Boron (B) Version 4.5 23 April 2017

Boron is essential to prevent milk fever.

Boron is neither a metal nor a nonmetal, it is a metalloid or a semimetal. Boron plays a role in the synthesis of oestrogen, vitamin D, and other steroidal hormones and protects some from rapid breakdown. In addition, boron strengthens the connective structure in bones. Like many minerals, boron can give plants increased resistance to pests and diseases. In Canada, field trials showed the application of boron increased drought tolerance of pastures and clover flea damage was reduced. In some crops, there is more damage by frosts if boron is low. OrganiBOR will be the best to use now because it is slow release, so is not lot by leaching.

Most of New Zealand is low in boron. The high rainfall, two metres per annum South West coast of the New Zealand South Island is VERY low in Boron because of leaching, so they had very bad milk fever with cows needing twice as much Calciumboroglucenate injections, and would then stand up but could not walk because of pain in pin joints. I got farmers to fertilise with boron and milk fever decreased. I wrote about it in the NZ Dairy Exporter in about 1980.

Boron is also necessary for bone health and joints because it activates vitamin D. Boron is needed in soils to absorb both calcium and magnesium. Studies show boron reduces the symptoms of arthritis and degenerative bone diseases, osteoporosis and Paget's disease. Boron also reduces the pain caused by these illnesses. One study found that a significant boron deficiency decreases brain activity as bad as lead poisoning does. Read Boron (B) for Humans.

Crops such as asparagus, brassicas, carrots and clovers need more boron, whereas grasses, wheat and barley don't.

Large areas around Otago in the South Island's semi arid hill and high country, are suffering invasion by the flat weed Hieracium. There are numerous possible causes, including rabbits and droughts which increase its spread, but four kg/ha of B reduced the Hieracium and had no bad effects on other plants, some of which were not affected by as much as 20 kg/ha of B. If applied by air on hills, more than 4 kg/ha should be spread to equate it going on at 4 kg per surface area, which ground spreading can achieve, but by air doesn't. Most of this information on Hieracium is from the Proceedings of the New Zealand Grassland Association 56: 169-173 (1994). Google for Hieracium and boron in New Zealand.

Oversowing with the best white clovers and grasses for your area, followed by heavy grazing to trample them in, and direct drilling have both been successful even in very dry seasons.

In spite of some negative MAF scientists, consultants and fertiliser reps with regard to boron application on pastures, there are still many other consultants and advisers who have seen the positive effects of boron and who regularly include it with their fertiliser mixes. The 1974 Annual Report of the Ministry of Agriculture recorded field trials where applying the equivalent of 9 kg/ha of Borate 48, recorded pasture dry-matter production increases of from 10 to 30 percent. In these trials it was noted that clover growth increased significantly, particularly in periods of high rainfall.

As in other chapters, some information comes from the internet, which is useful for checking science, much of which is old. Google gives hundreds of similar statements about each subject, which means it is pointless giving a credit to any one, and impossible to all.

Boron is one of 114 elements needed in soils, plants and animals, but despite this, very few New Zealand so called soil scientists, fertiliser consultants and fertiliser companies, know or do anything about it, the latter because the small amounts of it and other trace elements sold, increase the work, but not the fertiliser companies' profits, and increase their work and capital investment. In today's New Zealand, companies and even so-called co-operatives, care more about their profit than service and the success of their customers.

Boron is an anion, so its primary method of uptake into the plant is via the soil solution. Plants take up the water and if there is boron in the water then the plant gets it. If there is too little boron in the solution then the plant can develop boron deficiency and if the soil is dry so no moisture is being absorbed by plants, deficiency symptoms will show, and then disappear after rain. If there is too much boron in the solution then the plant can develop boron toxicity. Many of unsolicited have noticed B deficient symptoms in dry weather, disappear after rain.

B improves the frost tolerance of pinus radiata trees and could help clovers and lucerne (alfalfa). Check if applying B helps your clovers to grow more in winter and please let me know either way at

Boron.

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Some of those in the "NZ establishments" still seem unable to accept this fact. I've done dozens of comparative trials on many farms with positive results. The blockers are possibly influenced by some fertiliser companies that just like to sell plain N, P and K, and sponsor trials to prove that more of these are needed. The result is that B's use with fertilisers and/or lime is seldom done even for clover based pastures and maize crops, so cobs don't fill to the end, so the grain yield is 10% or more lower than when B is applied. The grain contains 90% of the feed value of the whole plant. B also helps levels of other essential minerals. Responses to boron fertilising are higher when all elements are correct.

