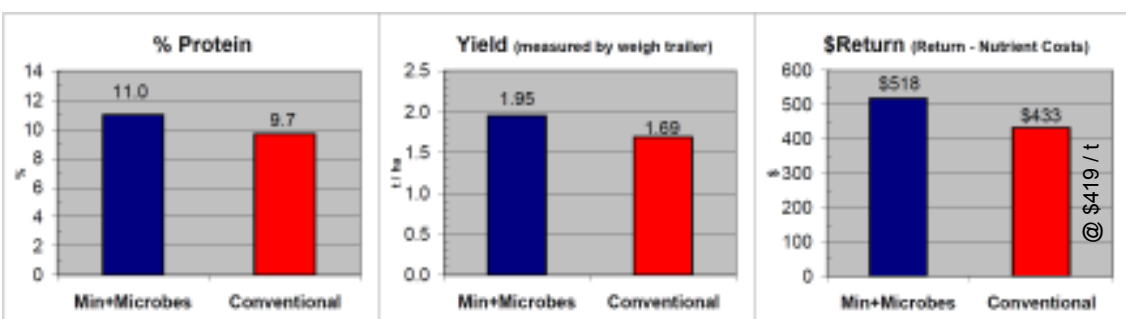
Conventional 80kg/ha DAP+20kg SOP
60kg/ha Post em Urea +Zn+Cu
Total units P 16.0 N 41.6
Total cost $94.06/ha



2007 Ravensthorpe Trial
(*wheat* @ 75kg/ha):

WMF 80kg/ha NPK Crop Plus+Microbes
27.5kg/ha Post em Urea + 25L/ha Liq-N
Total units P 7.2 N 25.4
Total cost $69.66/ha

Conventional 60kg/ha Agflow Extra
+20kg MOP + 50kg/ha Post em Urea
Total units P 8.4 N 30.6
Total cost $65.68/ha

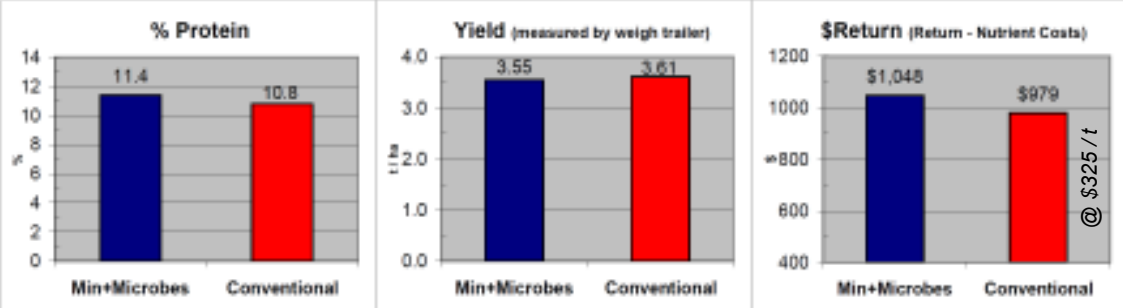


Biological Farming is about Results
- "Mineral" vs "Acid Soluble" Fertilisers

2008 Esperance Trial
(*wheat* @ 70kg/ha):

WMF 80kg/ha NPK Crop Plus+Microbes
Total units P 7.20 N 6.4
Total cost $105/ha

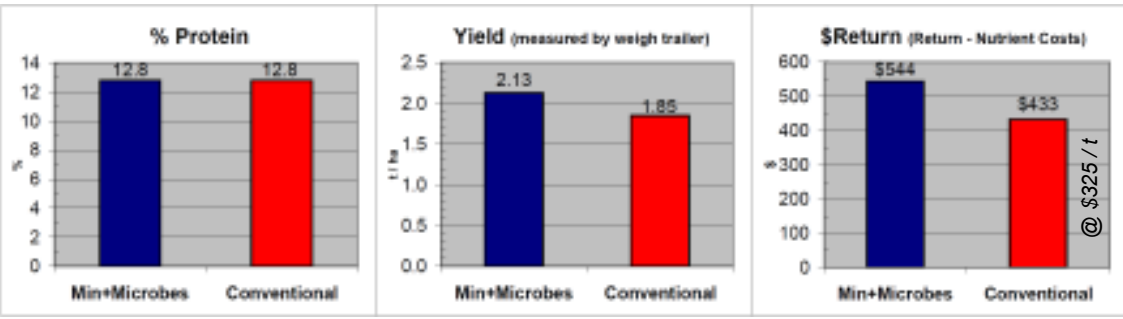
Conventional 120kg/ha Macro-Pro Plus +Fungicide+40L/ha Liq-N
Total units P 16.8 N 24.0
Total cost $194/ha



