



WESTERN MINERAL FERTILISERS



Update

January 2005

LEADERS IN BIOLOGY AND MINERAL FERTILISERS

Greetings

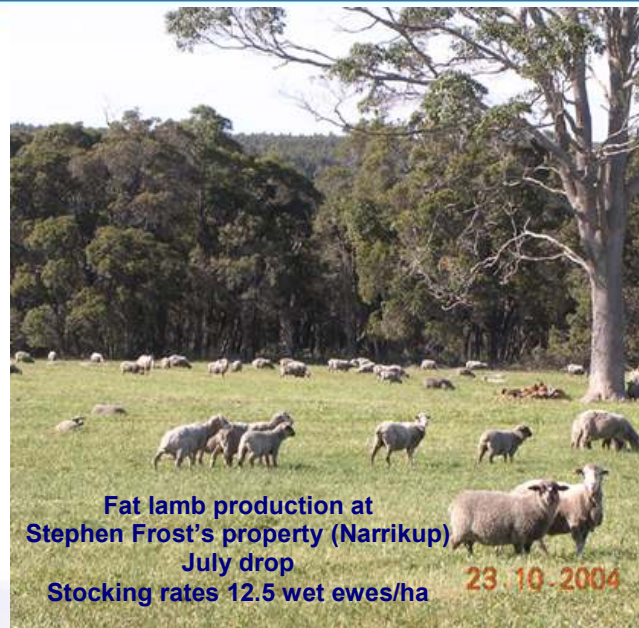
Welcome to the Western Mineral Fertilisers "Update" – our new quarterly newsletter – providing information on topics affecting agriculture in WA.

Over the past 7 years Western Mineral Fertilisers have been supplying mineral fertilisers and biological products to broadacre, cropping, pasture, vineyards, olives, horticulture, citrus etc - with supporting 'on farm' programs and advice. The establishment of the manufacturing facility at Tenterden (just north of Mt Barker) enables the Company to produce specific fertilisers for West Australian conditions.

After some early production issues, the facility now produces a high quality granular fertiliser – producing excellent field results in all facets of agriculture.

This newsletter is not only designed to keep growers informed, but also acts as a forum to pass on information that growers need to know. We encourage you to contact us if you require further information or if you wish to contribute to this newsletter.

All the best for the 2005 season.
Stephen Frost (Managing Director)



Fat lamb production at Stephen Frost's property (Narrakup) July drop Stocking rates 12.5 wet ewes/ha 23.10.2004

West Coast Update :



Chris de Largie (Harvey).
1st year mineral/biological
Vine and cover crop program

Western Mineral Fertilisers have an ever increasing customer base in the South West coastal region of Western Australia. Our fertilisers, microbes and programs have been having excellent results across agriculture – for example in horticulture, citrus, viticulture, olives, potatoes, grazing and dairy, etc.

To cater for the increased demand, **Agra-Force Fertilisers** (Western Mineral Fertiliser distributors in Bunbury) – are in the process of expanding the current facilities to better accommodate the warehousing, bulk handling & supply of Western Mineral Fertiliser products. They are extending storage capacity, allowing them to hold not only large quantities of fertilisers, but also a wider range of products – making them readily available on short notice, and with ease of handling and loading. Agra-Force also offer blending, bagging and the dispatch of bulk fertilisers to the South West coast region. For excellent service and products contact Brett, Linda & Wendy (9725-6557).

Upcoming Grazing & Cropping Seminar Series :

- | | | |
|----------------------|--------------------|--------------------------|
| 16 Feb 05 - Bunbury | (10.30am to 1pm) | – Agra-Force (9725-6557) |
| 21 Feb 05 - Pingelly | (1.30pm to 5.30pm) | – Andrew (9887-1476a/h) |
| 28 Feb 05 - Gingin | (7pm to 10pm) | – Tex (9575-2328a/h) |
| 9 Mar 05 - Denmark | (1.30pm to 5.30pm) | – John (0408-409-327) |

For further information, venue details, and bookings please contact Head Office at Tenterden (08)-9851-7222. You can also contact us if you have a group of growers who would like a seminar in your area discussing mineral fertilisers and microbes.

