WESTERN MINERAL FERTILISERS
WM FERTILISERS
Update
August 2006

LEADERS IN BIOLOGY AND MINERAL FERTILISERS

Welcome

Firstly I would like to apologise for the lateness of our summer/ autumn newsletter. We have been holding off until all the 05 season trial results are in and it has been worth waiting for. Over ALL the sites which include Dept Ag, Leibe and Ningham group Western Mineral programs yielded the best net return and quality per ha with the added bonus of lifting the soil biological status and long term soil fertility.

Even though this year has had very poor opening rains across the whole state we still have to "plough on" and look at how we can improve our returns in all farming sectors. In the wheatbelt we have particular problems where the "average season" is now dealing with unreliable rainfall (or rain at the "wrong" time of the year), higher frost and pathogen incidence.

As farmers we must seriously look at how we are conducting our programs and what advice we are getting - often from paid farm advisors, agronomists and consultants. Many of these experts will not even consider new technology like the advances in soil biology treatments. As a company we constantly clash with these advisors who refuse to look at this type of technology including our programs, which are backed up by years of independent research and farmer results. Often they push for big dollar up front cropping programs where spending up to $25/ha on preventative fungicide treatments is described as "cheap insurance" or high and expensive rates of up front nitrogen to so called "guarantee that yield"! Unfortunately often enough advisors for their own protection use the "Rolls Royce" programs where even on a good year the net returns are marginal. As a farmer myself, the buck stops with us and we need to take more responsibility for our decisions and more control in inputs for our farming programs.

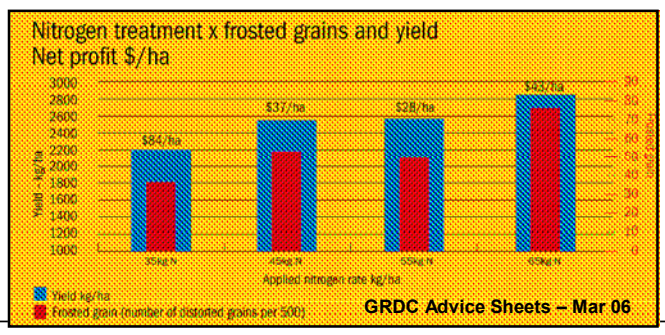
WMF is one of the few companies that consistently participate in independent trials and back our research with well-documented references and research papers.

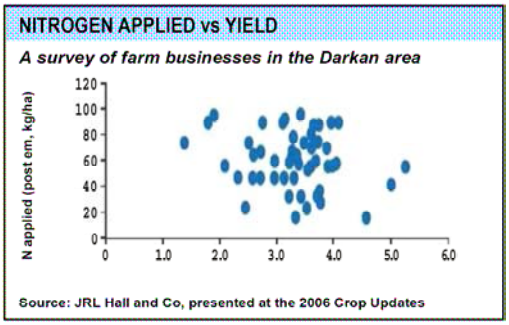
On a lighter note if you are conducting comparative side-by-side trials with our product the only accurate way to determine yield comparison is with weight trailers or weigh bridges. As our programs consistently give up to 20% more weight per individual grain this often results **in inaccurate weights through harvester yield monitors.**

During the 2005 Season, multiple trials were conducted using Western Mineral Fertilisers Mineral & Biological nutrition systems, compared with conventional solid fertiliser applications – and again, the WMF mineral microbe program out-performed conventional fertilisers in *QUALITY, YIELD & NET RETURN*. In 2005, the season can be summarised as a good break, followed by a mid-season drought (July through to mid-August, combined with several heavy frosts). There was a trend of increased plant above-ground biomass, frost-damage & larger screening numbers in Conventional treatments, whereas there was a general increase in germination rates & below-ground biomass in WMF programs. It is abundantly clear that *LARGE above ground biomass* does not necessarily translate to yield advantages, particularly in low rainfall areas. Larger plants may require more early moisture, whereas larger rooted plants have better water retention & water relations– particularly in dry years! Stephen Frost (Managing Director)

INCREASED NITROGEN INPUT DOES NOT MEAN INCREASED YIELDS IN CROPPING = INCREASED FROST?

Nitrogen: last year alone frost damage is calculated to have lost about 700,000 tonnes of WA wheat, worth around $90 million (GRDC Advice Sheets – Mar 06). DAWA trials in the Southern Wheatbelt (from Crop Updates 2006) showed that higher application of *Nitrogen* fertilisers on frost-prone paddocks led to a significantly higher incidence of frost damage. The practice of applying **higher amounts of *Nitrogen*** for higher yields is **leading to harvesting lower profits**. Other trials showed that the higher yielding results were using the lowest *Nitrogen* inputs.





