Plant nutrition *courier*

The best bits of plant nutrition research **Including Beneficial nutrients news**

Sulphur essential for a plant's defence

The days of acid rain are gone. Since smoke is large-scale desulphurized, sulphur supply of crops is reduced drastically. Nowadays plants get too little sulphur for a healthy growth, Bernd Zechmann from the Karl-Franzens-Universität Graz Institute of Plant Sciences knows. Recently the Austrian plant physiologist demonstrated the significance of sulphur for a plant's resistance to viral diseases. Zechmann traced the key precursors of the increased virus resistance in close cooperation with colleagues at the Institute of Plant Sciences and researchers from the Hungarian Plant Protection Institute. This study is the first to indicate a clear link between sulphur-induced resistance and the activation of cysteine and glutathione metabolism during a compatible plant-virus interaction, Zechmann says. He suspects to have found a general mechanism behind sulphur-induced resistance. Zechmann found the correlation between sulphur nutrition and resistance to a virus disease in experiments with tobacco mosaic virus infested tobacco seedlings, whether or not supplied with sulphur. Whether sulphur nutrition protects potato against viral diseases still needs to be tested. Plants take up sulphur from soil in the form of sulphate (SO_4^-), which is converted into sulphite (SO_3^{2-}) and afterwards in sulphide (S^{2-}). Sulphide is synthesized into cysteine, the final product of the sulphate assimilation. One of the most important cysteine-containing peptides is glutathione. Glutathione has many important functions in plants and plays key roles in a plant's defence through the activation of defence genes. Thus, glutathione metabolism can be directly linked to sulphur metabolism, Zechmann says. This linkage demonstrates the importance of sulphur for plant defence. Earlier he found that elevated glutathione and cysteine contents could be correlated with a suppression of symptom development and virus contents in *Cucurbita pepo*. Furthermore Zechmann found that glutathione and cysteine contents were substantially more elevated in a resistant pumpkin cultivar compared to a susceptible one during virus infection.

Tobacco plants inoculated with tobacco mosaic virus demonstrate the effect of sulphur nutrition. Left: Sulphur treated tobacco plant without virus symptoms. Right: Virus symptoms on leaves of tobacco plant not treated with sulphur. Photographs: Bernd Zechmann

Contents

Pre-harvest calcium sprays improve apple flavour

Pre-harvest calcium sprays improve the flavour of apples in the months prior to picking. The treatments enhance the contents of most of the compounds that contribute to the overall flavour in ripe fruits. So spraying calcium before harvest is a suitable method to improve fruit aroma at harvest, Universitat de Lleida researchers say in a recently published paper.
The Spanish researchers examined pre-harvest calcium prays with 'Fuji Kiku-8' apples in order to learn if such a treatment may be beneficial for apples aimed for long-term storage. Apple fruits for long-term storage are often harvested before full ripeness. Picking before optimal maturity improves the storage potential and resistance to postharvest handling procedures, but such fruits often fail to develop full flavour after harvest. Earlier the Spanish researchers reported that calcium dips

enhanced the flavour-related volatile esters after cold storage of 'Fuji Kiku-8' apples (see paper) and 'Golden Reinders' apples (see paper).

Adjuvant improves calcium performance

Sodium carboxymethyl cellulose (CMC) increases the retention and humectancy of calcium foliar fertiliser formulations on apple fruits. This adjuvant also enhances the penetration and distribution of calcium into the fruits and helps to reduce the incidence of calcium-related disorders like bitter pit. The food additive CMC outperforms polyoxyethylene sorbitane monolaurate, a spray adjuvant commercially available under the name Tween 20. Researchers at the Estación Experimental de Aula Dei have found this in laboratory and field experiments conducted with 'Golden Reinders' apples (see article).
CMC or Tween 20 added to a calcium chloride foliar fertiliser don't affect fruit quality traits in fresh or four weeks cold-stored peaches, the researchers noted in a still to be published experiment. In a second experiment with a more plant-friendly concentration of calcium chloride, adjuvants do improve peach quality.

Antagonists distinguish between nitrogen sources

Nitrogen deficiency limits the activity of antagonists of the mycotoxins producing fungus *Fusarium pseudograminearum* in cereal straw. The general antagonistic fungus *Trichoderma harzianum* seems to prefer urea or nitrate as nitrogen source, since ammonium addition removes the inhibitory effect on the growth of the crown rot causing cereal disease. The antagonistic fungi *Fusarium equiseti* and *Fusarium nygamai* seem to make no distinction between the three tested nitrogen sources, so it appeared from experiments conducted by researchers at the University of New England School of Environmental and Rural Science. The Australian researchers published their results in the scientific journal *Biological Control* (see paper).