Contents in This "Update" :

- Welcome from the Managing Director
- West Coast Update -Agra-Force Upsizing
- Upcoming Seminar Series
- Technical Update – Aluminium & Silicates
- Crop Update – Steve Bowman, Dawson Beeck
- Trial Update – Iluka, Liebe and Harvey
- Microbe Update – Plants talking to microbes?
- Soil Testing Update – Soil testing time

Review by Paul Storer

Introduction:

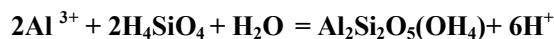
Silicates are formed from the element Silicon (Si). Silicon is a beneficial element for higher plants & is found in significant quantities in most plants - amounts comparable to that of phosphorus, calcium and magnesium. Plants can contain silicon at levels higher than any other mineral ¹. Bio-available Silicon is typically absorbed by plants as a Silicate ("monosilicic acid", H_4SiO_4 - also called "orthosilicic acid"). The Silicon is deposited as silica in the plant cell walls, improving cell wall structural rigidity and strength ², plant architecture and leaf erectness.

Silicon can stimulate plant photosynthesis, decrease susceptibility to disease and insect damage, and alleviate water and various mineral stresses ^{3,4}.

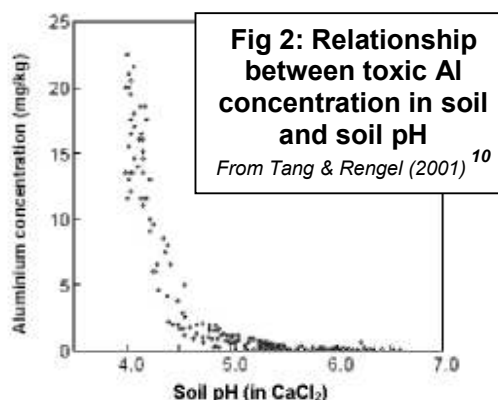
Silicon can decrease the toxic effects of Aluminium ^{5,6,7,8,9,10,11}. Several mechanisms have been proposed to explain Aluminium (Al) detoxification by Silicon :

- Silicon binds to aluminium - forming less toxic aluminosilicates ^{5,8} (see Fig 1),
- Silicon increases soil pH - Aluminium is very water soluble & mobile at acid pH's ⁹. Aluminium precipitates and falls out of solution at pH's above 4.6 in $CaCl_2$ ¹⁰; (see Fig 2) and
- Silicon mediated plant detoxification mechanisms – Silicates added to soils with high Aluminium concentrations can greatly stimulate plant roots to secrete organic acids (eg citrate and malate ⁵) and phenolics (eg catechin and quercetin ¹¹) – these organic exudates can chelate to Aluminium and reduce the activity of free Al ions.

Fig 1: Monosilicic acid (H_4SiO_4) can react with Aluminium (Al), forming aluminosilicates:



From Lumsdon and Farmer (1995) ³⁸



ALUMINIUM and Soil Acidification:

Soil acidification is a major threat to the sustainability of Western Australia's agricultural industries. About two thirds of WA's wheatbelt soils are either acid or at risk of acidification ¹². Aluminium is a significant contributor to acidification of soils in Western Australia ¹³.

In many acid soils, aluminium toxicity is one of the major limiting factors of plant growth and development ^{14,15,16,17}. There is a direct relationship between toxic aluminium concentration in soil and soil pH - particularly pH's below 4.6 in $CaCl_2$ (calcium chloride) ¹⁰.

Plants grown in aluminium dominated acid soils have impaired root systems and inhibited shoot growth, resulting in a decrease in vigor and yield ^{18,19,20,21} and ultimately profitability ²². Aluminium is reported to interfere with the uptake, transport, and metabolism of several essential nutrients (eg locks-up Phosphorous in less bio-available forms in acid soils); and plants display a variety of nutrient deficiencies ^{23,24} (e.g. Phosphorous, Calcium, Magnesium or Fe-Iron) and reduced water uptake ^{25,13}.

Western Mineral's Fertilisers are Silicate based!

Western Mineral Fertilisers have developed quality silicate based fertilisers. Materials included in the compound fertiliser granules (pellets) have been specially selected - based upon their plant-available silicates (Calcium Silicate, Potassium Silicates and mineral ore based silicates). Silicate based fertilisers play a key role in plant nutrition, insect and disease resistance ²⁶, soil adsorption capacity, and can optimize physical and structural properties of the soil ^{27,28}.

In addition, application of silicate mineral fertilisers increases water holding capacity, cation-exchange capacity and thus nutrient cycling ^{29,30,31}. The surface of silicate minerals may also provide sites for the formation of organic matter, thereby assisting to increase organic matter levels in deficient and disturbed soils ³².