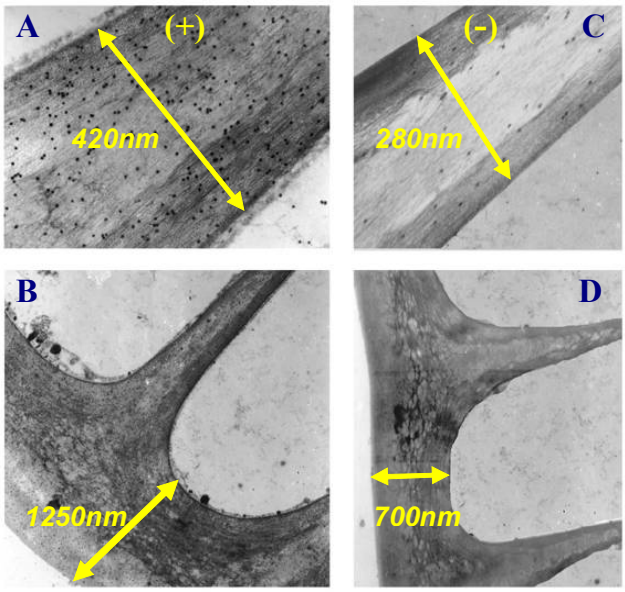
As applied nitrogen rate was increased there was an increase in the number of frost-distorted grains. For example, plots that received 35kg of applied *Nitrogen* achieved GP1 grade (@$84/Ha profit) but all higher *Nitrogen* treatments were downgraded to feed (65kg N/Ha @$43 net profit) - (***Ground Cover Direct Mar 06*** - Managing frost - minimising damage). . Excessive application of *Nitrogen* promotes rapid growth through rapid cell elongation – leading to problems associated with thinner cell walls.

SURVIVAL OF CROPS IN ADVERSE CONDITIONS

How do Silicates and Other Minerals help crops & pastures tolerate stresses such as drought & frost?

Silicates are formed from the element *Silicon* (Si). Bio-available *Silicon* is typically absorbed by plants as a *Silicate*. The beneficial effects of *Silicates* fertilization have been demonstrated for many plant species, especially when these plants are subjected to environmental stress such as drought, water stress, frost, wind etc (1,2). *Silicate* is readily absorbed by plant roots & is transported through the xylem of the plant & deposited in the roots, stems & leaves (3). *Silicates* are laid-down (together with other elements such as *Potassium*) in cell walls as an immobile amorphous silica (called phytoliths or opal), especially in epidermal, stomatal and leaf trichome cells (4,5). This adds cell wall strength & is reported to contribute to frost tolerance (6) & drought resistance through increased root biomass.

Effect of Silicate Mineral on Cell Wall Architecture:



Electron micrographs of epidermal cells showing differences in cell wall structure, cell wall thickness, and cell wall density (+/- Silicates) (Magnifications: A & C x 40,000; B & D x8,000)

Other effects of Silicates:

1.Improved Nutrient Uptake: *Silicates* have a positive effect on mineral nutrition & the growth of the plants by assisting uptake of *Zinc* & *Phosphorous* (7).

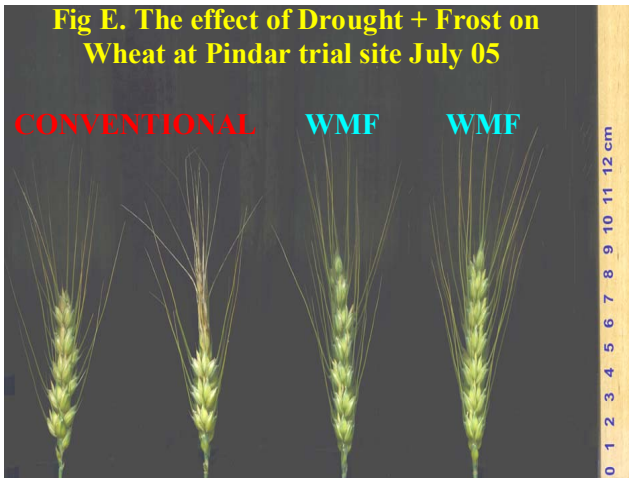
2.Aluminium: *Silicates* are linked to a reduction in the toxic effects of *Aluminum* (8) *(for further information,* read WMF Tech sheet Silicates in Plant Nutrition on our web site).

3.Drought: *Silicates* & *Potassium* regulate plant transpiration by controlling stomatal opening, thus maintaining turgor, & reducing water loss & wilting. This is the likely reason for the resistance shown by these plants to water deficits (part of the reason why crops on the Silicate mineral program have far better water harvesting ability and greater tolerance to periods of drought).

4.Disease: *Silicates* assist in protecting the leaves against pest and disease attacks (9,10,2).