Copper extends vase-life

Acacia foliage stems have a short vase-life, mainly because of a rapid decline in post-harvest water uptake. A treatment with copper (Cu^{2+}) ions improves the rate of water uptake by *Acacia holosericea* foliages stems and increases the fresh weight of the stems, compared to stems placed in de-ionised water. According to University of Queensland experts, the optimum treatments are 0.5 mM Cu^{2+} ions as a vase-solution, or 2.2 mM Cu^{2+} ions as a 5 h pulse. They suggest the improved water relations of cut stems may be associated with the suppression of bacteria, the inhibition of wound-induced physiological processes, or an enhancement of the hydraulic conductance of the xylem. The researchers are still studying Cu^{2+} action in *Acacia holosericea*. A part of this research has already been published.

Sulphur improves corn salad growth

A high sulphur availability in the nutrient solution increases nitrate uptake and assimilation in hydroponically grown corn salad. High sulphur availability too positively affects iron acquisition mechanisms, so it appears from recently published experiments conducted by researchers at the Università di Udine and the Free University of Bozen - Bolzano (see article). In order to grow corn salad equilibrately on hydroponics, the Italian researchers advise to account of the level of sulphur availability.

Ammonia synthesis with novel process

Scientists at the University of Cambridge are working on ways to improve the efficiency of the ammonia synthesis process. With between 3-5% of the world's natural gas used to create artificial fertilisers, the new research could have major implications for both the agricultural and energy sectors.

Ammonia (NH_3) is one of the most important chemicals in the modern world, due mainly to its use in the manufacture of fertilisers. Ammonia synthesis (via the "Haber" or "Haber-Bosch" process, see box **A century of ammonia synthesis**) is vital to the production of 100 million tons of fertiliser per year.
In nature, ammonia is generated by plants (predominantly legumes) and certain bacteria, which extract nitrogen from the atmosphere in a process known as nitrogen fixation. So, natural nitrogen fixation occurs at ambient temperatures and pressures. Artificial nitrogen fixation via the Haber-Bosch process however requires high pressures (150-250 atmospheres) and high temperatures (300-550 degrees Celsius) to produce the vast quantities of ammonia necessary to satisfy global demand.

"The Haber-Bosch process was developed in the early twentieth century, but has changed little since that time", physical chemist Stephen Jenkins say. "Even a tiny improvement in the efficiency of the ammonia synthesis process can have massive implications, not only for the economics of fertiliser production, but also for global energy demand." Jenkins leads the University of Cambridge Surface Science Group, a research unit in the chemistry department of this British university.

The secrets of the catalyst
The key to the Haber-Bosch process is an iron catalyst which encourages the dissociation of N_2 molecules, and provides a platform on which the resulting N atoms can be successively hydrogenated to yield NH, NH_2 and finally NH_3. Great efforts have been expended over many decades on the problems of understanding how the iron catalyst does its job, why the addition of certain elements such as potassium can improve the catalysts, and whether any of the lessons learnt thus far can help to predict a better catalyst that is economically viable. The Cambridge group's findings, reported in the *Proceedings of the National Academy of Sciences* (see paper), address some of these problems. The British researchers hope their findings will pave the way for a more efficient way to produce fertilisers.
Jenkins and his co-workers choosed a surface science approach, using single-crystal iron samples of high purity and conducted their experiments under ultra high vacuum (uhv) conditions. "We have conducted experiments that combine some of the attractive features of single-crystal uhv surface science with those of higher pressure techniques", so Jenkins explains his innovative approach.

A century of ammonia synthesis

It is 13 October 1908. On this Thuesday at the end of World War I, Fritz Haber files a patent covering the "synthesis of ammonia from its elements". A decade later he is awarded with the Nobel Prize in Chemistry for his discovery to synthesize ammonia from dinitrogen (N_2) and hydrogen (H_2) at high pressures and temperatures. For this purpose Haber uses osmium and uranium as catalysts. Afterwards the Badische Anilin- und Sodafabrik (now BASF) acquires this process of high-pressure synthesis of ammonia. BASF-chemist Carl Bosch transforms Haber's epoch-making finding from a tabletop technique into an industrial-scale process, using pure iron as catalyst. In 1931 the Royal Swedish Academy of Sciences awarded Bosch with the Nobel Prize in Chemistry for scaling up this process. Today the fully developed process is known as the so-called Haber–Bosch process.
"The importance of Haber's discovery cannot be over-estimated", scientists conclude in a *Nature geoscience* feature dedicated to the centennial anniversary of Haber's patent on ammonia synthesis.
"In his Nobel lecture, Haber explained that his main motivation for synthesizing ammonia from its elements was the growing demand for food", the researchers continue to say. As a result of the Haber–Bosch process, billions of people have been fed and a cascade of environmental changes has been set in motion.
"Haber's other motivation, not mentioned in his lecture, was to provide the raw material for explosives to be used in weapons, which requires large amounts of reactive nitrogen. Haber's discovery has therefore had a major influence on both World Wars and all subsequent conflicts".
"In addition, the large-scale production of ammonia has facilitated the industrial manufacture of a large number of chemical compounds and many synthetic products. Thus the Haber–Bosch process, with its impacts on agriculture, industry and the course of modern history, has literally changed the world".