A Ruakura boron pot trial gave production responses of 107% increase (Not just 7% increase. 107% which is more than double) on a boron deficient soil near Taupo in red clover, 74% in lucerne and 43% in white clover (From NZ Journal of Agricultural Research 1983, pages 197 ~ 203 which few read). Farmers often associate clovers with bloat, but this is often because of high nitrate levels in grasses that are force fed with nitrogen and/or excess potassium, and have low B levels.

A dairy farmer near Matamata applied boron to half a paddock and the clovers doubled in size and the cows grazed that half of the paddock shorter than the other.

Lucerne (alfalfa) without B in USA and NZ can fail. TW Walker, in his book White Clover, New Zealand's Competitive Edge (1995), showed B deficiencies. I've done many tests of deficiencies and excesses, but the 'establishment' still lag behind, losing farmers millions of dollars. Legumes need B more than grasses, but most plants and animals need some, and for soils, plants and animals, the best way getting it now is by adding at least 10 kg per hectare per annum of OrganiBOR slow release chips to fertiliser mixes. Some kiwifruit orchardists who applied too much plain boron suffered the splitting of their vines, which would not have happened with OrganiBOR. Most lime and fertiliser companies now stock it which the can get from rick@jabez.co.nz

OrganiBOR in Pastures

After boron has been applied and measured in the past, the B has been very soluble so had no lasting effect, so plants had a fleeting benefit before B leached away, but never long enough to provide the full benefit all year which OrganiBOR does. Only a 2% increase in pasture yield pays its cost.

B also improves the flavour of plants by aiding the uptake of moisture, sugars and positive cations, especially calcium so animals will eat more. Try comparative trials in your garden and your children might eat more fruit and vegetables! Based on plant levels, we design fertilisers containing all the deficient elements, so don't need other supplements.

Lynda Kamphuis buys and supplies small amounts for your garden from 33b Marshmeadow Road, Newstead, RD 6, Hamilton 3284, near HW 26 the Morrinsville Road. Phone 07-858-2200. Email john.kamphuis@maxnet.co.nz Take bags or buckets. She also stocks the best Waikato agricultural lime from Graymont Agricultural Lime Co from Farmlands. It is very fine and has 95% Ca and 2.4% Mg. I'd like more people to do this around the country. Currently Rorisons has a very low % of available Ca because is so coarse, some taking up to 20 years to become available.

In recent years there has been much talk about soil biology, mainly from sales people of way out products claiming all sorts of theoretical benefits from humate, rock dust, abron, etc. Most, if not all, make these claims without doing equal cost comparative trials against basic elements such as in LimeMagPlus which costs about $100 a tonne, delivered in the Waikato, which is about a seventh the cost of Abron and about a tenth that of Humates.

Feeding such a concentrated element as B where animals need so little, can be dangerous. I have never done it and never needed to because I have applied it to soils.

Some plants are more affected by a deficiency of B than others. Worst affected are sugar beet, lucerne, maize, and legumes. Celery, cauliflower, apples, grapes, pears, walnuts, sunflowers, and asters are a few of the others that can also suffer from too little. B deficiencies in cauliflowers causes browning of the heads. In apple trees, bitter pit, caused by low calcium levels, has reduced after boron applications.

Adequate lime helps increase soil humus as shown on six clients farm's in Japan.

Dry weather accelerates the deficiency of B in crops in soils low in available B. LP Latimer, of the New Hampshire USA Agricultural Experiment Station, found that drought in northern hemisphere June

and July led to B deficiency because the supply of available B was reduced, not by fixation, but by the inability of plant roots to feed on it in the dry soil. Keep the B up in your animals, through the soil to pasture and crops, not through supplements or injections. You should also keep your body's B up using capsules, to avoid dry painful joints as B helps reduce calcium and magnesium loss from bones. B also helps to regulate oestrogen levels in humans by helping to convert vitamin D to an active state. Oestrogen, in turn, increases calcium absorption, so the ability of B to improve oestrogen levels strengthens its ability to protect bones from disease and fractures. See Human Health Elements > Boron.