5.Lodging: *Potassium* builds cellulose and combines with *Silicate* in making stems stronger and thicker, as opposed to the negative effects of excessive nitrogen.

6.Frost: *Potassium* promotes growth of large xylem vessels, mobilization of nutrients (such as *Silicate, Copper and Molybdenum*) and high content of sugars and reserve carbohydrates in the cell *Potassium plus Silicates* help develop multi-layered cell wall architecture and thicker cell walls (see Figs. A&B vs C&D) - resulting in improved frost hardiness (Fig E).



Conclusion: **It can be seen how significant *Silicates* are in plant nutrition. In fact many cereals and Pasture species require more *Silicate* than *Nitrogen*. High-density cultivation systems with heavy applications of *Nitrogen* are becoming more prone to frost and drought damage due to rapid cell elongation and thinner cell walls. The beneficial effects of bio-available *Silicon* on plant growth are mainly attributable to the *Silicates* that accumulate in plant cell walls *(as shown in the cell wall photos)*. These *Silicates* are now becoming recognized as helping to generate tolerance to frost and drought, and resistance to disease and pests in many plants - and therefore may also reduce rates of application of pesticides and fungicides. Western Mineral Fertilisers contain up to 24% *Silicate*.**

References:

1. TAKAHASHI, E. (1995), Uptake mode and physiological functions of silica. In:MATSUO, T.; KUMAZAWA, K.; ISHII, R. (Ed.) Science of the rice plant: physiology. Tokyo: Food and Agriculture Policy Research Center,. p.420-433.
2. DATNOFF, L.E.; SNYDER, G.H.; KORNDÖRFER, G.H. (2001). Silicon in agriculture. Studies in plant science. Amsterdam: Elsevier, 403p.
3. RAVEN, J. A. (1983) Biol. Rev. 58, 179-207.)
4. JONES, L.H.P.; HANDRECK, K.A. (1967), Silica in soils, plant and animals. Advances in Agronomy, v.19, p.107-149.
5. YOSHIDA, S. (1965), Chemical aspects of the role of silicon in physiology of the rice plant. Bulletin of the National Institute of Agronomic Science Serie B, v.15, p.1-58.
6. EPSTEIN, E. (1994), The anomaly of silicon in plant biology Proc. Natl. Acad. Sci. USA Vol. 91, pp. 11-17.
7. MARSCHNER, H., OBERLE, H., CAKMAK, I.& ROMHELD, V. (1990) Plant Soil 124,211-219.
8. MA, J.F.; SASAKI, M.; MATSUMOTO, H. (1997), Al-induced inhibition of root elongation in corn, Zea mays L. is overcome by Si addition. Plant & Soil, v.188, p.171-176.
9. COCKER, K.M.; EVANS, D.E.; HODSON, M.J. (1998), The amelioration of aluminium toxicity by silicon in higher plants: solution chemistry or in plant mechanism? Physiologia Plantarum, v.104, p.608-614.
10. MA, J.F.; MIYAKE. Y.; TAKAHASHI, E. (2001), Silicon as a beneficial element for crop plants. In: DATNOFF, L.E.; SNYDER, G.H.; KORNDÖRFER, G.H. Silicon in agriculture. Studies in plant science. Amsterdam: Elsevier,. v.8, cap.2, p.17-39.

SURVIVAL OF CROPS IN ADVERSE CONDITIONS

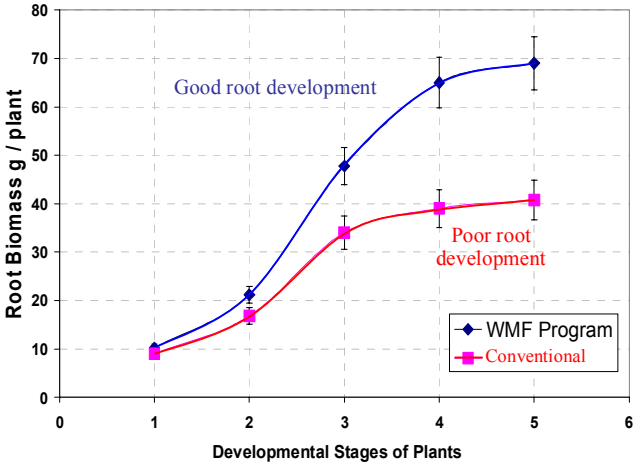
The following is a summary and a discussion of some of the consistent Results obtained during 2005 - using Western Minerals Biological/Mineral approach to agriculture *in Western Australian conditions*.