Publications about plant nutrition research

General
The fertility of North American soils, 2010. Better crops with plant food 94(2010)4:6-8
The fertility of North American soils – summary 2010. Better crops with plant food 94(2010)4:32
Global crop intensification lessens greenhouse gas emissions. Better crops with plant food 94(2010)4:16-17

Granulation
Crystallization a tool for product design. Advanced powder technology 21(2010)3:227-234

Mapping, sampling and analytics
Study on the threshold values of soil potassium parameters for release and fixation: a prognostic approach to improve the use efficiency of soil and fertilizer potassium. Communications in soil science and plant analysis 41(2010)22:2661-2675
Organic soil phosphorus considerably contributes to plant nutrition but is neglected by routine soil-testing methods. Journal of plant nutrition and soil science 173(2010)5:765-771
On design and statistical analysis in soil treatment experiments. Soil science 175(2010)11:519-529
Use of the stable isotope ^{57}Fe to track the efficacy of the foliar application of lignosulfonate/Fe^{3+} complexes to correct Fe deficiencies in cucumber plants. Journal of the science of food and agriculture 91(2011)2:395-404
Use of reference soils in determinations of 0.01 M calcium chloride available metals. Communications in soil science and plant analysis 41(2010)21:2602-2612

Humic acids
Effect of *Fusarium oxysporum* f. sp. *lycopersici* on the soil-to-root translocation of heavy metals in tomato plants susceptible and resistant to the fungus. Journal of agricultural and food chemistry 58(2010)23:12392-12398
Effect of foliar-applied humic acid to dry weight and mineral nutrient uptake of maize under calcareous soil conditions. Communications in soil science and plant analysis 42(2011)1:29-38
Direct effects of humic-like substance on growth, water, and mineral nutrition of various species. Journal of plant nutrition 34(2011)1:46-59

Nano-fertilisers
Use of surface modified inorganic nano materials as slow release nitrogen fertilizer. Sustainable agriculture development. Part 3:171-184

Specific release
Use of surface modified inorganic nano materials as slow release nitrogen fertilizer. Sustainable agriculture development. Part 3:171-184
Preparation and properties of the coated slow-release N and P fertilizer. Plant nutrition and fertilizer science 16(2010)4:1027-1031
Effects of different mixture rates of coated urea and prilled urea on rice grain yield and nitrogen use efficiency. Plant nutrition and fertilizer science 16(2010)4:918-923
Effects of co-situs application of polymer-coated fertilizers on grain yield, root distribution and soil residual N_{min} in summer maize. Plant nutrition and fertilizer science 16(2010)4:924-930
Applications of polymer coated urea with different release time and conventional urea on summer maize growth. Plant nutrition and fertilizer science 16(2010)4:931-937
Preparation and properties of a coated slow-release and water-retention biuret phosphoramide fertilizer with superabsorbent. Journal of agricultural and food chemistry 59(2011)1:322-327
Multifunctional slow-release organic–inorganic compound fertilizer. Journal of agricultural and food chemistry 58(2010)23:12373-12378

Nitrogen
Preparation and properties of the coated slow-release N and P fertilizer. Plant nutrition and fertilizer science 16(2010)4:1027-1031
Nutritional constraints on displacement of *Fusarium pseudograminearum* from cereal straw by antagonists. Biological control 55(2010)3:241-247
Effects of different mixture rates of coated urea and prilled urea on rice grain yield and nitrogen use efficiency. Plant nutrition and fertilizer science 16(2010)4:918-923
Effects of co-situs application of polymer-coated fertilizers on grain yield, root distribution and soil residual N_{min} in summer maize. Plant nutrition and fertilizer science 16(2010)4:924-930

Plant nutrition on the web

Direct Application of Phosphate Rock

A fertiliser planner or a diagnostic tool - the web has dozens of interesting websites. In this issue the FAO/IAEA/IFDC Direct Application of Phosphate Rock.

Website Direct Application of Phosphate Rock
URL www-iswam.iaea.org/dapr/srv/en/home
Languages English
Description Decision support system to predict the relative agronomic effectiveness of phosphate rock with respect to water soluble phosphorus fertilisers at field and farm level.
Offered by Food and Agriculture Organization of the United Nations (FAO), International Atomic Energy Agency (IAEA) and International Fertilizer Development Center (IFDC).