Dr Rex Newnham's research has found persuasive evidence worldwide linking low intake of boron with increased levels of arthritis. In parts of Australia, for instance, where the drinking water contains high boron levels (seven parts per million), there is no arthritis in either humans or animals. Body joints are like two balls against each other. The pressure is concentrated in a very small spot, which can become damaged.

Other examples are -

• In Israel, with high soil boron levels, arthritis occurs in about 1% compared to 20% in USA, with both low water and low soil boron levels.

• The Xhosa tribe in southern Drakensberg mountains, South Africa has boron in their water, so only 3% of its people suffer from arthritis. If they move away, their arthritis levels rise to those in that area. The opposite is also true. In parts of the world where boron intake (from both food and water) is under one milligram a day, arthritis levels generally run between 20% and 70% and benefit from boron.

Boron plays an essential role in a plants reproductive cycle, controlling flowering, pollen production, and seed setting and development. B is also essential for healthy animal and human growth. B is required for the maintenance of bone structure and normal blood levels of oestrogen and testosterone. Unfortunately, few farmers fertilise with boron, which is the best way to get it to animals. B deficiency in humans can and cause arthritis, osteoporosis, joint problems (clicking joints, especially knees) and decreasing brain functions. See Human Health Elements > Boron.

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Not enough attention is given to agricultural lime and boron. The latter is sometimes required only in amounts as little as one kg per ha (one lb per acre) of actual elemental boron, which is contained in 9 kg per ha of OrganiBOR. I repeatedly advise everything to be finely ground. OrganiBOR is soft so dissolves at a predetermined speed for slow release benefits and is made into small chips.

Boron and Ca are often deficient on dairy farms and are needed to replace the Ca and B used and removed in milk, and to assist animal health and production, especially in high rainfall and/or irrigated pastures where more is leached. A consultant recommended feeding gypsum without boron before calving to increase the cows' calcium levels, which in New Zealand are usually adequate because mixed pasture has 1% calcium, and a lot is eaten, while grain has only about half as much Ca.

Boron and calcium (Ca) are synergistic and work together to promote healthy soils, pastures and animals. Boron is a catalyst for the uptake of Ca, and visa versa. This synergism is important for animals that need BOTH Ca and boron to be healthy, grow, reproduce, and make milk. Calcium, boro (boron) gluconate has been used to treat milk fever since the 1950s. See Elements > Calcium. When cows are getting milk fever and not responding to treatment, I will ask farmers if they are fertilising with boron, because I know of cases since the 1980s where, after fertilising with B, milk fever

decreases, and those farmers who do everything correctly have no milk fever.

Unfortunately low calcium is a very common occurrence in New Zealand simply because so little lime has been applied to most soils for decades, since the change to metrics. The 1.3 million tonnes applied in NZ in 2006 was the same amount as applied in 1981. It was insufficient then, and even more so now that milk production per hectare has doubled.

Around 1981, boron was first shown to be an essential mineral for growing poultry. It was not until 1990 that boron was accepted as an essential nutrient for humans.

On Brendan and Tania Fernyhough's Walton hills dairy farm in the Waikato, which had not had enough lime for four or five decades because the pH was 5.8 and higher, applying 3 tonnes per hectare (1.3 tons of LimePlus/acre) which is calcium, serpentine and deficient elements including Ulexite (the then slow release fertiliser boron that contained 11% boron) grew more pasture than normal phosphorus based fertiliser and nitrogen, and reduced the ill effects of dry weather. Applying a second 3 t per ha of lime and trace elements (including B), three months after the first, really boosted the pasture. Clover seeds waiting for calcium and deficient minerals, germinated and greened the paddocks amazingly with more clover and much higher pasture yields. The herbage boro fflen levels in ryegrass rose from 5 to 15 mg/kg and calcium herbage from 0.4% to 0.9%, both closer to where they should be. It cost only half as much per hectare as normal fertiliser applications! This dramatic improvement was repeated on many farms across Australasia. See 'Beef' for details of an example. These results were not new, I achieved similar increase in production in 1958 on our peat farm and on Ian McDonald's farm at Patetonga. See 'Ian McDonald' in 'Testimonials'.

Considerable research has been done on boron in some countries, but not always in conjunction with correct calcium levels. Some farmers, after fertilising with boron, report improved clover growth and animal health, with fewer bone problems, but some researchers call it "anecdotal", rather than checking it themselves for New Zealand's benefit.