In CROPPING – ABOVE GROUND BIOMASS DOES NOT EQUAL YIELD

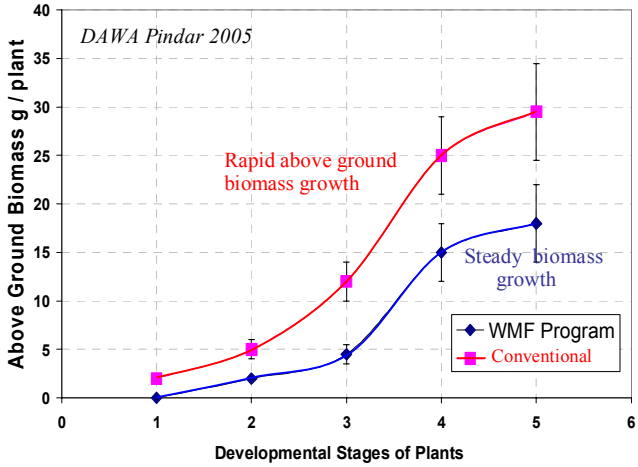
– and the significance of Minerals and Biology

1. *In cropping* - Minerals play a substantial role in microorganism and plant nutrition, and yield quality. Field observation show that wheat inoculated with VAM (Mycorrhiza), and grown on mineral fertilisers, consistently have larger root systems and smaller above ground biomass, increased water retention *and an increase in yield*. This occurs in good years and also under water stress and drought – *compared to* Conventional/District practice treatments.

Comparison between WMF & Conventional Programs – Root Biomass vs Above-Ground Growth:



Graph 1: Root Biomass



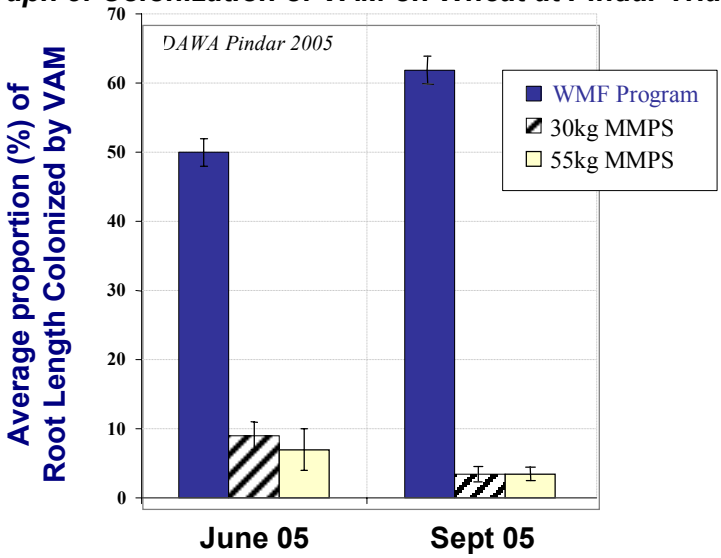
Graph 2: Above Ground Biomass

Comparison between WMF & Conventional Programs – looking at Yield, Protein and Return:

Fertiliser and rate	OM %	Screenings %	Yield kg/ha	Fertilisers Cost $/Ha	Post N Cost $/Ha	Gross Return $ @165/t
MMPS 55 kg/ha Site 3t	1.387	1.9	1889	$28.00	$19.16	$311.68
MMPS 55kg/ha Site 1.5t	1.277	2.1	1787	$28.00	$19.16	$294.85
WMF 100 kg/ha Site 3t	**1.210**	**2.1**	**2018**	**$46.50**	**$19.16**	**$332.97**
WMF 100kg/ha Site 1.5t	**1.300**	**2.0**	**2032**	**$46.50**	**$19.16**	**$335.28**

Pindar 2005 - Note Wheat price given is without consideration of protein differentials

Graph 3: Colonization of VAM on Wheat at Pindar Trial



2. *Biomass data* shows that WMF Mineral / Microbe program yielded higher while developing **larger root systems** (*Graph 1*) & **less above-ground biomass** (*Graph 2*), compared to Conventional programs.

