agKnowledge
TNM™ "Total Nutrient Management"
April 2005
THE Fertiliser Review
ISSUE 14

ACIDIFICATION DUE TO FERTILISERS?

Working as I do, one-on-one with many farmers, I am surprised by the number of times this issue arises. Typically, the farmer will say: but so-and so said I should not use that fertilizer because it will acidify the soil. More cynically, the argument is used to sell some "alternative" more benign product. What does the science say?

A little theory.

Chemists use the symbol H+ to denote acids, and their chemical opposite, called alkalis, are denoted with the symbol OH-. [To confuse the layman, alkalis are sometimes referred to as bases but, for some reason, acids are not called sopranos!]. The degree of acidity is measured on a pH scale of 1 to 14 and it works upside down. The lower the pH the higher the concentration of acid.

Acid (eg sulphuric acid) + water = H+ *pH decreases*

Alkali (eg caustic soda) + water = OH- *pH increases*

The same applies to soils. Some products we add to soils add alkali (OH):

eg.
limestone (calcium carbonate) + soil = OH-
soil pH increases

Others products add acid (H):

eg.
elemental S + soil = H+
soil pH decreases

Table 1 lists some common fertilizers and identifies those which add acid or alkali. In each case the amount of lime (pure calcium carbonate) required to neutralize the added acid is given. In the case of those products that add alkali, the equivalent amount of lime is given.

Table 1. Some fertilizer and their effects on soil acidity

Product P Fertilisers	Adds acid or alkali?	Amount of Lime Required to Neutralize the Acidity (kg pure lime/100 kg product)[1]	Years to decrease (or increase) pH by 0.1 pH unit if product used at typical rates[2, 3]
Superphosphate (fully cured)	nil	0	No effect
Superphosphate (14% free acid ie 'green')	acid	2	60 - 90
Triple superphosphate	nil	0	No effect
DAP	acid	8	33 - 50
MAP	acid	23	12 - 18
RPR	alkali	42	4 - 6
N Fertilisers			
Urea	acid	24	18 - 27
Ammonium sulphate	acid	43	4 - 6
CAN	acid	7	30 - 44
S Fertilisers			
Gypsum	nil	0	No effect
Elemental S	acid	320	4 - 6
K Fertilisers			
Potash	nil	0	No effect
Potassium sulphate	nil	0	No effect

Notes: 1) These figures assume typical reactions of the products in the soil
2) It is assumed that the buffer capacity of the soil is 0.10 to 0.15 pH units per tonne of lime
3) Typical rates being 50 kg P or S/ha/yr, 75 kg N or S/ha/yr and

DAP adds acid to the soil but, once again, note that the amounts of acidity produced are not large. DAP applied annually at 250 kg DAP/ha would be required for 30-50 years before the pH would decrease by 0.10 pH units. MAP is about 3 times more acid than DPD per kg P applied.

RPRs typically add alkali to soil. A single application of RPR of say 250 kg RPR/ha would add the equivalent of about 100 kg/ha of pure lime. This will increase the pH by about 0.01 pH units. It would take about 4-6 years of annual applications of 400 kg RPR/ha (50 kg P/ha) to increase the soil pH by 0.10 pH units.

Note that elemental S has the equal and opposite effect – it adds acid to soils. So if you are adding S to the RPR, which is frequently the case, then the overall effect on soil pH will be approximately zero. Not many salespeople tell you this part of the story do they?

The common N fertilizers, urea, CAN and ammonium sulphate all add acid to soils, but the latter is the 'worst'. Urea is the most commonly used N fertilizer so it is worth closer scrutiny. It you are applying 75 kg N/ha/yr as urea (ie 160 kg urea/ha/yr) then it will take approximately 20-30 years for the soil pH to decline by 0.10 units, say from 5.8 down to 5.7.

Potash fertilizer and gypsum (a component of super) have no effect on soil acidity.

If you are getting the message that fertilizers generally have very little practical effect on soil pH when used at realistic rates then you have correctly interpreted the message.

But this conclusion raises two further questions which must be dealt with:

If fertilizers have very little practical effect on soil pH, why do we need lime? The answer is that there are many other 'natural' biochemical reactions which occur in healthy soils which product acids. It is these god-given processes which release acids creating the need for lime. (see Fertiliser Review No 5 for further details). If your soil pH levels are falling, blame your God but not your fertilizer company.