My trials in the spring of 2011 show problems caused by some fast release boron and some fertiliser companies not knowing nor caring that plain boron is highly water soluble. This solubility means that the boron is absorbed rapidly by plants which causes edge of leaf burn (as shown above) and also leaching. I put some on our broad beans when 1.5 metres high to increase pod formation which it did, and improve sweetness which it does, and some leaves showed excess boron burning as shown. I checked and the boron was not Ulexite, but was water soluble straight boron which is comparatively fast release. After a month the burning stopped. The slow release OrganiBOR would not have done this.

I recommend OrganiBOR® chips (10% B), because figures show it to be better than other brands even if they contain one or two percentage points more boron. A beauty of OrganiBOR® chips is that its chips can be identified in a fertiliser or fine LimePlus mix. Trace elements can be forgotten (it costs $50/kg/ha) to be added and if not identifiable, buyers never know whether they were included or not. One milk fever dead cow pays for one kg/ha on 40 hectares.

Other borons are fast release, so pasture and crop levels rise, sometimes too high, and then after a few months drop too low.

Read http://www.jabez.co.nz/ and more below for more information.

Problems

Scientists use averages to play safe. I want correct, optimum, and perfect levels, not just average levels.

B is very low right across North America. The many samples I have done, and seen, have been as low as 2 mg/kg, and not just in isolated areas. A Vancouver Island grazing dairy farm client, Edgar Smith of Beaver Meadow Farms, had many samples with only 2 mg/kg, as is right across the USA. Most other countries have these extremely low levels - and they wonder why they can't grow clovers. Millions of hectares of soils in USA contain only enough B to produce a fifth of the normal yield of lucerne hay. The USA ryegrass boron mineral level is mostly around 4 mg/kg. B levels in NZ ryegrasses vary between 4 and 16 mg/kg, but all should be close to 20 mg/kg in ryegrass.

It is strange that most lucerne (alfalfa) growers know that they have to apply boron to avoid failures, but many pasture farmers who can't grow clovers (which are also legumes) do nothing about boron! Adequate lime would also help to increase their boron levels in pastures and crops.

Some of the establishment believe that boron is not deficient in any part of NZ or USA, but pasture analyses frequently reveal severe deficiencies in both, and in many other countries.

A New Zealand dairy farmer going bankrupt before I reversed what he was doing, emailed me, “Our consultant got a Reams soil test done by International Ag Labs in the States, which showed our Boron level was 1.0 mg/L, their desired range being 0.8-1.2 mg/L. Another lab’s soil test showed boron of less than 0.5 mg/L in all three paddocks tested.”

When I analysed their plants for 17 elements (using world famous Hill Laboratories in Hamilton, NZ, a lot more quickly and cheaply than others) the boron in perennial ryegrass was about 5 mg/kg, which is a quarter of the 22 mg/kg it should be. This low boron level is typical of most pasture analyses done in New Zealand, USA and many countries, before applying 10 to 15 kg per hectare of OrganiBOR.

There are times when fertiliser companies run out of trace elements or forget to add one of more, but don’t want to miss the sale, so buyers should always check each load.

Trial results

I was getting good responses in the 1970’s from adding boron, based on pasture analyses, to lime and fertiliser mixes on the farms in my Walton dairy farmer group on light volcanic soils. Mike O'Connor of AgResearch criticised its use so I challenged him to do a trial, which he did on a Walton farm, but didn’t apply lime on the deficient farm so made the trial useless, which he admitted at a field day decades later. Despite this, his figures showed a 9% increase in clover which he ignored and reported ‘No response’. Who would not like a 9% increase in clover. Adequate lime and using a slow release boron, would have given an even higher pasture response.

However, even 9% of 16,000 kg DM per ha (14,000 lb per a) of pasture, which can produce 1,000 kg of milk solids per hectare at $7.50 per kg of milk solids or 55 NZ cents a litre (US 42 cents), is worth NZ$675 per hectare (US$500), minus the cost of the B at NZ$20 per ha (US$8 per a). If spread with lime or fertiliser, there is no spreading cost.

This and more misinformation has come from New Zealand research since facial eczema research recommended toxic sprays when adequate agricultural lime and its synergisms on our farm (and others later) from 1958 on, prevented facial eczema totally at no cost because of the increased pasture DM yield.