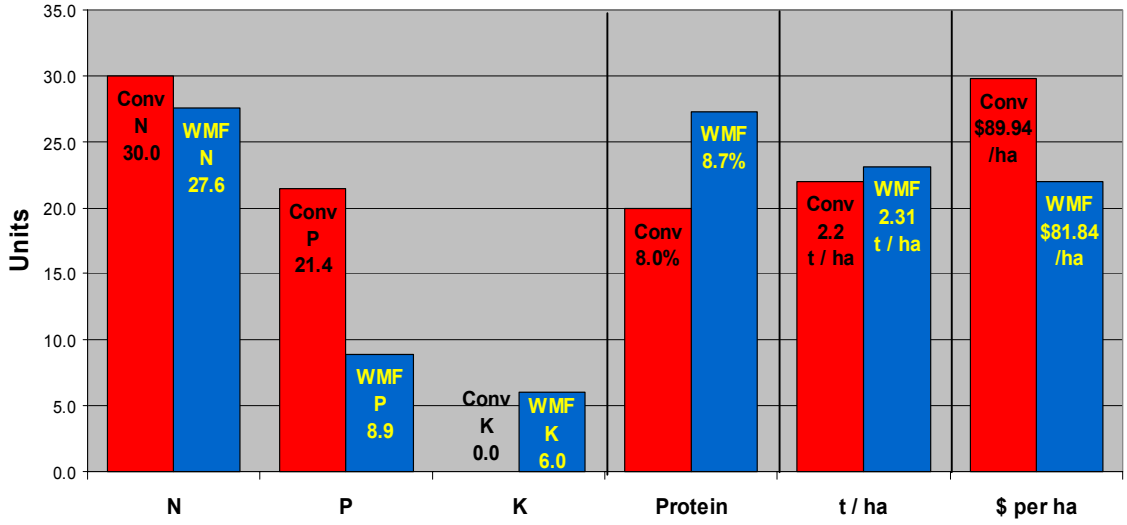
3. *VAM (Mycorrhiza)* colonization of wheat was also significantly up on the WMF Mineral/Microbe program (*Graph 3*) compared to the Conventional (UFC Multimaps + fungicide seed-dressing). VAM associations were found in 50% to 100% of plants in WMF Program - while only in 0% to 25% in MMPS treatments. WMF program returned $28.00/Ha higher net return than Conventional Program.

Long Term GRDC funded Liebe Trials – looking at Yield, Protein and $ Return:

For the second year running, WMF mineral and Biological programs have out yielded, with better protein and higher net return, than the conventional fertiliser programs at the Liebe trial site at Buntine. WMF input costs were over $8.00/Ha less and resulted in higher yields, better protein and a net gain over $26.00/Ha.

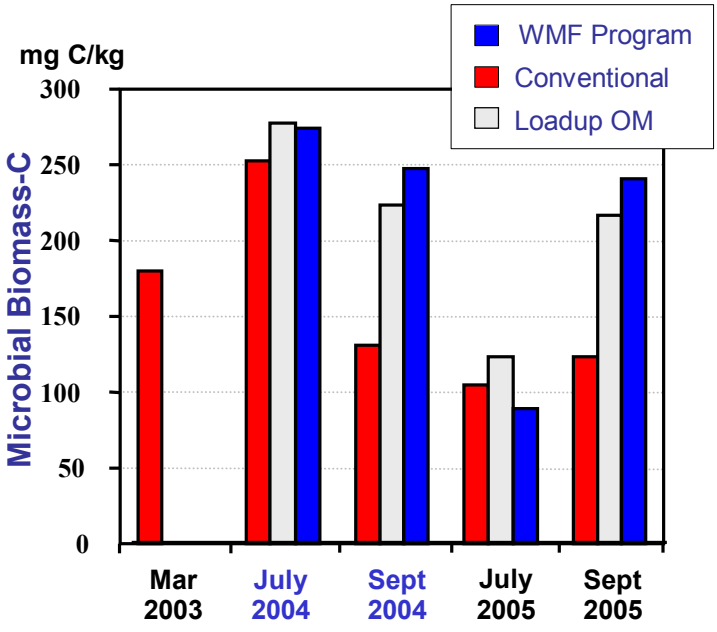
Liebe – Wheat Yield 2005

80kg/ha Wyalkatchem wheat sown 4th June 05



***WMF** (down boot) – NPK Crop (120kg/ha) + banded UAN (60L/ha)*

Organic and Microbial Components of the Soil:

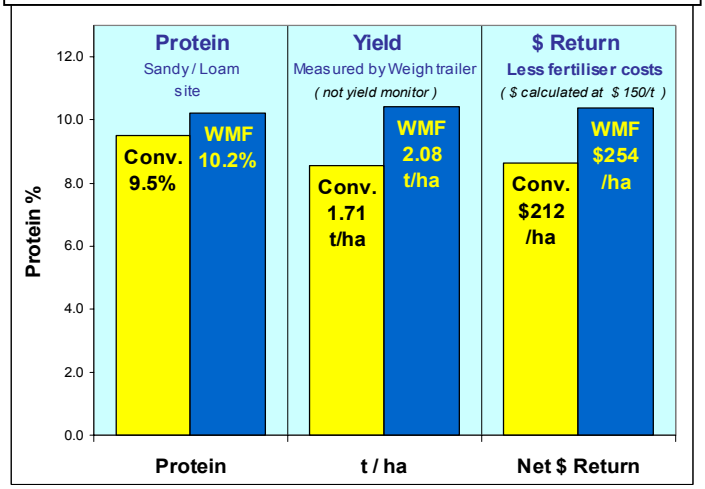


Graph 4: Liebe Trial Site Microbial Biomass-Carbon

Equally as important as the short term performance of the fertiliser program, is the long term sustainability of the programs. The goal is to increase soil fertility AND the soils ability to maintain crops, even under adverse seasonal conditions. Part of this goal is to increase the soils *ORGANIC* and *MICROBIAL BIO-MASS.*

