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Sodium: not a cure-all...

SODIUM

The use of common salt (sodium ((Na)) as a fertiliser for pastures has been clouded with several controversial theories. For example it was suggested that fertiliser Na could decrease the incidence of bloat. This has now been debunked.

I have recently had the opportunity to review all the New Zealand trial data on the benefits and use of Na as a fertiliser. The following are the main points and conclusions that come from this review.

Na is not an essential element for pasture plants. So don't apply fertiliser Na and expect an increase in pasture production. It is essential however for animals. It is required by the animal to maintain its water balance and for muscle and nerve functioning.

Even though it is not required for plant growth, the common pasture species (white clover, ryegrass) will take up Na, if it is present in the soil, and transport it to the leaves. Some pasture species (browntop, kikuyu, paspalum and lucerne) absorb Na into the roots but do not translocate it to the plant tops. Thus, Na deficiency is more likely to be found in animals grazing lucerne or on poor quality pastures.

The critical pasture Na concentrations for animal health is given below. Lactating dairy cows have the highest requirement for Na – it follows that animal Na deficiency is more likely to occur in dairy cows.

Recent results from the Waikato and Southland indicate that leaching losses of Na from pastoral soils are between 30-80 kg Na/ha/yr. Inputs of Na via the rainfall in these regions are about 30 kg Na/ha/yr. This suggests that soils in these regions are in Na deficit –more is going out than coming in. This is not a problem while existing soil Na reserves are adequate (i.e. soil Quick test levels above 5 and pasture Na levels above 0.1%). However, it is predictable that with time, the occurrence of Na deficiency in animals is likely to increase in these regions.

Class of Animal	Pasture Na Concentration below which Deficiency is likely to occur
Lambs, sheep maintenance	< 0.04 %
Sheep flushing and lactation, young cattle and cattle maintenance	< 0.06 %
Cattle lactation	< 0.09 %

Na inputs via rainfall will be greater than indicated above in regions closer to the coast. This would include Northland, BOP, Taranaki, and the East and West Coast of the South Island. These regions should remain in a positive balance.

The region at most risk is the North Island Central Plateau. Na inputs are likely to be lower and leaching losses higher than above. (The pumice soils are further inland, are typically coarser and have a lower ability to hold nutrients like Na (lower CSC)). Their natural soil reserves of Na, as measured by the Na soil test, also tend to be lower.

However, do not rush out and order some Na fertiliser. Not yet at least.

Mr Mike O'Connor (AgResearch Ruakura) has for some years now been trying to find a dairy farm with pasture Na levels consistently below 0.10% (the critical level). To date none have been found. One of the problems is that pasture Na concentrations vary widely from season to season by 40-100%. Thus careful monitoring of pasture Na status is required to accurately establish a specific need for fertiliser Na.

My advice. For farmers, particularly on pumice soils and inland ash soils, include pasture samples in your normal soil testing monitoring program, being careful to collect soil and plant samples from the same paddock or transect at the same time each year. If pasture Na levels are consistently below 0.1% then adopt one of the following remedial strategies:

1. Drench with NaCl at 14g NaCl/cow/day
2. Salt licks

3. Water trough treatment (25g NaCl/litre)
4. Apply fertiliser NaCl at 50-100 kg/ha/yr.

LIMING AND LIMING MATERIALS

Why Lime?

Lime is an essential input for the sustainable management of pastoral soils. It is required to neutralise the acidity produced by many biochemical processes in the soil. One example is the microbial conversion of plant unavailable organic N to plant available nitrate N.

The net result of all these acidifying processes is that about 500 kg/ha/yr limestone is required to neutralise this acidity and maintain the soil pH. Thus the typical practice is to apply 2.5 tonnes lime/ha to a fifth of the farm every year.

How much Lime?

The optimum pH for pasture production on New Zealand soils (except peat soils) is 5.8-6.2 Liming acid soils to this pH can result in annual increases of pasture production of 5-10% depending on the starting pH. The lower the initial pH the greater the response.

But note, lime responses are seasonal and most of the response occurs in the summer autumn period. On a seasonal basis the responses can be 15-20% - large enough to see visually. Hence the frequent farmer observation that limed soils last longer into the summer.

As a rule of thumb 1000 kg/ha lime is required to raise the soil pH by 0.1 pH units. To change the pH from 5.5 to 6.0 requires 0.1 x 1000 = 5000 kg (5 tonne) lime.

What does Lime Do?