Had AgResearch done their boron trials on correctly limed soils, especially peat or pumice the responses would have been much higher, and if only they used increased dollar income as their criterion, they would have had to admit that I and farmers were right - again.

I’ve been encouraging Ruakura and our researchers since 1960 to use the extra net dollars earned, not just extra dry matter grown. Some started doing so in the 1990s when an intelligent friend Dr John Penno was director of Ruakura, but most still don’t. John is now manager of Synlait Milk Company in Dunsandel, Canterbury.

Trials that are not tied to financial income are useless and a waste of research money, but is how AgResearch and most other government trials are done.

Grazed pasture can remove 100 grams of boron per ha (1.4 oz per acre) per annum. Harvested pasture removes more. Some soils can replace this naturally, while other soils (most of North America and New Zealand) need regular applications. Trials I have done showed that, after applying 10 kg per ha (9 lbs per acre) of Ulexite (11% B, equals 1 kg of B) to deficient consolidated peat soils, improves clover, brassicas and maize yields. However, 20 kg per ha (18 lbs per acre) on the same soil can decrease yields, so avoid excesses. Never exceed 22 mg/kg of boron in pasture tissue.

Many of my clients who’ve applied lime and boron at least six months before a drought, noticed that pastures are much less affected by dry weather. Also, in some soil types and areas, disease and fungi resistance in plants have improved.

Boron slows surplus moisture uptake by plants, so reduces the "thin soup" high nitrate, sappy pasture problem that causes scours. Adequate selenium also reduces scours from sappy pasture. Boron also hastens maturity, which encourages the clover to flower, and some farmers notice less bloat when clover is flowering.

A farmer applying boron to a deficient paddock, noticed that clover leaves increased in size dramatically, and after a year there were fewer weeds in the paddock, because clovers grew better and covered the bare patches. Applying as little as 8 kg per ha (7 lbs per acre) of Borax to deficient soils in Eastern Waikato made the latest clover species then (Grasslands Kopu ll) grow leaves and stems four times bigger than previously in soils with adequate calcium! Kopu doesn’t last because it was bred from

and annual one. Before this was publicly known we wasted our money sowing in on 107 ha. See Pastures > Clovers.

The new, higher producing, more vigorous clovers are more likely to respond than old (NZ White & Huia), low producing clovers. New pasture cultivars are selected and developed on well fertilised fertile soils, so need the same conditions on your farm to produce to their maximum and to survive.

Boron also helps pasture take up sugars (energy), calcium and magnesium, and helps keep pasture potassium (K) levels down. High potassium levels in pastures are a serious problem in New Zealand because the establishment, most scientists, and even private laboratory recommended analyses levels, are too high. Some AgResearch scientists have admitted this, but do nothing about lowering them for fear of being called a "whistle blower", or "rocking the boat", so nothing happens and bureaucracy continues at the expense of farmers, who in the case of DairyNZ, pay all their salaries. The owner of a private laboratory agreed with me, **but** didn't want their figures to be different from those of AgResearch. Overseas farmer clients and even scientist clients from Slovenia question the high potassium applications by some people in New Zealand. See 'Potassium'. In the northern hemisphere they aim for only 1% of K in feed. Most New Zealand pastures have between 3 and 4%, when it should be about 2.2%.

The following UK clover leaf figures confirm the above comments regarding borons effect on other elements. Calcium and B are not as low in the UK as in USA and New Zealand. The southern parts of Britain from the White Cliffs of Dover to Wales has chalk subsoils.

Clover - no boron applied

B	K	Ca	Mg
11 mg/kg	2.1%	0.7%	0.4%

Borax 11% B applied at 50 kg per hectare

B	K	Ca	Mg
50 mg/kg	1.6%	1.1%	0.7%

All these changes in levels after applying boron are beneficial to livestock health, especially reducing milk fever. Boron need not be as high as 50 mg/kg. Half that is ample in New Zealand pastures.

Excesses in animals

Symptoms include diarrhoea. If problems are suspected, analyse the pasture and water. High levels in pastures have not caused toxicity problems. Cows consuming 150 to 300 mg/L of boron exhibited inflammation and oedema in the legs and around the dewclaws.

Soil & plant deficiencies

Boron, like cobalt, is held in the organic matter in soils in a mobile form that can be rapidly leached, so it is best to apply ample LimeMag and trace elements, to help increase the organic matter.