Soil microbial Carbon is the living component of soil Organic Matter & serves as a bio-available concentration "pool" of nutrients including Carbon, Nitrogen, Phosphorus and Sulphur (Sparling 1992, Chen et al 1999). Microbial Biomass (*Graph 4*) was significantly higher in the WMF Mineral/Microbe program compared to Conventional (Summit MAPZSC) & Conventional + 20T Barley Hay/Ha load-up. Av. Fertiliser costs 2004/2005 – WMF $86.00, Summit $92.00. **Average Yield 2004/2005 (Wheat) – WMF 2.9t/Ha, Summit 2.56t/Ha**.

Graph 5: Wheat Yield '05 – Ninghan Group Mukinbudi



Another independent trial conducted during 2005 included North Mukinbudin as part of the Ninghan Group (Graph 5).

Again, the WMF Mineral Microbe Program resulted in better yields & higher protein, with Net gain per hectare over the Conventional Program (Zinc Star + Urea) in light land of $18.19/Ha and heavy land of $41.39/Ha.

CROPPING – Grain Quality

At different stages of grain development, various environmental factors, *such as frost*, can affect yield. Generally, frost can cause empty florets & severely pinched grains (which are likely to be screened out due to small size) - resulting in reduced tonnage & adversely affected grain quality. The poor quality can lead to downgrading of harvested grain to 'feed wheat'. Most of these low quality grains will not be able to be used as seed for the following year - due to poor germination and low vigour.

WHEAT HEAD SIZES, SEED FILLING & GRAIN WT:

The following table is the result of Grain Mapping vs Floret position of 100 samples comparing Conventional and WMF Fertiliser Programs at Narembeen:

Arano Wheat
harvested
2nd Dec 05
(Narembeen)

Number of samples = 100	WMF	Conventional
Av. Length Wheat Head	87mm	79mm
Av. Number Grains per Head	36 seeds @5.91g	30 seeds @3.9g
Av. Weight of Grains:	0.164g/seed	0.130g/seed

CONCLUSION - *WMF Mineral Microbe Programs:*

The significant difference found between the Conventional and Mineral programs in Grain Quality was reflected across all the Trial sites - Liebe Buntine site 2004 & 2005; Pindar 2005; Mukinbudin 2005; and "on-farm". These Results included:

- Consistently Higher grain numbers (Av. up 20%)
- Consistently Higher grain weight (Av. 26% higher hectolitre wt)
- Considerably less shrivelled grain and screenings
- Considerably less Frost effects.

HAY, PASTURE & ANIMALS

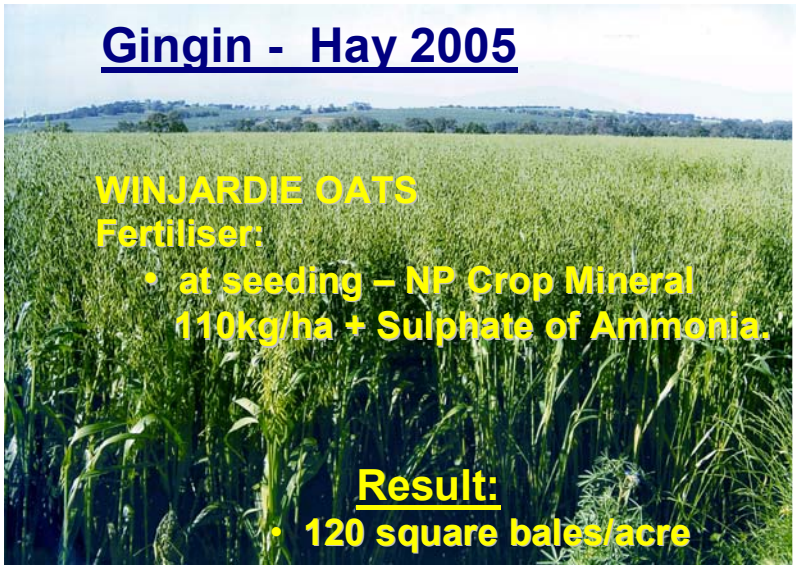
Minerals for plant & animal nutrition = Feed Quality

Even though the bulk of our 2005 trials were conducted in Cropping, we have also been getting tremendous results in both *hay* and general *pasture*. In 2005, we launched our new Pasture products which have seen a massive increase in *Dry Matter yields*, without compromising *feed quality*.