Finally, given that fertilizer generally are benign with respect to soil acidity, why all the "porkies" about these "nasty acid fertilizers" and the damage they are doing to our soils and environment? It is called the free-market. There are, in practice, no restrictions on what you sell and how you sell it, in the New Zealand fertilizer market. So if you are confused, blame the salesman. Don't blame me and the science.

GROWING FOR GOOD

The Parliamentary Commissioner for the Environment, Dr Morgan Williams, has released his report "Growing for Good", on the state of farming in New Zealand. From his perspective, current farming practices in New Zealand are not sustainable. He argues that we are currently depleting our resources of air, water and land and that we need to redesign our farming practices bearing this in mind. I agree with him in the sense that there is more we could do, on the farm, to improve our management of these most precious of resources.

The question is how? In the first instance we need a robust workable definition of sustainability. How do we test whether a given farming practice, such as the use of fertilizers, is sustainable or otherwise?

It is an important issue. Talk to a greenie and he will insist that sustainability means conserving the environment to the exclusion of all other considerations, such as economics and profitability. Alternatively, a businessman may insist that his operation must be economically profitable if it is to be sustainable and if resources are spoiled in the process so what! Most farmers, in my view, because they operate close to their essential resources – soil water and air - know instinctively that they must be profitable and be careful stewards of the land.

So how can we define this complex concept, sustainability? Most definitions I have come across are unsatisfactory. They frequently reflect the bias of the particular author. The only definition I have found which is robust, balanced and comprehensive was developed by two Canadian soil scientists back in 1985. It also has the joyous attributes of being readily understood and applied.

This definition, which they called FESLM (an acronym for Framework for the Evaluation of Sustainable Land Management) has five criteria (production, risk, economics, environmental, social) against which to test whether a given practice is sustainable. It says that any practice is sustainable if it simultaneously meets these five criteria. It asks:

Production – *will this practice achieve my production goal?*

Risk – *does the practice reduce the risk of achieving my production goal?*

Economic – *is the practice economic?*

Environmental – *does the practice adversely affect the environment (water, air, soil, land)*

Social – *is the practice socially acceptable (are there third party issues such as noise, dust, smell).*

This test is robust, for it requires that all the five criteria are met simultaneously. This avoids extremist dogma. A greenie-like argument that we must get rid of farming because it is bad for the environment fails the test because it ignores the national economic and social consequences of such a measure. Similarly, the extreme capitalistic argument fails because it does not consider the environmental consequences of exploitation. Interestingly organic farming also fails this test. If New Zealand exclusively adopted the practices espoused by the organic farming movement, national production would predictable decline by 40-50% - is this either economically or socially acceptable? Would the otherwise well meaning, urban-dwelling, organic enthusiast, accept a lower standard of living?

This test is comprehensive, it can be applied at a national, regional and farm level. Within the farm it can be applied to all management practices, such as the use of fertilizer, cropping practices, erosion control practices, animal management and indeed staff management.

Note that, at the individual farm level, the production and economic criteria are most likely to be set by the farmer. However, the environmental and social requirements are more likely to be set by the broader community in which the farm exists. This appropriately allows flexibility. Environmental criteria (such as water quality) are likely to be very stringent for farmers in sensitive catchments, such as Lake Taupo and the Rotorua lakes. In contrast, lower environmental standards may be completely socially acceptable in other more forgiving catchments.

I know farmers' are a bit jaded, and perhaps frightened, by all this environmental stuff. So I feel obliged to end on a positive note. Our one-on-one Total Nutrient Management system which we have developed uses FESLM as its starting point. We get our farmers to tell us what their goals are in respect to these five goals or criteria and this is used to develop the fertilizer and nutrient management plan for the farm which optimizes profitability and minimizes the environmental risks. The farmer's goals drive the fertilizer plan. Todate we have processes about 90 dairy farms and the average saving in fertilizer costs is about $8,000 to $10,000 per year. The point is this: environmental compliance goes straight to the bottom line, It is a classic win-win. What is good for the environment turns out to be good for the balance sheet.

PRICE WATCH

There have been several adjustments to fertilizer prices since early November 2004. These are summarized in Table 2 which compares the cost of the 4 major nutrients (N, P, K and S) in the major generic fertilizer products, over the period, early November 2004 to late February 2005. All figures are expressed as the cost (ex works) per kilogram of nutrient, deducting, where necessary the cost of any companion nutrient (s).