Liming can have many effects, but by far the most universal in our organic-matter-rich New Zealand soils is that the change in pH stimulates microbial activity and increases the availability of soil N. Trials show that 5.0 tonnes/ha releases the equivalent of 25 kg N/ha. This is why limed soils appear greener -the liming effect is like an N fertiliser response.

If the soil pH is initially < 5.5 liming can also be beneficial because it removes (precipitates) soluble aluminium, which is toxic to plants. Additionally there are a few soils on the dry East Coast where liming changes the availability of soil P. This effect is not large enough such that fertiliser P inputs should be reduced.

It is important to remember that these effects of lime occur because liming changes the soil pH. If there is no change in the pH then there will be no benefit from liming.

The pH change occurs, not because lime contains Ca but because of carbonate (and sometimes oxides) in the lime. For this reason Mg carbonates (eg dolomite) are as effective as Ca carbonates (limestone) as liming materials. It is this – the carbonates (and sometimes oxides) then are the active ingredient in liming materials, and this is measured in lime equivalents.

I mention this because some people get hung-up on Ca when talking about lime. In a sense the Ca in lime is almost irrelevant for a number of reasons. First, soil Ca deficiency is unheard of in New Zealand. Our soils are already Ca rich. Also a lot of Ca goes into our soils as a component of super and other P fertilisers, sufficient to make good any losses from the farm.

Liming Materials

The Table below lists a selection of the common liming materials available in New Zealand (burnt lime, slaked lime and by-products containing these are not included as they are not commonly available).

The products are divided into 3 types

a) ground limestone

b) lime/super mixtures and

c) slurried or liquid lime. For each product the typical price ex works is given together with the cost per unit of lime equivalent.

For Fertmark registration the particle size of ground limestone must be a) not more 95% bigger than 2mm and b) a minimum of 50% smaller than 0.5 mm. All of the products above meet this requirement.

For the ground limestones the lime-equivalent (ie the amount of active ingredient) range from 70–95 %, but the cost per lime-equivalent fall within the range $15-20.

Arguments are sometimes advanced that some limestones are softer and therefore faster acting than others. While this is true at a theoretical and laboratory level the field trial evidence says that providing the above particle size criteria are meet, softer limes are no better or worse than hard limes, when compared on an equivalent weight of lime-equivalent applied. In other words the farmer need only be concerned with the cost per unit lime-equivalent.

Ground Limestone						
Region	Company	Typical Lime equivalent	Particle size %		TypicalCost[1] ($/tonne)	Typical Cost ($/tonne lime-equivalent)
			>2mm	< 0.5mm		
Northland	Bellinghams	70	0.2	76.0	14	20.0
Auckland	Redvale	70	0.9	67.0	11	15.7
Waikato	McDonalds	90	0.3	59.9	16.5	18.3
Waikato	Rorisons	95	0.0	68	15.5	16.3
Hawkes Bay	Hatuma	90	<5.0	>50	16.52	18.3
Southland	Awarua	90	3.3	64.2	17.8	19.7

Notes: 1) ex-works costs excluding GST
2) from company brochure Sept 1998

Proprietary Lime: Super Mixtures				
Product	Composition	Cost[1] ($/tonne of product)	Cost ($/tonne of lime)	Cost ($/tonne lime-equivalent)
Hatuma dicalci[2]	Superphosphate (50%) Ground limestone (50%)	126.1	92[3]	102
Northfert[4]	Not known	-	-	-

Notes: 1) ex-works costs excluding GST
2) from company brochure Sept 1998
3) Assuming that superphosphate costs $160/tonne
4) Northfert declined to provide the relevant information on the grounds that they are changing their product mix.

Lime Slurries				
Product	Composition	Cost[1]	Cost[1] ($/tonne of lime)	Cost[1] ($/tonne lime-equivalent)
Prescription Aqualime	Not known	$5.46/kg[2]	5460	5460[3]
Bubb's liquid lime[4]	Ground limestone/water (63.6% w/w carbonate)[4]	$300/200 litres	2360	2360

Notes: 1) ex-works costs excluding GST
2) from farmers recommendation 1999
3) assuming 100% lime-equivalent
4) from advertisement Nov 1998

Remember that limestone is a sparingly soluble material and both hard and soft limestones require time to dissolve in the soil and thus neutralise the acidity. Generally it takes about 12-18 months for lime to have its maximum effect on soil pH, depending on the rainfall and the amount of acidity in the soil (the pH) to begin with. So talk about fast or slow acting lime is in my view inconsequential.