Publications about plant nutrition research

Applications of polymer coated urea with different release time and conventional urea on summer maize growth. Plant nutrition and fertilizer science 16(2010)4:931-937
The effects of nitrogen rate and the ratio of NO_3^-:NH_4^+ on *Bemisia tabaci* populations in hydroponic tomato crops. Crop protection 30(2011)2:228-233
Effect of nitrogen fertilizer on the growth and survival of *Rhopalosiphum padi* (L.) and *Sitobion avenae* (F.) (Homoptera: Aphididae) on different wheat cultivars. Crop protection 30(2011)2:216-221
Preparation and properties of a coated slow-release and water-retention biuret phosphoramide fertilizer with superabsorbent. Journal of agricultural and food chemistry 59(2011)1:322-327
Corn salad (*Valerianella locusta* (L.) Laterr.) growth in a water-saving floating system as affected by iron and sulfate availability. Journal of the science of food and agriculture 91(2011)2:344-354
Gas exchange and antioxidant response of sweet pepper to foliar urea spray as affected by ambient temperature. Scientia horticulturae 127(2011)3:334-340
Mobilization of nitrogen in the olive bearing shoots after foliar application of urea. Scientia horticulturae 127(2011)3:452-454
Changes in saccharide, amino acid and S-methylmethionine content during malting of barley grown with different nitrogen and sulfur status. Journal of the science of food and agriculture91(2011)1:85-93
Influence of nitrogen form, growing season and sulfur fertilization on yield and the content of nitrate and vitamin C of broccoli. Scientia horticulturae 127(2011)3:181-187
Iso-osmotic regulation of nitrate accumulation in lettuce. Journal of plant nutrition 34(2011)2:283-313
On-farm evaluation of real-time nitrogen management in rice. Better crops with plant food 94(2010)4:26-28
Slow-release nitrogen and boron fertilizer from a functional superabsorbent formulation based on wheat straw and attapulgite. Chemical engineering journal 167(2011)1:342-348
Biological amelioration of subsoil acidity through managing nitrate uptake by wheat crops. Plant and soil 338(2011)1-2:383-397

Phosphorus
Preparation and properties of the coated slow-release N and P fertilizer. Plant nutrition and fertilizer science 16(2010)4:1027-1031
Organic soil phosphorus considerably contributes to plant nutrition but is neglected by routine soil-testing methods. Journal of plant nutrition and soil science 173(2010)5:765-771
Ability of various water-insoluble fertilizers to supply available phosphorus in hydroponics to plant species with diverse phosphorus-acquisition efficiency: Involvement of organic acid accumulation in plant tissues and root exudates. Journal of plant nutrition and soil science 173(2010)5:772-777
Available organic soil phosphorus has an important influence on microbial community composition. Soil Science Society of America journal 74(2010)6:2059-2066
Carboxylic acids affect sorption and micro-scale distribution of phosphorus in an acidic soil. Soil Science Society of America journal 75(2011)1:35-44
Preparation and properties of a coated slow-release and water-retention biuret phosphoramide fertilizer with superabsorbent. Journal of agricultural and food chemistry 59(2011)1:322-327
Agronomic use of phosphate rock for direct application. Better crops with plant food 94(2010)4:21-23

Publications about plant nutrition research

Forage radish cover crops increase soil test phosphorus surrounding radish taproot holes. Soil Science Society of America journal 75(2011)1:121-130

Potassium
Mineral sources of potassium for plant nutrition. Sustainable agriculture. Volume 2. Part 2:187-203
Study on the threshold values of soil potassium parameters for release and fixation: a prognostic approach to improve the use efficiency of soil and fertilizer potassium. Communications in soil science and plant analysis 41(2010)22:2661-2675
Precision management of root zone potassium for corn: considerations for the future. Better crops with plant food 94(2010)4:24-25
Future research needs on K for sustainable crop production. Karnataka journal of agricultural sciences 24(2011)1:91-99 and full text

Calcium
Preharvest calcium sprays improve volatile emission at commercial harvest of 'Fuji Kiku-8' apples. Journal of agricultural and food chemistry 59(2011)1:335-341
Improving the performance of calcium-containing spray formulations to limit the incidence of bitter pit in apple (*Malus x domestica* Borkh.). Scientia horticulturae 127(2011)1:23-28
Implications of calcium nutrition on the response of *Salvadora persica* (Salvadoraceae) to soil salinity. Communications in soil science and plant analysis 41(2010)22:2644-2660

Sulphur
Corn salad (*Valerianella locusta* (L.) Laterr.) growth in a water-saving floating system as affected by iron and sulfate availability. Journal of the science of food and agriculture 91(2011)2:344–354
Changes in saccharide, amino acid and S-methylmethionine content during malting of barley grown with different nitrogen and sulfur status. Journal of the science of food and agriculture91(2011)1:85–93
Influence of nitrogen form, growing season and sulfur fertilization on yield and the content of nitrate and vitamin C of broccoli. Scientia horticulturae 127(2011)3:181-187

Boron
Slow-release nitrogen and boron fertilizer from a functional superabsorbent formulation based on wheat straw and attapulgite. Chemical engineering journal 167(2011)1:342-348
Effect of soil properties on boron adsorption and release in arid and semi-arid benchmark soils. Communications in soil science and plant analysis 41(2010)21:2532-2544

Copper
Treatment with Cu^{2+} ions extends the longevity of cut *Acacia holosericea* foliage stems. The journal of horticultural science & biotechnology 86(2011)1:55-61

Iron
Fe(III)–humate complexes from Megalopolis peaty lignite: A novel eco-friendly fertilizer. Fuel 89(2010)7:1480-1484
Stability in solution and reactivity with soils and soil components of iron and zinc complexes. Journal of plant nutrition and soil science 173(2010)6:900–906
Performance of soil-applied FeEDDHA isomers in delivering Fe to soybean plants in relation to the moment of application. Journal of agricultural and food chemistry 58(2010)24:12833-12839
Corn salad (*Valerianella locusta* (L.) Laterr.) growth in a water-saving floating system as affected by iron and sulfate availability. Journal of the science of food and agriculture 91(2011)2:344–354
Use of the stable isotope ^{57}Fe to track the efficacy of the foliar application of lignosulfonate/Fe^{3+} complexes to correct Fe deficiencies in cucumber plants. Journal of the science of food and agriculture 91(2011)2:395–404