Remineralising pasture improves pasture quality, constantly resulting in:

- Greater Dry Matter/Wet Wt comparison,
- Increased stock weight gain per hectare,
- Higher reproductive performance in both cattle and sheep,
- Overall better animal health, and replaces the need for lick blocks and mineral supplements,
- Gives pasture a high tolerance to drought and insect stress.

Gingin - Hay 2005



Serpentine - Jutland Park

Jutland Park is owned and operated by Pat and Guy Jellicoe. They have won numerous awards, including 9x Red Angus Champion awards from the Perth Royal Show and back-to-back Cattle Bonanza Awards. "Last year we had to wean earlier because of the phenomenal growth, which we put down to the better pastures which were fertilised with products from Western Mineral Fertilisers. We feel that this has been very beneficial to our herd." Guy said.

MINERAL NUTRITION IN ANIMALS

The nutritional quality of pasture, forage and diet plays a major role in the health and reproductive performance of animals. Mineral nutrition is a significant component in the management of any animal. Micro or trace mineral deficiencies are associated with soil deficiencies or UN-availability (due to lock-up in the soil matrix).

Certain minerals can act antagonistically against the absorption of other minerals. Bio-availability of one mineral is influenced by the concentration of other minerals in the diet. For example - calcium interacts directly with phosphorus and Vitamin D. If calcium levels are extremely high, phosphorus availability can be reduced. Intricate macro and micro mineral interactions can also arise - high levels of calcium can reduce the absorption of phosphorus, magnesium, manganese, zinc, iron, cobalt and iodine. On the other hand, high levels of phosphorus and magnesium reduces calcium absorption. High levels of sulfur or molybdenum can hinder copper absorption. While analysis of the feed may show a sufficient copper concentration, because of this antagonism, an animal may actually be copper deficient.

Animals require multiple different minerals. The amount and combination of minerals required will vary depending on the age, weight, health, species and type and level of production of the animal. For example, young animals absorb minerals such as Ca more efficiently than older animals, but they have higher mineral requirements. Mineral uptake is best achieved from the diet when in a Bio-available form.

For further information, refer to WMF Mineral Fact Sheet (either on our Web site or contact our Tenterden Office).

Understanding Life in the Soil – Microbial Analysis

Beneficial Microbes (bacteria and fungi) in the soil create a healthy and sustainable living system, that need to be supported and managed properly in order to obtain optimum plant development and growth. Soil microbes have the same importance for plant nutrient availability as do Rumen bacteria for animals such as cattle and sheep. Understanding this soil biology is a key component to successful outcomes in a Biological / Mineral soil management program. The following summarizes some of the basics of analytical microbiology – used routinely by *microbiologists* to assess microbe to plant performance. *Other than for visual soil indications, assessing soil biology is NOT just a matter of looking through a microscope in the paddock.*

1. Staining :

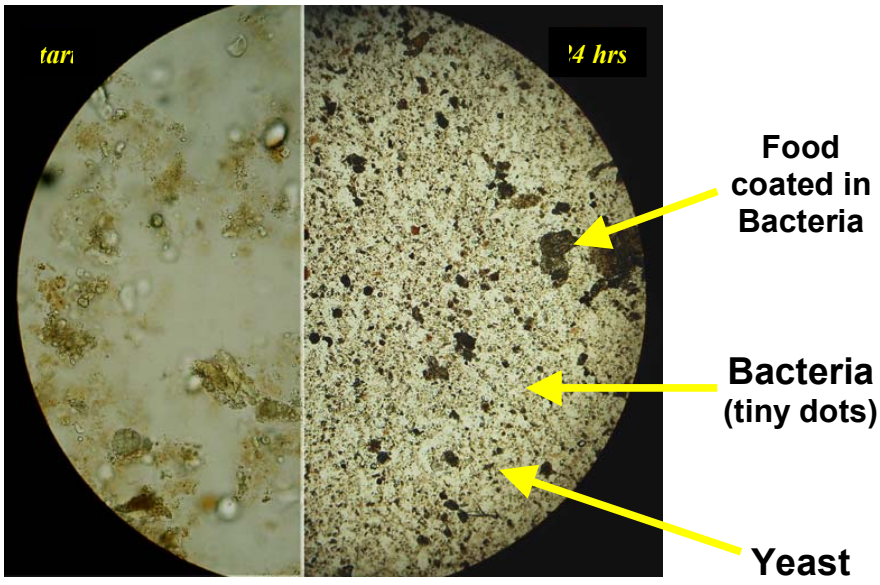
a. Gram stain appearances of important bacteria

As bacteria are so small, they need to be viewed under a high powered microscope using special stains; the stain that is traditionally used for this is called the "Gram stain". In this process, purple dyes are poured over bacteria that have been spread out thinly on a microscope slide and the cell walls of the bacteria (made out of peptidoglycan) take up the colour. If a solvent is then applied to the slide, bacteria which have only got a cell wall still keep their purple colour, but bacteria which have got an extra cell membrane (made out of phospholipid) outside their cell wall quickly lose the purple stain and become colourless; in order to be able to see these bacteria under the microscope a second red stain is then used.