Table 2: Changes in the cost of nutrients ($/kg nutrient) in the major generic fertilizers over the period November 2004 to February 2005.

Nutrient	Product	Ballance[1]		
		November 2004	February 2005	% change
Phosphorus (P)	Super	1.28	1.46	14
	RPR[2]	1.41 (4.25)	1.68 (5.04)	19
	DAP	1.62	1.72	6
	Triple super	2.07	2.07	0
Nitrogen (N)	urea	0.82	1.04	27
	Ammonium sulphate	1.12	1.28	14
	DAP	1.20	1.33	11
Potassium (K)	Potash	0.67	0.79	18
	Potassium sulphate	1.00	1.06	6
Sulphur (S)	Durasul	0.34	0.34	0
	Potassium sulphate	1.17	1.01	- 13

Notes: 1) November 2004 prices are from the Ballance trade price list dated 1 July 2004. February 2005 prices are from the Balance trade price list dated 21 February 2005.
2) the first figure is the cost of P per unit total P and the figure in brackets the cost per unit available P assuming that on average RPR dissolves at 30% per year.

These figures are based on Ballance AgriNutrients Ltd price lists. Similar calculations using Ravensdown prices over the same period show that their prices are very similar on a per unit of nutrient basis. It must be noted also that the costings given above do not include rebates, volume discounts or special client deals.

These prices rises range from 0 to 30% depending on product. The major products used in pastoral farming in New Zealand are super, potash and urea. The prices increases in these high volume products are 14-15%, 18-19% and 27-30% respectively, depending on the company. It is predictable therefore that for most farmers their fertilizer bill will increase by 14-30%, depending on the proportion of these products purchased. Assuming an average increase in fertilizer costs of say 20%, will add $6,000 to the fertilizer costs on the farm.

Despite these changes there are some important points to emphasis:

1. Super is still the cheapest form of phosphorus (P), urea is the cheapest nitrogen (N) fertilizer and potash (potassium chloride) the cheapest form of potassium (K).

2. Phosphorus (P) is still the most expensive nutrient ($1.47/kg) followed for nitrogen (N) at about $1.04/kg and then potassium (K) at about $0.80/kg. In comparison sulphur (S) is very cheap at $0.35.

3. The companies are price neutral with respect to these generic products. The one exception is RPR. The product sold by Ravensdown, Ben Guerir, is much cheaper that the Gafsa RPR from Ballance, but note that on a "soluble P" basis RPR generally is not cost competitive relative to super.

4. The comparisons above are based on ex works prices and do not include the cost of cartage and spreading. However, as discussed elsewhere (see Fertiliser Review No. 8) the higher analysis alternatives are only cost effective if the distances from the works are very large (> 300-400 km).

My Advice:

1. When selecting your fertilizers choose the least cost product on a kg nutrient basis. Essentially this means sticking to the 'tried and true'.

2. Because P is the most expensive nutrient, ensure that the other less expensive nutrients are not limiting the benefit of the P.

3. Farm at, not above the economic optimal Olsen P level (ie the Olsen P range which maximizes your long-term profits).

4. On dairy farms, use the dairy shed effluent as a resource. You will be surprised how much it is worth in terms of its nutrient content.

Finally, if you are too busy for all this - and we know farmers are time poor - or if the technical issues are too difficult for you to get your head round - I can understand this too - give use a call at agKnowledge. We have been doing this nutrient management planning one-on-one, with farmers for 3 years now.

MORE GOOD NEWS: SOIL QUALITY

In the last Fertiliser Review (Number 13) we discussed the effect of fertilizers generally, and chemical fertilizers specifically, on the biological activity in soils. Fertilisers we concluded are good for soil bugs. In this issue we look more broadly at soil quality. How good is the quality of our New Zealand soils?

Dr Graeme Sparling (Landcare Research) has just published the results of the first comprehensive survey of the quality of New Zealand soils. It provides a snap shot of their health.

Seven soil properties (see below) were measured on samples collected from 511 sites, representing 98% of New Zealand's land area and including seven land uses: arable cropping, mixed cropping, drystock (sheep and beef), dairy, tussock grassland, plantation forestry, indigenous forest.