WMF Microbe technology has been developed to enhance the performance of these Mineral fertilisers. Microorganisms play an important role in the weathering of silicate minerals and in turn the minerals appear to play an important role in microbial ecology ^{33,34,29}. 90% of terrestrial plants form symbiotic associations with microorganisms such as mycorrhizal fungi. In these plants, the fungal hyphae of the mycorrhiza perform a vital function in the acquisition of Phosphorous ^{35,36}, and other mineral nutrients (such as silicates ³⁷) for the plant.

Conclusion (*Aluminium and Silicates in Plant Nutrition*):

The beneficial effects of bio-available Silicon on plant growth are mainly attributable to the silicates that accumulate in plant cell walls. These effects are demonstrated most clearly under high-density cultivation systems with heavy applications of nitrogen. Silicon is now becoming recognized as an 'agronomically essential element', as it helps to generate resistance to disease and pests in many plants, and may also reduce rates of application of pesticides and fungicides. Silicon is also considered as an environment-friendly element - in relation to soils, fertilisers and plant nutrition. In addition Silicon uptake (in a bio-available form) is enhanced by good soil microbiology (involving mycorrhiza in particular).

Western Mineral Fertilisers products (minerals and microbes) are designed and manufactured for the complexities of West Australian soils, and are having a significant positive impact in Agriculture across Western Australia. Western Mineral Fertilisers recommends and uses only biologically-friendly forms of inputs in our Mineral fertilisers. WMF's Plants-Microbe-Mineral-Soil management system assists with more efficient uptake, retrieval and internal use of Silicon (and other nutrients).

References: (for list of References in larger text contact WMF or visit our web site www.wmf1.com)