Studying boron in hundreds of applications, I consider 22 mg/kg in pasture herbage to be optimum. Unfortunately, most establishments (NZ medical and other authorities), without practical experience, use averages to determine their recommended optimum levels, so countries with low levels have low averages, so low recommendations. The one I like to quote is that New Zealand human average selenium in blood is half that in the UK, where it is also a bit low. Both countries use their averages as optimums, which is a bad policy. See Human Health Elements > Boron. Some now know to aim for 1,200 in the blood.

Sometimes only about 4 kg per ha (3.6 lb per acre) of Ulexite that has 11% boron is required, but none should be applied unless a herbage test shows a deficiency exists, even if the area is known to be deficient, because soils can vary over short distances, as can rainfall on two sides of a mountain. The high rainfall area can be low in boron and the low rainfall side of the mountain can be too high, but not available, that is another example of getting wrong messages from soil testing. Importantly, pasture analysing shows what is needed to be known.

Pasture boron herbage levels decrease during dry weather because pasture roots don't spread to new soil, and boron doesn't move to roots in dry soil. Some summer forage crop failures have been the result of not chisel ploughing the fertiliser in, especially boron. Boron deficiencies can be seen in pastures after no rain for a month because it is consumed, then after rain, pasture tissue levels rise and deficiency symptoms disappear after roots move to new soil.

If boron is deficient, clover seedlings have shallow roots and they don't grow as well. The edges of

old clover leaves can go reddish, hard, brittle and die, while new leaves on the same plant can be a healthy green. The tips of grasses can die.

Low boron can cause aluminium (Al) toxicity, which is even worse, as the roots of aluminium susceptible plants (ryegrass is the worst) don't go deep in high Al soils, increasing drought effects. In Mexico, where irrigated perennial ryegrass had only 3 mg/kg of boron, and aluminium pasture levels were 700 mg/kg, which is extremely high (it should be under 100 mg/kg), plants were stunted and low yielding, and stopped growing once dry weather started. Boron needs ample moisture to keep it available to plants. I'll repeat that in a different way. Trials showed that when the tops of soils got dry, roots weren't able to absorb boron from the dry soils. A big maize company has repeatedly claimed lower grain yields on cobs not filling because of dry weather. They don't chisel plough and don't cultivate the fertiliser in to any depth, so when in our climate the tops of soils start getting dry in November (May in northern hemisphere), their maize cobs start suffering, even in silage, where the grain is the main feed value.

Adequate boron levels and low potassium and/or drought effects can also look the same, so herbage tests are important to be certain of the underlying issue.

Uneven grazing by stock can be another symptom. Lignin (fibre) levels are higher in low boron plants, so could be a cause. High potassium can accentuate the problem.

Boron deficiency causes hard brown or red clover leaves, especially around the edges as shown.

It is the only non-metallic micro-nutrient.

Boron is anionic and highly leachable. It should be applied every year.

Boron is known as the calcium helper and for the metabolism of calcium, magnesium and phosphorus. If calcium is the trucker of minerals, boron is the driver.

Low Boron reduces growth of soil bacteria.

Without boron, plant cells may continue to divide, but structural components are not differentiated. This means the plant has a hard time making xylem tissue. This leads to plugging of sap vessels and cross-transfer of plant fluids among vessels. Sort of like clogged arteries in humans, and in plants leads to poor movement of sap, sugar and carbohydrates in the plant.

This reduction in cellular differentiation leads to compromised meristematic cell elongation, which also reduces flowering and pollination, notably growth of pollen tubes. This affects timing of maturity, pollination, reproduction and ultimately yield. Boron in conjunction with Ca influences reproductive process.

Low boron causes low lignin in the plants. Lignin leads to sturdier plant stalks.

Low boron compromises cell membrane function. Like Calcium, Boron is non mobile in plants and a continuous supply is needed. Cell walls contain 90% of plant Boron and provide structural linkages within cell walls, stabilising membranes. Boron keeps calcium in the cell walls, calcium pectates do not form in the absence of boron. Low boron increases fungal invasion of the cell

Calcium deficiency alone favoured the colonisation of plants but disease severity was greater when calcium and boron were deficient

Boron deficiency leads to higher incidences of Powdery Mildew, Rhizoctonia, Fusarium and Verticillium and others.

Zinc applications reduce boron uptake, and can reduce the rare boron toxicity, and boron can reduce zinc levels, so keep both levels at optimum.