2008 Bruce Rock Trial
(*wheat* @ 70kg/ha):

WMF 100kg/ha NPK Crop Plus+Microbes Post em 30L/ha Liq-N
Total units P 9.0 N 17.0
Total cost $148/ha

Conventional 100kg/ha Macro-Pro +Fungicide+Post em 30L/ha Liq-N
Total units P 11.2 N 18.7
Total cost $168.50/ha



WMF Mineral / Microbe programs in comparison to conventional practice generally show:

- **Improved nutrient uptake.**
- **Improved quality (screenings and protein).**
- **Improved yield and net $ return.**
- **Increased soil biology (eg Mycorrhizal attachment).**
- **Increased Root to Shoot ratios and Organic C.**
- **Greater tolerance to environmental stresses.**

For further detailed information on Programs and Products - please contact your local agent or see our website

Staff Update :

In July 2009, **Andrew Pauley** was officially welcomed onto the staff of Western Mineral Fertilisers as our **Field Manager**.

Andrew is based and farming in Pingelly, and is also currently running a sheep and cropping enterprise.

Back in the mid nineties Andrew went on the search for a more sustainable farming system. This led him to information and practices from the eastern states and overseas that wasn't being promoted in Western Australia at that time.

With the knowledge gained, he has now been successfully Biologically Farming for thirteen years, with the last ten years using Western Mineral Fertiliser and Microbe programs as the foundation for building soil fertility.

Andrew has also been a WMF agent for the past nine years, mainly working across the central wheatbelt.

"In my role with WMF, I look forward to being able to direct you down the path to increase your overall farm production, and help show you practical ways to implement this. Please feel free to contact me to discuss your programs"…

Andrew Pauley - mobile 0408-871-476

Biological Farming is about viable Beneficial Microbes - "Liquid" vs "Powder" Microbes

The Benefits of Freeze Dried Powders for long term storage

One of the main desirable properties of a microbial inoculum is stability when stored. Just as not all microbes are the same, not all bacteria and fungi react in the same way when stored for a period of time – particularly in an "activated" water liquid culture.

Freeze drying uses a process that dries the microbes by freezing it within a vacuum. All that is removed is the water and therefore the microbes are concentrated in much smaller volumes. The microbes can then generally be stored indefinitely. Addition of water at the time of use or application *reactivates* the microbes and they rapidly achieve optimum performance.

Microbes supplied as "Activated" or "in water" Liquid preparations have some *major disadvantages* – particularly shorter shelf life, potentially losing their viability within weeks of being produced (see Fig A). Storage of these water activated liquid cultures survive marginally longer if stored @ 4°C. In addition, certain species of microbes tend to "out compete" and dominate the rest (see Fig B). That means that if an activated "liquid culture" is more than 4 weeks old, the bulk of the species of microbes may have been depleted, and only a few will survive. This can be compounded if the water culture is not stirred or bubbled with air, as O_2 levels in the bottom of the container will become depleted and can become anaerobic. So the value of a water "activated" culture is very dependent on the date of manufacture.

WMF microbe blends are supplied in powder form. Desirable properties include *1).* long term storage viability (as long as they are stored in sealed containers away from atmospheric moisture), *2).* numbers of each species are optimised when resuspended in liquid (either water or Micro-Stix2 for dry seeding) at time of desired use. *3).* In addition, transportation is easier and costs are minimised – as **bulk volumes of water are not being transported** (as with pre-mixed water cultures).

Do not add extra "Food" to WMF Microbe Blends

WMF microbe blends are supplied with *all* the microbe food required to kick start *all* the species supplied within the blend. Addition of extra microbial "food" to WMF microbe blends are usually *not necessary.* For example, the common practice of adding molasses to microbial products is *NOT recommended* in WMF microbe blends – as the molasses can immediately throw out the fungal:bacterial ratio (compare Fig B with Fig C).