- Bacteria that manage to keep the original **purple** dye only have a cell wall - they are called **Gram positive**.
- Bacteria that lose the original purple dye and can therefore take up the second **red** dye have both a cell wall and a cell membrane - they are called **Gram negative**.

Light Microscopy:

Example of growth of WMF Ag Blend Microbes over 24 hours
0.1g powder is mixed and reconstituted by slow inversion with sterile water until suspended and left on the bench at Room Temperature (approx 21°C). At specific times, a drop is taken and spread out thinly on a microscope slide and then stained. Slides are stained appropriately and then observed using Oil emersion microscopy using 1000X *Total* magnification. A similar process is used for soil from a root system.



b. VAM Mycorrhiza associations with Plant roots - stained with chlorazol black E. stain

VAM Mycorrhiza are specialized fungi associated with plant roots, and require a different analysis. Samples are collected at various stages during the development of the plants. Roots are assessed for vesicular-arbuscular mycorrhiza (VAM), by clearing and staining with chlorazol black E. The gridline intersect method is used to determine Percentage of root length colonized by VAM.

2. Culturing and Plating out of Microbes:

Testing for the viability of bacteria involves plating out on specific agar plates. WMF Microbe powder (as a control) or soil from root zone is reconstituted with 10ml water by slow inversion until suspended. A sample is then inoculated into sterilized liquid culture and shaken at 30°C for 48hr. The final ferment is plated out on agar plates, and cultures are observed after 2 days at 30°C. Samples are then taken to check for total count and the presence of different species. Individual colonies are streaked out on selective media agar plates. The final ferment is also checked for the absence of pathogens & contaminating microorganisms (such as *Escherichia coli* and *Staphylococcus aureus*).

HORTICULTURE – REMineralising for Intensive plant production and nutrition

Over the past 5 years Western Minerals microbe / mineral fertiliser programs have been extensively adopted throughout horticulture. In 2005, we successfully launched our new Grow Safe Range of products, and they have been extremely well accepted by growers across the Horticulture industry. During the last 12 months, numerous on farm trials have been conducted, particularly in viticulture and also in vegetables, potatoes, lettuce etc.

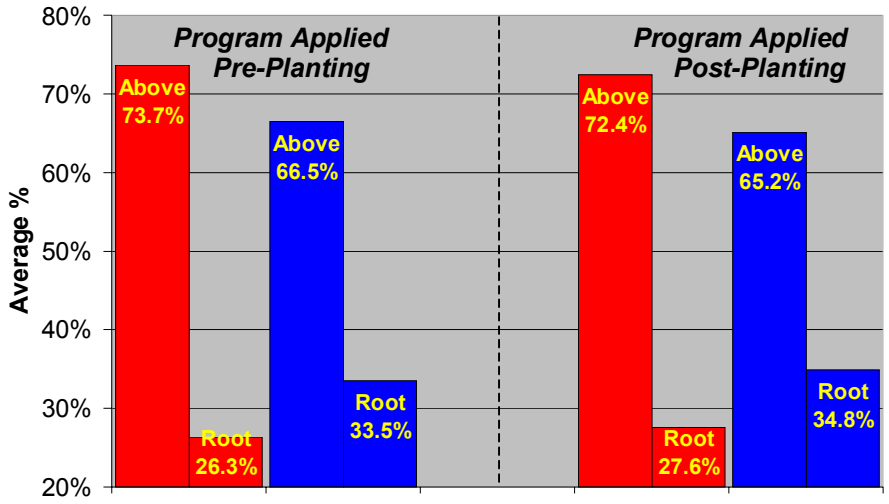
Wanneroo - Broccoli 2005

Another example of where WMF Mineral Fertili & Microbes have achieved significant outcomes in Broccoli, (whether as a Pre-Plant progr incorporated into the soil, or as a program appl Post-Planting). Results show:

- Increase Root Biomass compared to Above Ground (Herbage) Biomass.
- Greater Dry Matter/Wet Wt comparison :
  - o More fiber & Organic Matter in the Broccc heads (ie less water).
  - o more wt per head.
- Less insect damage.
- Improved quality and shelf life.

Conventional Program WMF Program

Broccoli Plant Biomass - % Above Ground vs % Root



Head Biomass - % Dry Mass vs % Moisture Content