Manganese
Effects of manganese fertilizers on yield and yield components of dwarf dry bean. Journal of plant nutrition 34(2011)1:127-139

Zinc
Stability in solution and reactivity with soils and soil components of iron and zinc complexes. Journal of plant nutrition and soil science 173(2010)6:900–906

Silicon determination with novel method

What is the silicon status of a plant, or a soil? A number of chemical extraction procedures have been developed, but an simple, dependable and robust method for routine testing of plant available silicon is not generally acknowledged as yet. The challenge is to develop a method for routine testing that correlates well with changes in soil silicon status and corresponding plant tissue levels. Researchers at the University of Illinois and Kansas State University recently have added a new silicon determination procedure to the already existing range of analytical methods: the plant alkaline fusion technique. After dry-ashing of the plant tissue to be analysed, the procedure includes alkaline fusion, solubilisation of the fusion cake, dilution, and colorimetric determination to quantify total silicon content. The researchers tested the new method on five ornamental plant species and four reference materials (pine needles, peach leaves, rice straw and soil). Silicon concentrations are assessed using the plant alkaline fusion technique procedure and the silicon values are compared to two different inductively coupled plasma-optical emission spectroscopy (ICP-OES) procedures conducted by independent laboratories. Silicon determination by the plant alkaline fusion technique procedure "typically reported the greatest value or was within 15% of the two ICP-OES procedures while costing significantly less than both ICP-OES procedures", the researchers say in a recently published paper.

Extractors tested for availability of fertiliser silicon

A small team of American and Brazilian researchers advise Na_2CO_3 + NH_4NO_3 as extractor for the determination of available silicon in solid fertilisers. For liquid fertilisers, the total silicon (HCl + HF) is found to be the best method. The researchers found their recommendations on a study in which seven extractors have been tested on ten solid or liquid silicon-containing fertiliser products. The analytical methods tested are: hydrochloric acid (HCl) plus hydrofluoric acid (HF) extraction, leaching column; sodium carbonate (Na_2CO_3-10 g/l) plus ammonium nitrate (NH_4NO_3-16 g/l); citric acid (50 g/dm^{-3} or 5%); hydrochloric acid (0.5 N); neutral ammonium citrate (NAC); and resin (Amberlite IRC-50, pK 6.1). Results of this investigation are published in the *Journal of plant nutrition* (see article).

Lignosulphonates differ in performance

Lignosulphonate ligands differ in efficacy. So it appears from a study with softwood and hardwood Fe-lignosulphonate complexes as foliar fertiliser to correct iron chlorosis in hydroponically-grown cucumber plants. The softwood (spruce) Fe-lignosulphonate outperforms the hardwood (eucalyptus) Fe-lignosulphonate; chemical modification however improved the iron complexing ability of the hardwood (eucalyptus-based) Fe-lignosulphonate. All the tested Fe-lignosulfonates stimulate the vegetative growth of the cucumber plants. Furthermore these lignosulphonate foliar fertilisers don't require surfactants and don't burn the leaves, researchers at the Universidad Autónoma de Madrid and Universidad de Oviedo conclude from this experiment. The Spanish plant nutrition scientists used the stable isotope ^{57}Fe to track the efficacy of the foliar applied Fe-lignosulphonate complexes. In the February issue of the *Journal of the science of food and agriculture* they published an article about this research. In earlier work this research group around Juan Jose Lucena Marotta investigated the efficacy of fifteen iron chelates and complexes including Fe-lignosulphonate to correct iron chlorosis of soybean (see article). Lignosulphonates have several advantages over synthetic chelators like EDTA and EDDHA: relatively cheap, biodegradable and providing some adjuvancy like wettability, adsorptivity and dispersibility. In calcareous soils Fe-lignosulphonates don't perform well - a consequence of interactions with soil colloids, plant nutrition researchers at the Universidad Autónoma de Madrid and the Università di Udine say (see article). Fe-lignosulphonates however are efficient foliar fertilisers and are also well-performing in nutrient solutions for hydroponically-grown crops.

Silicon is food for plant ecologists

"Plant ecology is more siliceous than many realise". With this understatement the Australian plant ecologists Julia Cooke and Michelle Leishman motivate colleagues to study silicon *per se*. "Although silicon occurs in all plants, it is an element that is largely overlooked by many plant ecologists", researchers at the Macquarie University Plant Invasion and Restoration Ecology Laboratory say in an opinion forming paper.