WMF "Micro-STIX2" polymer for Dry Seeding

Western Mineral Fertilisers innovative microbe coating and polymer technology products (such as "Micro-STIX2") are the culmination of 8 years extensive R & D.

Micro-STIX2 has been designed to allow WMF microbe blends to be applied as seed coating for dry seeding. The unique properties of Micro-STIX2 allows the microbes to remain with the dry seed (either in the bin or when sown into dry soil) without being activated by atmospheric moisture. Once enough moisture is available for the seed to germinate, the microbes in turn activate right where they are needed – ie in the root rhizosphere.

Figure A –Starter Culture during Storage (1 species)

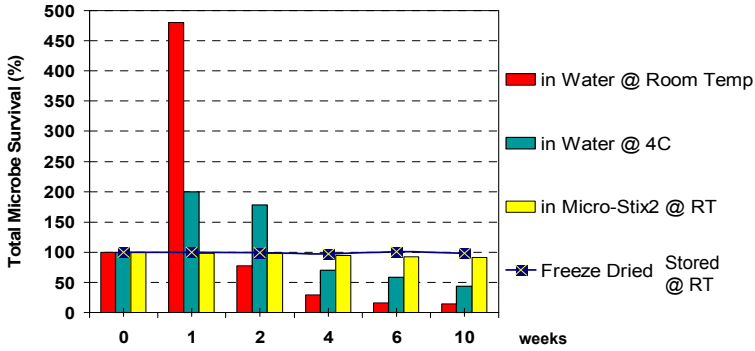


Figure B – Survival of multiple Microorganisms after activation in water @ Room Temperature

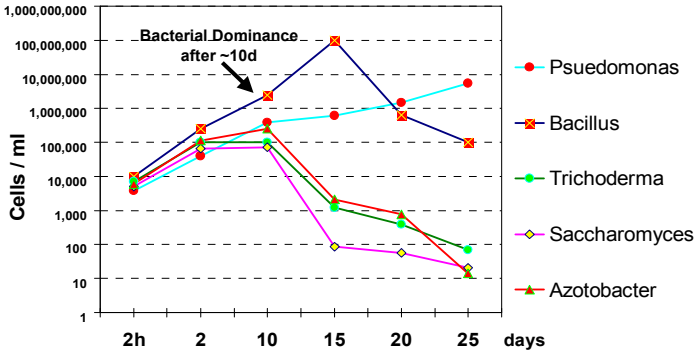
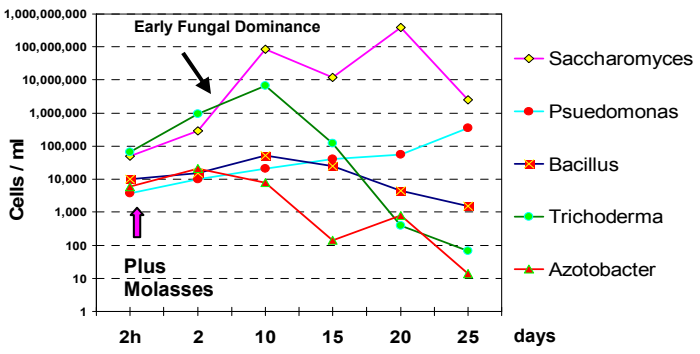


Figure C – Survival of multiple Microorganisms after activation in water @ Room Temperature - *with the addition of Molasses*



Western Mineral Fertilisers *Mineral & Microbe* programs are designed to help remineralise depleted nutrients, restoring mineral and microbial balance to the soil; and to grow larger roots to increase organic matter and organic Carbon levels. In addition, by increasing the root system and ultimately the area for colonization by beneficial microbes (such as Mycorrhizal fungi), crops may have better access to soil moisture during periods of mid-winter water stress / drought. They may also access additional nutrition later in the growing season.

In dryland agriculture, farmers *can* respond to many of the challenges of mineral & biologically depleted soils; and the direct effects of climate change, and changes in weather patterns; by adjusting their practices. A Mineral / Microbe program that increases nutrient bio-availability and encourages larger roots systems & increases farmer $returns while restoring the soil asset - *is an important place to start.*

WESTERN MINERAL FERTILISERS
Head Office Tenterden WA Ph: (08)-9851-7222 *Fax (08)-9851-7293*