- McManus WR, RG Anthony, LL Grout, AS Malin and VNE Robinson (1979) Biocrystallization of mineral material on forage plant cell walls, *Aust Journal of Agricultural Research* **30**(4) 635 – 649
- Nelwamondo A, Jaffer MA, Dakora FD (2001) Subcellular organization of N₂-fixing nodules of cowpea (*Vigna unguiculata*) supplied with silicon *Protoplasma*; **216**(1-2):94-100.
- Epstein E (1999) Silicon. *Annu Rev Plant Physiol Plant Mol Biol* **50**: 641-644.
- Ma JF, Miyake Y, Takahashi E (2001) Silicon as a beneficial element for crop plants. In L Datonoff, G, Korndorfer, G Snyder, eds, *Silicon in Agriculture*. Elsevier Science Publishing, New York, pp 17-39.
- Cocker, K.M., Evans, D.E. & Hodson, M.J. (1998) The amelioration of aluminium toxicity by silicon in higher plants: Solution chemistry or an in planta mechanism? *Physiol. Plant*. **104**, 608.614.
- Ma JF, Sasaki M, Matsumoto H (1997) Al-induced inhibition of root elongation in corn, *Zea mays* L. is overcome by Si addition. *Plant Soil* **188**:171-176.
- Zsoldos F, Vashegyi A, Bona L, Pécsvárad A, Szegetes Zs (2000) Growth and potassium transport of winter wheat and durum wheat as affected by various aluminium exposure times. *J Plant Nutr* **23**:913-926.
- Vashegyi, A., Zsoldos, F., Pécsvárad, A., Bona, L. (2002) Aluminium/silicon interactions in cereal seedlings *Acta Biologica Szegediensis* Volume **46**(3-4):129-130.
- Simonsson M., Berggren D. (1998) Aluminium solubility related to secondary solid phases in upper B horizons with spodic characteristics. *Eur. J. Soil Sci.* **49**:317-326.
- Tang, C., and Rengel, Z. (2001) Liming & Reliming Enhance Barley Yield on Acidic Soil, *Bulletin 4509 - Western Australia Soil Acidity Research & Development Update*.
- Kidd, P.S., Llugany, M., Poschenrieder, C., Gunsé, B. and Barceló, J. (2001) The role of root exudates in aluminium resistance and silicon-induced amelioration of aluminium toxicity in three varieties of maize (*Zea mays* L.) *Journal of Experimental Botany*, **52**, No. 359, pp. 1339-1352.
- Porter, B. (1997) *Bulletin 4505 - Western Australia Soil Acidity Research and Development Update*.
- Gazey C. and O'Connell, M. (2001) Soil Acidity Management Pays Off, *Bulletin 4509 - Western Australia Soil Acidity Research and Development Update*.
- Delhaize, E. & Ryan, P.R. (1995) Aluminium toxicity & tolerance in plants. *Plant Physiol.* **107**, 315-321.
- Horst, W.J. Schmohl, N., Kollmeier, M., Baluska, F. & Sivaguru, M. (1999) Does aluminium inhibit root growth of maize through interaction with the cell wall-plasma membrane-cytoskeleton continuum? *Plant Soil* **215**, 163-174.
- Marienfeld, S., Schmohl, N., Klein, M., Schroeder, W.H., Kuhn, A.J. & Horst, W.J. (2000) Localisation of aluminium in root tips of *Zea mays* & *Vicia faba*. *J. Plant Physiol.* **156**, 666-71.
- Kollmeier, M., Felle, H.H. & Horst, W.J. (2000) Genotypical differences in aluminum resistance of maize are expressed in the distal part of the transition zone. Is reduce basipetal auxin flow involved in inhibition of root elongation by aluminum? *Plant Physiol.* **122**, 945-956.
- Mossor-Pietraszewska, T., Kwit, M. & Legiewicz, M. (1997) The influence of aluminium ions on activity changes of some dehydrogenases & aminotransferases in yellow lupine. *Biol. Bull. Poznan* **34**, 47-48.
- Nosko, P., Brassard, P., Kramer, J.R. & Kershaw, K.A. (1988) The effect of aluminum on seed germination and early seedling establishment, growth and respiration of white spruce (*Picea glauca*). *Can. J. Bot.* **66**, 2305-2310.
- Blancaflor, E.B., Jones, D.L. & Gilroy, S. (1998) Alterations in the cytoskeleton accompany aluminum-induced growth inhibition and morphological changes in primary roots of maize. *Plant Physiol.* **118**, 159-172.
- Taylor, G.J., Blamey, F.P.C. & Edwards, D.G. (1998) Antagonistic and synergistic interactions between aluminum and manganese on growth of *Vigna unguiculata* at low ionic strength. *Physiol. Plant*. **104**, 183-194.
- Sandison, A. & Bathgate, A. (1997) *Bulletin 4505 - Western Australia Soil Acidity Research and Development Update*.
- Foy, C.D. (1988) Plant adaptation to acid, aluminum-toxic soils. *Commun. Soil Sci. Plant Anal.* **19**, 959-987.
- Huang, J.W., Pellet, D.M., Papernik, L.A. & Kochian, L.V. (1996) Aluminum interactions with voltage-dependent calcium transport on plasma membrane vesicles isolated from roots of aluminum-sensitive and -resistance wheat cultivars. *Plant Physiol.* **110**, 561-569.
- Gunse, B., Poschenrieder, Ch. & Barcelo, J. (1997) Water transport properties of roots and root cortical cells in proton- & Al-stressed maize varieties. *Plant Physiol.* **113**, 595-602.
- Datnoff, L.E., Deren, C.W., Snyder, G.S. (1997) Silicon Fertilization for Disease Management of Rice in Florida. *Crop Protection*. **16**, 6, 525-531
- Matchenkov, V.V., & Ammosova, J.M., (1996) Effect of amorphous silica on soil properties of a sod-podzolic soil. *Eurasian Soil Science* **28**(10):87-99.
- Jacinin, N.L. (1994) Colloid High-Molecular Systems in Northern Kazakhstan Solonetz, *PhD Thesis* Tashkent.
- Bennett, P.C., Rogers, J.R., Hiebert, F.K., Choi, W.J. (2001) Silicates, silicate weathering, and microbial ecology. *Geomicrobiol. J.* **18**, 3-19.
- Harley, A.D., (2002) The evaluation and improvement of silicate mineral fertilisers, *PhD Thesis* University of Western Australia.
- Rogers, J.R. & Bennett, P.C. (2004) Mineral stimulation of subsurface microorganisms: release of limiting nutrients from silicates, *Chemical Geology* **203**, 91-108.
- Harley, A. & Storer, P. (2004) Silicate minerals: increased microbial stimulation, source of nutrients and de-facto organic matter? Implications for mine rehabilitation. *In press*.
- Malinovskaya, I.M., Kosenko, L.V., Votselko, S.K., Podgorskii, V.S., (1990). Role of Bacillus mucilaginosus polysaccharide in degradation of silicate minerals. *Mikrobiologiya* **59**, 49-55.
- Berthelin, J., (1988). Weathering microbial processes in natural weathering. In: Lerman, A., Meybeck, M. (Eds.), Physical and Chemical Weathering in Geochemical Cycles. Kluwer Academic, New York, pp. 33-59.
- Bolan NS (1991) A critical review on the role of mycorrhizal fungi in the uptake of phosphorus by plants. *Plant Soil* **134**: 189-207.
- Smith SE, Read DJ (1997) Mycorrhizal Symbiosis. Academic Press, San Diego, CA.
- van Hees, P. A. W., Jones, D. L., Jentschke, G. & Godbold, D. L. (2004) Mobilization of aluminium, iron and silicon by *Picea abies* and ectomycorrhizas in a forest soil. *European Journal of Soil Science* **55** (1), 101-112.
- Lumsdon D.G., and V.C Farmer (1995) Solubility characteristics of proto-imoqolite sols: how silicic acid can detoxify aluminium solutions. *European Soil Sci.* **46**, 179-186