The 7 soil tests were carefully selected to represents the 3 facets of soil quality: chemical, biological and physical. The specific tests were:

Soil chemical quality – *Olsen P and pH*

Soil biological quality – *total carbon, and nitrogen and mineralisable N*

Soil physical quality – *bulk density and macroporosity*

Target ranges were established for each soil test, land-use, and where necessary soil group, by a panel of New Zealand soil scientists. The target ranges are in effect the 'ideal range' for a given soil test, taking into account the land use and soil group, to maximize production and minimizes possible environmental effects. For example, the ideal range for Olsen P for pastures on pumice soils was set at 40-45. Below this range pasture production is limited and above this range, excess runoff of P may occur. For some tests setting the ideal range was problematic because of the lack of scientific information. In such cases a best estimate approach was adopted.

The hundreds of soils tests results collected from the survey, where then compared with the relevant ideal ranges. The authors overall conclusion, based on this analysis, was that, "…….80% of the soil properties fell within target ranges identified as desirable to maintain soil quality for production and environmental objectives." In other words you could say the "teacher" has given New Zealand an 8/10. That, in my opinion is a good result. Not perfect but good.

Where are the problems? What do the exceptions – those 20% of properties which do not fit the ideal ranges - tell us? Table 3 shows the proportion of soil characteristics which did not meet the target ranges.

Table 3: The proportion of soil quality characteristic not meeting the respective target ranges (from Sparling and Schipper 2004).

Land Use	Soil quality characteristics of concern (% not meeting the target range)			
	Soil Acidity	Organic matter depletion	Nutrient status	Soil compaction
Crops/ Horticulture	1	14	35	24
Pastures	0	36	23	35
Forestry	8	30	25	45
Indigenous Forest	9	26	3	64

Soil acidity is not a problem on cropping and pastoral soils but a few forestry soils appear to be more acid than desirable. Depletion of organic matter is a general problem across all land-uses, including forestry. Converting our pastoral soils to forestry is not necessarily going to save our soils in this respect. It must be noted however that New Zealand soils generally have high soil organic matter levels, relative to international standards, and this is reflected in the defined target ranges. Thus, depletion of organic matter in this sense is relative to a high target.

Nutrient status, in this case excessively high soil Olsen P levels and organic N levels was identified as a problem on all land uses except indigenous forestry. Too many farmers, it appears, are operating their soils at Olsen P levels above that required for optimal production. Not only is this uneconomic but it causes unnecessary enrichment of waterways with N and P. Soil compaction was identified as a problem across all land use classes, more so in forestry soils.

What can or should be done? Changing land use is unlikely to change this picture because where problems exist they occur in all land-use classes, this is certainly the case for organic matter depletion and soil compaction.

Conserving organic matter is good for soils because organic matter stabilizes soil structure and is a storehouse of the N, P and S. So management practices which deplete organic matter need to be minimized or eliminated. Cropping is the worst offender in this regard. Continuous cultivation exposes the soil to the air and accelerates the oxidation of organic matter. Cropping rotations which include legumes and grazing, and hence accumulate organic matter, are a must. Direct drilling is also an emerging technology to avoid organic matter depletion.

Soil compaction arises in cropping soils because of the impact of heavy machinery and this is exacerbated as organic matter is depleted. In pastures, it is caused by the treading of animals, and is much worse when pastures are pugged and damaged when soils are waterlogged. Once again there are simple practices which can be adopted to overcome or at least minimize this problem. (see Fertiliser Review No 7 for a full discussion of remedial options).

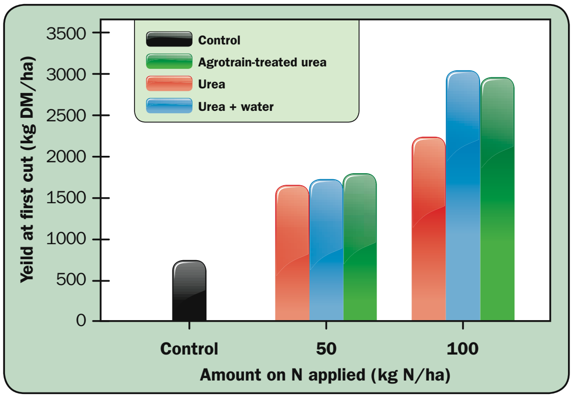
Conclusions

By and large our soils are in good shape. There are some problems such as excess fertilizer use, soil compaction and organic matter depletion. The good new is that we have the knowledge and techniques already available to overcome these problems.