Recent silicon publications

General

Extractors for estimating plant available silicon from potential silicon fertilizer sources. Journal of plant nutrition 34(2011)2:272-282

Plant alkaline fusion technique followed by colorimetric procedure for the detection and quantification of total silicon in ornamental plants. Communications in soil science and plant analysis 42(2010)1:75-92

Is plant ecology more siliceous than we realise? Trends in plant science 16(2011)2:61-68

Calcium and silicon mineralization in land plants: Transport, structure and function. Plant science 2011

Arable crops

Wheat	Silicon-induced growth and yield enhancement in two wheat genotypes differing in salinity tolerance. Communications in soil science and plant analysis 42(2011)4:395-407 Wheat resistance to leaf blast mediated by silicon. Australasian plant pathology 40(2011)1:28-38
Oat	Seed germination and seedling development of white oat affected by silicon and phosphorus fertilization. Scientia Agricola 68(2011)1:18-23 and full text
Rice	Deficiency in silicon uptake affects cytological, physiological, and biochemical events in the rice–*Bipolaris oryzae* interaction. Phytopathology 101(2011)1:92-104
Grass	Silicon effects on Poa pratensis responses to salinity. Hortscience 45(2010)12:1876-1881
Lucerne	Effects of NaCl and silicon on activities of antioxidative enzymes in roots, shoots and leaves of alfalfa. African journal of biotechnology 10(2011)4:545-549 and full text
Soybean	Effects of silicon applications on soybean rust development under greenhouse and field conditions. Plant disease 95(95)3:317-324
Sorghum	Doses of silicon in the control of aluminum toxicity for mass production of drought in sorghum. Uniciências 14(2010)2:177-186 and full text
Stylosanthes guianensis	Nodulation and root production of stylosanthes Mineirão under the effect of lime, silicate and phosphorus. Ciência e agrotecnologia 35(2011)1:99-107

Fruit and vegetable crops

Avocado	Effects of postharvest potassium silicate application on phenolics and other anti-oxidant systems aligned to avocado fruit quality Postharvest biology and technology 60(2011)2:92-99
Cucumber	Effect of silicon nutrition on oxidative stress induced by *Phytophthora melonis* infection in cucumber. Plant disease 95(2011)4:455-460
Pakchoi	Response of glucosinolate and flavonoid contents and composition of *Brassica rapa* ssp. *chinensis* (L.) Hanelt to silica formulations used as insecticides. Journal of agricultural and food chemistry 58(2010)23:12473-12480
Tomato	Transcriptome of silicon-induced resistance against *Ralstonia solanacearum* in the silicon non-accumulator tomato implicates priming effect. Physiological and molecular plant pathology 75(2011)3:83-89 Effects of soil amendment on bacterial wilt caused by *Ralstonia solanacerum* and tomato yields in Ethiopia. Journal of plant protection research 51(2011)1:72-76 and full text Cultivation of tomato in organic substrates under leaf spraying of potassium silicate in protected environment. Ciência e agrotecnologia 35(2011)1:56-61

Ornamentals

Sunflower	Correlation between tissue and substrate silicon concentration of greenhouse produced ornamental sunflowers. Journal of plant nutrition 34(2011)2:217-223

Crop protection

Influence of atmospheric and climatic change on plant-pathogen interactions. Plant pathology 60(2011)1:54-69

Soil and fertilisers

Mineral sources of potassium for plant nutrition. Sustainable agriculture. Volume 2. Part 2:187-203

Silicate mineral weathering rate estimates: Are they precise enough to be useful when predicting the recovery of nutrient pools after harvesting? Forest ecology and management 261(2011)1:1-9

Focus on plant nutrition patents

SKW Stickstoffwerke Piesteritz GmbH (Germany) has applied for a patent covering a novel anti-caking agent: an aqueous solution comprising a polyvinyl alcohol and a fatty acid esterified with polyoxyethylene sorbitane as a surfactant and optionally a nitrification inhibitor (see patent publication WO2011015305). Other patent applications from this company are related to a paraffin-based formulation agent (WO2011009572) and a novel liquid fertiliser high in nitrogen and sulphur (WO2011015306).

Other noticeable patent publications disclose a novel process for the preparation of Fe(III)-HBED and its derivatives (WO2011006763), and a slow release fertiliser from Swedish origin (WO2011005174 and WO2011005175).

Patent publications

Anti-caking etc.
Anticaking agent for urea-based fertiliser, fertiliser formulations comprising said anticaking agent, and method for producing same (WO2011015305). SKW Stickstoffwerke Piesteritz GmbH

Chelates / counterions
A process for the preparation of Fe(III) chelates of N,N'-di(2-hydroxybenzyl)-ethylenediamine-N,N'-diacetic acid and its derivatives (WO2011006763). PPC ADOB

Specific release
Method for preparing slow release fertilizers (WO2011005175). Sveaskog Förvaltning AB
Slow-release fertilizer (WO2011005174). Sveaskog Förvaltning AB

Nitrification and urease inhibitors
Compositions consisting of a urea-based fertilizer, a phosphoric acid amide derivative as urease inhibitor and paraffin-based wax, and process for the production thereof (WO2011009572). SKW Stickstoffwerke Piesteritz GmbH