Staff Update :

Paul Storer (BSc, MSc) joined the staff in July 2004 and heads up WMF's R&D and Technical section. Paul is a microbiologist and agricultural advisor who has 18 years university research experience into the interaction between soil microbes and plant systems. He has an extensive research publication record, and has been working extensively in W.A, Victoria and SE Asia assisting farmers and plant breeders to enhance production through improving soil nutrition and increasing beneficial microbe levels.





LEADERS IN BIOLOGY AND MINERAL FERTILISERS

Paddock Update and Results:



Steve Bowman (Napier) cattle farming - 5 years on mineral/biological program – resulting in heavy stocking rates & top weight gain. Added bonus – stock no longer require lick blocks. 180days old, Wt gain 1.4kg/head/day from birth in an extremely dry year.

Dawson Beeck (Katanning), 4 years on mineral/biological program. Achieving above average yields, with the added bonus of excellent biological stubble breakdown. 3.5 tonnes/Ha wheat NPK Crop Mineral fertiliser 120kg/Ha Very low screenings.



Trial Update :

Independent field Research continues at Iluka (Capel – pasture renovation – comparative trials – feed quality, dry matter yield, and improvement in soil quality), Leibe Group (Buntine – long term cropping trials focusing on future sustainability, monitoring yield and increase in organic matter and soil biology) and Harvey (comparative pasture trials). Reports in future “Updates”.

Microbe Update:

Salinity and Mycorrhiza : Soil salinity is a widespread problem, restricting plant growth and biomass production. Fast growing trees such as Sesbania & Acacia sp. (moderately salt-tolerant legume trees) are now being used in the reclamation of saline soil. However, these trees usually exhibit a considerable dependence on mycorrhizae (Plenchette 1983 Plant Soil 70:199–209), especially for an adequate supply of phosphorus and other nutrients. Research conducted by Bhoopander & Mukerji (*MYCORRHIZA* 2004 14:307–312) demonstrated that under salinity stress conditions, Sesbania sp. showed a high degree of dependence on mycorrhizae, increasing with the age of the plants. This process happens with most commercial cropping and pasture species of plants. The reduction in sodium (Na) uptake together with a simultaneous increase in P, N & Mg absorption & high chlorophyll content in mycorrhizal plants may be important salt-alleviating mechanisms for plants growing in saline soil.

Plants Communicating with Microbes : It is now well established that there are numerous communications sent to & from plants & microbes (eg nodule-specific messages or nodulins). Research published in the latest edition of the scientific journal *MYCOLOGIA* (Nagahashi & Douds, Dec 2004, v 96 5:948-954) has demonstrated evidence for a second messenger in plant root secretions that can directly induce growth & branching of mycorrhizal fungi – thereby increase nutrient uptake to the host plant.

Soil Testing Update :

It's Soil Testing Time –We recommend comprehensive CEC tests ... (includes Aluminium, C/N ratio & Total Phosphorous analysis)! Contact Western Mineral Fertilisers for your soil testing kit....

Next Update :

In the Autumn edition of “Update” – we will include the latest Research Report.

WMF Head Office Tenterden Phone (08)-9851-7222

Fax (08)-9851-7293 Web Site www.wmf1.com

Local Distributors: Gingin – Tex Marten (08)-9575-2328

Pingelly – Andrew Pauley (08)-9887-1476

Denmark – John Dawes 0408-409-327

Forrestfield – Colin & Heidi Pember (08)-9453-6782

Margaret River – Nick MacPherson Viticultural Services (08)-9757-6425

Bunbury – Agra-Force (08)-9725-6557

Esperance – Terry Mitchell (08)-9076-5009

Cranbrook – Stirling Bulk Distributors (08)-9851-7218