Lime purchased in form of proprietary lime:super mixtures is more than 2 times more costly than straight lime. The proprietors of these products justify this by claiming that these mixtures are more effective than the sum of the 2 components. The science does not support this view (see The Fertiliser Review Bulletin 1). In my opinion farmers should avoid these products if they are aiming to achieve maximum production for minimum inputs

Many farmers swear by these proprietary products and claim all sorts of benefits. I accept this. My view is that they could achieve all these benefits at lower cost by applying their super and lime separately. (In any case most fertiliser companies and some lime works will provide lime-super mixes to order charging only the cost of the components and a small mixing charge)

Of even greater concern is the extremely high price being charged for lime slurries. Per unit of lime equivalent these products are more than 200 times more expensive than conventional lime products.

The proprietors claim that their lime is micro-fine and therefore fast acting and that it can be spread more evenly. This may be so, but the recommended rates of application are 15-20 kg lime-equivalent/ha. Such inputs are trivially small when compared to the inputs known to be required to have a practical effect on soil pH. I would not recommend these types of products under any situation.

My conclusions from this survey of a sample of lime products is that the cheapest forms of lime are ground limestone. Compare the products available in your region and purchase on the basis of the cost per lime-equivalent.

THE P FIXATION BOGEY (continued from Bulletin 1)

In "The Fertiliser Review" Bulletin 1, Spring 1998, it was explained that most of the fertiliser P added to soils is converted by various chemical and biochemical reactions to inorganic and organic forms. It is "fixed". In this form it is not immediately available for plant growth and furthermore cannot be leached.

As the plant grows this fixed P is converted back to plant available P ready for plant uptake. Thus, the process of P fixation can be regarded as nature's way of storing this important nutrient in a form that cannot be leached, until the plant requires it.

How much P is stored in this manner and in the long–term, how much of this P is utilised by the plant?

It is useful to think of the soil as a nutrient tank. In the case of P there are in fact two tanks – the inorganic P tank and the organic P tank (Figure 1). As fertiliser P is added to the soil the tanks fill up. This is often referred to as the development phase, when capital inputs of fertiliser are required. To optimise pasture production the tanks must be filled to a certain minimal level.

Different soil groups have different size tanks (Figure 2). Ash soils have large tanks and can store large amounts of organic and inorganic P. This is a consequence not only of the types of soil minerals present, but also reflects the ability of these soils to accumulate organic matter. It is for these reasons that ash soils require very large inputs of fertiliser during development.

At the other extreme the sedimentary soils on the East Coast accumulate much less organic matter (they are drier) and contain less active iron and aluminium minerals. They have smaller tanks and require less fertiliser to "get them going".

The Phosphate Retention (PR) test (now called more correctly the "Anion Storage Capacity", is a measure of the size of the soil tank. The Olsen P test measures how full the tank is.

The relative size of the inorganic and organic tanks is approximately constant - soils with a large inorganic P tank also have a large organic P tank and visa versa. Averaged over many soils, 54% of the total P is organic P and 46% inorganic P.

This means that when measuring the total P fertility in a soil it is not necessary to measure both tanks. Indeed, the Olsen P test (as with most soil P tests) measures only the inorganic P pool. Furthermore, it measures only a small proportion (about 6 %) of the inorganic P. This is not a problem – it is analogous to measuring the MS content in milk by taking a small representative sample.

The important point is that the measurement used (in our case the Olsen P test) is calibrated against plant growth so that a given Olsen P level can be related to a given level of production. This has been done with many different soil P tests and it has been found that for New Zealand soils, the Olsen P test gives the best relationship with pasture production.

And so to the final point. How much of the P in the inorganic and organic tanks is utilised by plants?

From field trials and modelling calculations it has been found that about 80-85% of the fertiliser P applied is retained within the soil-plant system in the long-term. The balance (15-20%) is lost from the system. This includes P in products and animals removed from the farm, P transferred to non-productive areas, and runoff.

Only a small proportion (probably < 5%) of the 15-20% of the fertiliser P which is lost from the system, is removed forever and irreversibly (ie permanently fixed) by reaction with soil minerals and organic matter. Yet some salesmen would have their clients focus their fertiliser dollar solely on this small component. Why? A case of not seeing the wood for the trees!

(In the next issue of The Fertiliser Review – can products be applied to release this "locked-up" P, and is that a good idea?).