Nitrogen
Novel N/S liquid fertiliser having a high nutrient content (WO2011015306). SKW Stickstoffwerke Piesteritz GmbH
Compositions consisting of a urea-based fertilizer, a phosphoric acid amide derivative as urease inhibitor and paraffin-based wax, and process for the production thereof (WO2011009572). SKW Stickstoffwerke Piesteritz GmbH
Method for preparing slow release fertilizers (WO2011005175). Sveaskog Förvaltning AB
Slow-release fertilizer (WO2011005174). Sveaskog Förvaltning AB
Ammonium nitrate fertilizer with carbonates and zeolite (LT2009048). AB Achema

Phosphorus
Phosphate rock and sulphur based fertiliser for farming or horticultural applications(NZ589461). Christopher Copplestone *et al*.
Potassium polyphosphite composition for agricultural use and associated methods (US7887616). Carl Fabry

Potassium
Potassium polyphosphite composition for agricultural use and associated methods (US7887616). Carl Fabry

Sulphur
Phosphate rock and sulphur based fertiliser for farming or horticultural applications(NZ589461). Christopher Copplestone *et al*.

Iodine
Plant fertilizer composition comprising iodine and method for manufacturing it (WO2011000061). SQM Europe

This service page is dedicated to original patent publications covering innovative plant nutrition products, novel fertiliser formulations and related products of general interest. Information on this page is provided by national and international patent offices.

Focus on plant nutrition products

Potassic lime
A three-in-one fertiliser treatment, so 4Recycling presents its Potassic Lime. Besides 4% K_2O and 8% SO_3, this fertiliser and lime replacement product contains calcium (19% Ca) and trace elements. According to the British manufacturer, the neutralising value expressed as CaO is 31%. One of the raw materials for Potassic Lime is kiln dust, a residual dust from the cement industry. Potassic Lime is a bulk product containing 25% moisture. The light brown, free flowing, dusty material is suitable for wide belt (lime spreader) application.

Photographs: 4Recycling

Sportsmaster WSF

Scotts has a successor to its Sierrasol water soluble fertilisers: Sportsmaster WSF. The Sportsmaster WSF range consists of three formulations: High N, High P and High K. Scotts says the range is ideal for use on sports fields and fairways to compliment the main granular fertiliser programme, but can also used on greens, tees and local authority and landscaped areas. As adjuvant the Sportsmaster WSF formula's contain Tmax.

Selenium prill

Under the brand name Agsel Extra the New Zealand fertiliser manufacturer and distributor Ballance Agri-Nutrients sells an 1% selenium prill. The irregular shaped green granule has been developed by the New Zealand company Unitech Industries and has been designed specifically for topdressing pastures. Each granule contains both sodium selenate (fast-releasing selenium) and barium selenate (slow-releasing selenium).

Super High S

Super High S is high in sulphur and relatively low in phosphorus. Cooperative Ravensdown (New Zealand) makes this solid fertiliser by blending phosphate rock, calcium sulphate and sulphuric acid and adding molten elemental sulphur. 60% of the sulphur is in the ready available sulphate form, 40% is in the slow releasing elemental form. According to Ravensdown, Super High S is "ideal for aerial or groundspread application".

Arginine-based nitrogen fertilisers

SweTree Technologies has developed two arginine-based fertiliser formulations: arGrow Complete and arGrow Support. Arginine is a nitrogen-rich amino acid. According to the Swedish plant and forest biotechnology company, arginine is easily absorbed by plants. Scots pine fertilised with arGrow Complete produces a double amount of root tips and is twice as much mycorrhized than Scots pine treated with an ammonium nitrate based fertiliser, SweTree Technologies concludes from field tests. In 2005 the company had taken over the arginine project from Holmen AB, an investor of SweTree technologies.

With the discovery that many plants absorb basic L-amino acids (in particular L-arginine) at high rates, scientists at the Swedish Umeå Plant Science Centre - Berzelii Centre for Forest Biotechnology laid the foundation of the arGrow arginine-based fertilisers. Such N forms have specific advantages for cultivation of woody plants such as conifer seedlings, researcher Torgny Näsholm says.

This service page is dedicated to innovative plant nutrition products, novel fertiliser formulations and recently introduced local products of general interest. Information on this page comes from manufacturers and suppliers. Information about novel products can be sent to Plant nutrition courier.