A MATTER OF OPINION?

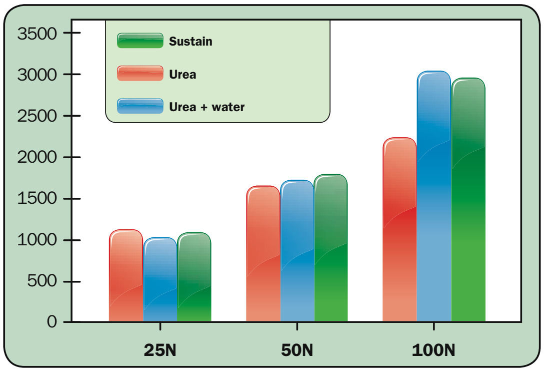
In their official newsletter, FertScience, dated Spring 2004, SummitQuinphos reproduced the results from a trial conducted by AgResearch Ltd. Their graph is given below (fig. 4).

Fig. 4: Kikuyu production (kgDM/ha) in response to nitrogen application. *Trial run for Ballance by AgResearch, Northland (Source: Ballance's "Grow" newsletter, Spring 2004). First cut only. Data for subsequent cuts not provided.*



Summit-Quinphos stated that these results, ... "showed that Agrotain-treated urea (made with Agrotain supplied by us) performed better than straight urea at both 50 and 100 kgN/ha.

Below are the original results for the trial from AgResearch as published by Balance AgriNutrients in their newsletter "Grow" Spring 2004.



Note: the treatment differences need to be bigger than the error bars to be regarded as 'real'

Note that the trial actually included four rates of nitrogen (N) – nil, 25, 50 and 100 kg N. For some reason SummitQuinphos did not include the results obtained at the 25 kg N rate. In their defence, Dr Quin of SummitQuinphos replied that "The 25 kg

N/ha gave no statistically useful information". We disagree with this narrow interpretation. It is true that there were no statistically significant treatment effects at the 25 kg N/ha. In other words the product Agrotain had no effect, given the background variation in the trial, at this rate. The same was also true for the higher rate (ie 50 kg N/ha).

As Mr Mike O'Connor and Brian Hunt of AgResearch, who conducted the trial, concluded based on all the data, "It is strikingly clear that the urease inhibitor [ie Agrotain] only had a significant effect at 100 kg N/ha, and even then the same result can be obtained by rain or irrigation." In other word their conclusion was diametrically opposite from Dr Quin's.

My interpretation of the data is that agrotain treated urea is no better than ordinary urea when applied at typical rates used by farmers (ie 25 to 50 kg N/ha). In the extreme situation where a high rate of N (100 kg N/ha) is applied in a single dressing in mid-summer to a kikuyu pasture Agrotain has a benefit (ie reduces N volatilization from the urea) if there is no rainfall (in this trial 5 mm) shortly after application. This situation – ie a high rate of urea, applied in the summer to a kikuyu pasture –is, I'm sure you agree, rather unique. Nevertheless it is in one sense, entirely consistent with much other research (see Fertiliser Review 13 Spring 2004) which shows that volatilization of urea – and hence the need for products such as Agrotain - is minimal in our temperate environment, if urea is used at recommended rates (20 to 50 kg N/ha per application) and at recommended times (ie not in the summer when there is very little pasture growth).

So who does the farmer believe? The scientist or the company selling the product? In this case, which party is independent in the sense of any possible pecuniary outcome? The Advertising Standards Authority can assist us in this respect. In 1997 they were required to consider whether a person selling a financial product was entitled to claim that they offered independent financial advice.

The Board ruled: "The receipt of fees in relation to the sale and servicing of (the financial product), and the fact the advertiser had exclusive rights to the market of the product, dissolved the advertiser of any claim of independence." Further, the Board said: "Consumers could be confused and misled [by the claim of independence] into thinking they would receive advice from an adviser who would not benefit from the result of a subsequent sale of a recommended product." I think their meaning is clear.

My Advice: I can do no better than to quote Dr Quin's (General Manager Summit-Quinphos Ltd), conclusion in the same article referred to above: "...... but it is vital that farmers receive full unbiased data, presented in perspective, from trials on these products."

More information?

Freephone : **0800 FERT INFO** (0800 33 73 46)
Fax: **07 834 0315**
Email: **info@agknowledge.co.nz**

Dr Doug Edmeades