THE COST OF P IN SUPER

The article "Cost of Nutrients" (The Fertiliser Review, Bulletin No 1) stimulated a number of readers to ask, how did I determine that the P in superphosphate costs $1.20/kg. Here is how.

At present, super costs about $160 per tonne. Typically super contains 9% P and 11% S as sulphate. Thus $160 buys 1000 kg of super which contains 90 kg P (1000 x 9/100) and 110 kg S (1000 x 11/100).

To calculate the value of the P alone we must first deduct the value of the S. What is sulphate S worth? There are 2 ways to proceed.

We know that elemental S sells at about $400 and that it is pure S (100% S) Thus a tonne of elemental S costing $400 contains 1000 kg S (1000 x 100/100). Thus elemental S is worth 40 cents/kg (400/1000).

Thus the 110 kg S in a tonne of super can be valued at $44. Deducting this from the total cost of a tonne of super we get $116 (160-44). This is the value of the 90 kg P in a tonne of super. Thus P costs $1.28/kg (116/90).

This calculation assumes that a kg of sulphate S, as in super, has the same agronomic value as a kg of elemental S. This is in fact not the case. The elemental S that you buy at the works is too coarse and hence too slow acting to be regarded as equivalent to sulphate S. It would need to be further processed and this would add to the cost. Thus the sulphate S in super is worth more than 40 cents, and correspondingly, the P in super worth less than $1.28/kg.

The alternative approach is to use ammonium sulphate as the base. This product costs about $306 per tonne and contains 21% N and 24 % S as sulphate S. Thus 1000 kg of ammonium sulphate contains 210 kg N (1000 x 21/100) and 240 kg S (1000 x 24/100). This time we must deduct the value of the N to determine the value of the S.

We know that urea (46% N) costs about $400 per tonne. Thus N is worth 86 cents/kg (ie 1000 x 46/100 = 460 kg of N @ $400 = 86 cents/kg).

So the 210 kg N in ammonium sulphate is worth $180.6 (0.86 x 210) and hence the 240 kg of sulphate S is worth $125.4 (306 – 180.4) or 52 cents/kg sulphate S.

This is slightly higher than the figure of 40 cents derived earlier based on elemental S. This is expected and bears out the point that sulphate S is more valuable than elemental S.

Back to super and applying this figure of 52 cents/kg sulphate S.

The 110 kg of sulphate S in super is worth $57.5 and thus the 90 kg P is worth $102.5 or $1.13/kg P.

Bearing in mind price variations etc etc and without being too pedantic I thought a figure of about $1.20 was reasonable. If I have erred it was against superphosphate and in favour of products like RPR! You wouldn't read about it would you!

A PLEA FOR SCIENCE

By Professor T W Walker

The first 10 years of my working life were spent in research and extension work in England investigating problems of crop and animal production. So I soon became acquainted with the clever charlatans out there hoping to make a fast buck from gullible farmers. I have often thought if I had wanted to be rich I should have sold farmers some fancy liquid fertiliser or other panacea, blinding him with pseudo –science and perhaps believing it all.

Speaking to and writing for farmers and gardeners for nearly sixty years has given me the opportunity of exposing some of these quacks. Many times have I been threatened with court action only to have the complaint withdrawn at the last minute. I remember being sued for $15,000 dollars for saying in Hawkes Bay that buying some particular liquid fertiliser was an expensive way of acquiring 44-gallon drums. I could never understand why the Journal of Agriculture continued to advertise such stuff and took it up with the then Director General of Agriculture with no effect whatsoever which was rather dispiriting.

Doug Edmeades has a similar background to mine. After completing a degree in chemistry at Auckland he specialized in soil science at Lincoln where he finished a PhD. He is fearlessly honest which did not endear him to the bureaucrats when he challenged all and sundry trying to hoodwink farmers. I must confess I welcomed his efforts. Now out on his own he is no longer fettered by these bureaucratic chains and farmers and advisers should greet him with open arms.

I am also absolutely delighted that we now have a champion to advise farmers' on fertiliser and soil fertility. He has only their interests at heart and I beg them and their advisers to subscribe to The Fertiliser Review to learn the truth and distinguish between Fertiliser Facts and Fallacies in which booklet Dr Edmeades exposes the myths propagated by salesmen more concerned about their own rather than the farmers profits.

PRESCRIPTION FERTILISERS

I have recently been sent for comment a fertiliser recommendation made by Prescription Fertilisers Ltd. What follows is my analysis and opinion.