Low calcium and excess phosphorus, and/or excess potassium can reduce boron uptake.

Optimum boron is achieved most precisely through tissue sampling.

Effects on plants

Lucerne (alfalfa) suffers boron deficiencies. Its leaves go yellow, flowers fail to form and buds are white or light brown dead tissue.

Turnips and swedes can have rotten centres (Brown Heart).

Maize (corn) can have 25% fewer cobs which suffer irregular distribution of kernels, shrivelled on the side adjacent to the stem, with fewer on the tips. The leaves of young deficient plants don't unroll. Wide white stripes can also develop between the leaf veins. High lysine maize needs even more boron. In deficient soils, 20 kg per ha of OrganiBOR has increased maize grain yields by 15%!

No kernels on the tip and on the stem side are symptoms of low boron absorption which again, is accentuated in dry soils. Being synergistic with boron, calcium is also likely to be low. Some blame droughts solely for this symptom, but when the boron level is adequate, or 20 kg per hectare of Ulexite boron is spread and chisel ploughed in, it is not a problem. A recent publication claimed that it is low potassium causing this, so I've asked the author for evidence, which has not been supplied, so will do trials next summer. If you know either way please let me know.

The second cob shows slight boron deficiency in the same year and same area. It had optimum potassium, lime and all other elements.

The bottom cob below shows no deficiency at all because it got Ulexite borax at 20 kg per hectare, and optimum LimeMag and trace elements.

Some citrus can be sour when boron is deficient. Applying a boron product at 20 kg per ha (18 lb per a) or 0.01 kg per 5 m2 (2.2 m by 2.2 m) under the tree, can, make the fruit taste sweeter. Try yours, and you'll see why animals prefer pastures with optimum boron levels.

Radiata (Monterey) pine trees have browning and die-back of their growing tips when boron is low so big growers spread boron on by air.

Boron is less available in very dry, very acid and also VERY alkali soils which are rare.

These clover leaves show B deficiency symptoms of reddy brown edges which feel hard and dry, had them disappear after rain when the roots grew and were able to access more boron in the soil. Some farmers complain about stunted clovers and some can't grow clovers. The fault lies with the current 'establishment' which is ignorant about lime, boron and excess potassium K). High K kills red clovers first, then when higher kills white clover.

B deficiencies are more prevalent in sandy, low organic matter soils, peats (despite being high in un-decomposed organic matter), high rainfall areas, after long dry periods, and after prolonged wet periods because of leaching. New Zealand's high rainfall (up to 3,000 mm) south west coast very low B soils because of leaching from already low B soils, causes cows to suffer milk fever more than in drier areas. Liming with boron reduced milk fever and speeded recovery after treatment with CalciumBoro (B) Glucentate.

Clover pasture boron levels can be adequate in a moist soil, but then show a boron deficiency in dry conditions.

Plants vary in their requirement for boron. Levels of 20 mg/kg in ryegrass herbage appear to be correct. Clovers need more.

Pigs, especially fast growing ones, can suffer joint and lameness problems which have been reduced by feeding boron. In cases where B was not given, arthritis developed.

Boron feeding not approved

The USA Food and Drug Administration has not approved boron in any form for feeding to animals, possibly because it is dangerous (was the world's first weed killer) and the soil and plants need it, which is the best way of supplying toxic minerals to animals.

Further Information

For more information on OrganiBOR, and your nearest supplier in bulk, or for 1 kg to mix into your garden fertiliser, click http://www.jabez.co.nz

If B is very low, apply OrganiBOR at a maximum of 20 kg per hectare which is 0.02 kg per 10 m2, but not if B is already in your fertiliser.

Borax, also known as sodium borate (a salt of boric acid), has many uses. It's found in many household cleaning products, detergents, and cosmetics. It's probably best known as a roach poison.

The US National Library of Medicine and the National Institutes of Health declare sodium borate to be a dangerous poison. Side effects include: vomiting, diarrhoea, skin rash, blisters, collapse, coma, convulsions, drowsiness, fever, low blood pressure, decreased urine output, sloughing of the skin, and

twitching of facial muscles, arms, hands, legs, and feet.

Sodium borate has been banned in the US as a food additive.

It's astonishing that such a dangerous ingredient is added to vaccines. There are other toxic ingredients in vaccines as well—all "adjuvants": aluminium, formaldehyde, and polysorbate 80, to name a few.