Calendar of events

2011		
FMB Asia Fertilizer Conference and Exhibition in 2011	30/03 - 01/04	Beijing, China
9th New Ag International Conference & Exhibition	28/06 - 30/06	Athens, Greece
10th world copper conference	04/04 - 06/04	Santiago, Chile
Solids	06/04 - 07/04	Antwerp, Belgium
BulkSolids India 2011	06/04 - 08/04	Mumbai, India
TSI Sulphur World Symposium 2011	11/04 - 15/04	New York, USA
IFS General Meeting and Annual General Meeting	14/04	London, UK
SYMPHOS 2011	09/05 - 13/05	Marrakech, Morocco
II International symposium on soil and soilless cultivation	15/05 - 19/05	Puebla, Mexico
ICAS2011 - IUPAC International Congress on Analytical Sciences	22/05 - 26/05	Kyoto, Japan
79th IFA Annual Conference	23/05 - 25/05	Montreal, Canada
12th International Symposium on Soil and Plant Analysis	05/06 - 10/06	Chania, Greece
China International Sulphur & Sulphuric Acid Conference 2011	15/06 - 17/06	Shanghai, China
IFA/IFDC Phosphate Fertilizer Production Technology Workshop	20/06 - 24/06	Berlin, Germany
FMB East Europe Fertilizer Conference & Exhibition 2011	22/06 - 24/06	Odessa, Ukraine
11th Int. Conference on the Biogeochemistry of Trace Elements	03/07 - 07/07	Florence, Italy
China International Water-soluble Fertilizer Conference & Exhibition	07/07 - 08/07	Beijing, China
38th Annual Meeting & Exposition of the Controlled Release Society	30/07 - 03/08	Maryland, USA
Soil, Plant and Food Interactions	06/09 - 08/09	Brno, Czech Republic
5th International Conference on Silicon in Agriculture	13/09 - 18/09	Beijing, China
Soil Science in a Changing World	18/09 - 22/09	Wageningen, NL
2011 World Fertilizer Conference	25/09 - 27/09	Chicago, USA
V International symposium on vegetable nutrition and fertilization: vegetable farms management strategies for eco-sustainable development	26/09 - 29/09	Giza, Egypt
Stickstoff in Pflanze, Boden und Umwelt	27-09 - 29-09	Kiel, Germany
ANNA 2011	02-10/07/10	Denver, USA
IFA/IFDC Nitrogen Fertilizer Production Technology Workshop	03/10 - 07/10	Seville, Spain
3rd International Zinc Symposium	10/10 - 14/10	Hyderabad, India
ASA-CSSA-SSSA Annual Meeting	16/10 - 19/10	San Antonio, USA
Sulphur 2011	07/11 - 10/11	Houston, USA
19th International Symposium of CIEC	07/11 - 11/11	Mexico City, Mexico
CIS Fertilizers	16/11 - 18/11	Odessa, Ukraine
2012		
Phosphates 2012	19/03 - 21/03	El-Jadida, Morocco

Colophon

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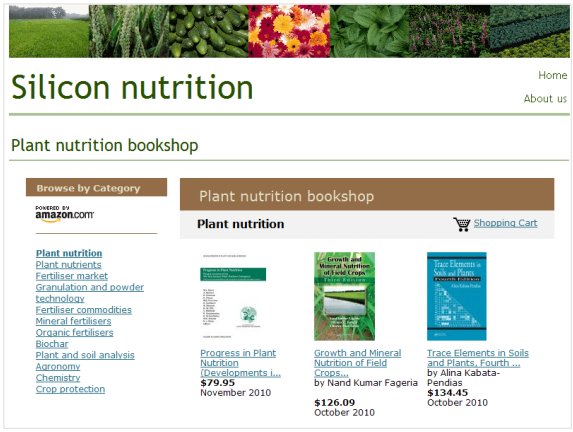
Plant nutrition bookshop



The best bits of plant nutrition research at very keen prices - that is the chief characteristic of the online Plant nutrition bookshop offered by Silicon nutrition.

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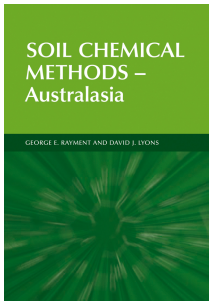

Soil Chemical Methods - Australasia
George E. Rayment and David J. Lyons

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ISBN-13: 978-0643067684
Publishers' price: $ 140.77 (AU $140.00) *
Plant nutrition bookshops' price: $ 91.18 exclusive of shipment costs *
* *Prices not binding, while subject to change; shipping rates differ per destination.*

About the book
Soil Chemical Methods - Australasia describes over 200 laboratory and field chemical tests relevant to Australasia and beyond. There is guidance on the choice and application of analytical methods from soil sampling through to the reporting of results. In many cases, optional analytical 'finishes' are provided, such as flow-injection analysis, electro-chemistry, multiple flame technologies, and alternatives to chemical testing offered by near-range and mid-range infrared diffuse reflectance spectroscopy.

The book supersedes and updates the soil chemical testing section of the 1992 *Australian Laboratory Handbook of Soil and Water Chemical Methods* of Rayment and Higginson, while retaining method codes and other strengths of that Handbook. Chapters cover soil sampling, sample preparation and moisture content; electrical conductivity and redox potential; soil pH; chloride; carbon; nitrogen; phosphorus; sulphur; gypsum; micronutrients; extractable iron, aluminium and silicon; saturation extracts; ion-exchange properties; lime requirements; total miscellaneous elements; miscellaneous extractable elements; alkaline earth carbonates and acid sulphate soils. In addition, there are informative appendices, including information on the accuracy and precision of selected methods.

This handbook targets practising analysts, laboratory managers, students, academics, researchers, consultants and advisors involved in the analysis, use and management of soils for fertility assessments, land use surveys, environmental studies and for natural resource management.

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