The property concerned is a Northland dairy farm on a sandy soil. The relevant soil tests are given below compared with the optimal ranges for maximum pasture production.

	pH	Olsen P	K	Sulphate S	Organic S	Mg
Farm	5.8	50	8	3	3	21
Optimal Range	5.8-6.0	35-45	7-10	10-12	10-12	8-10

My interpretation of these results is;

- Maintenance P inputs only are required
- A maintenance input of K is required
- A large input of immediately available S is required
- No lime or Mg is required at this stage

Taking into account that we are dealing with a sandy soil with a low ASC (ie leaching will be a major source of nutrient loss) and the stocking rate, I estimate the nutrient requirements for this block of the farm to be:

Nutrient Inputs (kg/ha/yr)		
P	K	S
30	70	50[1]

Notes: 1) as a mix of immediately available sulphate S and fine elemental S

Without going into the detail, the cheapest fertiliser to deliver these nutrient inputs is 30% potassic sulphur super, applied in 2 equal split dressings of 250 kg/ha in spring and autumn (500 kg/ha/yr).

This would cost about $116/ha (ex works BOP) and deliver the following inputs. (Note that although this product applied at this rate delivers more S than required it is nevertheless the cheapest option)

Comparing this recommendation with that offered by Script Fertiliser Ltd we have:

Product	Rate of application	Nutrients Applied (kg/ha/yr)			Cost ($/ha)
		P	K	S	
30% potassic sulphur super	500 kg/ ha/yr	30	75	70	117
Prescription Fertiliser	20 kg/ha/yr[1]	2.8	3.2	1.4 (+4.5)[2]	130

Notes: 1) recommended at 15-20 kg/h
2) aqualime containing S is also recommended. This would add a further 4.5 kg S/ha

For a slightly higher cost per ha, the Prescription Fertiliser recommendation provides significantly smaller amounts (by 11 to 40 times) of the nutrients required for sustainable management of this farm. (Note that Prescription Fertilisers also recommended lime as Aqualime. This is a very expensive means of purchasing lime – see article Lime and Liming Materials in this issue)

What is surprising and concerning about the Script Fertiliser advice is the small inputs of nutrients (and lime) recommended, relative to the amounts known to be required from field trials.

The company claims in its advertising that this is possible because the nutrients in their products are protected by a mucilage gel, once in the soil, from either leaching, runoff or fixation.

There is no scientific evidence to support these claims and frankly from a science perspective they are unlikely to be true. Therefore I could not recommend these products or the approach adopted by this company.

MAXICROP IS BACK

Remember the Court Case? Remember the High Court Judgement that "Maxicrop can not and does not work". This after evidence from 40 scientists both from New Zealand and overseas. Well, believe it or not, Maxicrop is back, albeit under a different name, Combo!

A recent advertising brochure states that Combo is the combination of 2 products: Supa Crop Liquid Humus and Maxicrop Triple. It is claimed to contain 10% N, 5% P and 6% K, a range of trace elements and a number of plant growth stimulating compounds and soil conditioning compounds. It is recommended to be applied at 10 litres/ha.

The brochures also provide results from 2 pasture trials claiming large responses in dry matter production. No statistical information is provided to ascertain the reliability of the data.

In press articles and advertisements, which appeared in the farming press in September 1998 it was claimed that Combo unlocks "fixed P" (see article The P Fixation Bogey in this bulletin).

What intrigues me is this. During the Court Case an expert witness from Britain presented evidence to the court showing that Maxicrop Triple was no better than the equivalent amount of water on a range of crops – some 45 trials in all. My question is this - if Maxicrop Triple is ineffective why mix it with another product, in this case Supa Crop Liquid Humus and call the product Combo? Perhaps you could ask the salesman if he should call !

In the meantime consider the following facts. Based on the analysis above, a standard application of 10 litres/ha would supply about 1 kg of N, 0.5 kg P and 0.6 kg of K per hectare. Not a product I would recommend if the intention were to replace soil nutrients or increase soil nutrient levels.

Also remember that New Zealand pastoral soils contain, by international standards, large amounts of organic matter - typically over 100 tonnes per hectare - a large component of which is humic acid. Given this, I doubt whether the small amount of humic acid in a product like Supa Crop Liquid Humus, when applied as directed, would have any effect on soil fertility. Overseas trials show this to be the case.

My advice? Hold all bets until data is available from scientifically designed and conducted trials.