agKnowledge
TNM™ "Total Nutrient Management"
February 2000
THE Fertiliser Review
ISSUE 4

NITROSOL: LIQUID BLOOD & BONE

In the last issue (The Fertiliser Review No 3 1999) the effectiveness of applying nutrients in either a solid or liquid form was compared. It was concluded that it is far cheaper to apply nutrients in a solid form. As promised, The Fertiliser Review continues this scientific investigation into liquid fertilisers, looking first at Nitrosol, a product that uniquely claims to be a 'total replacement' fertiliser.

Specifically, the company literature claims that Nitrosol:

1. is a 'a total replacement fertiliser to provide all the nutrients that healthy plants and animals need to survive and thrive'.
2. contains plant growth promotants,
3. works by unlocking soil nutrients, particularly P and,
4. is organic.

Claim 1

Nitrosol is recommended to be applied at between 10-25 litres per hectare. From this, and the typical analysis, the amounts of nutrients applied when the product is used at the highest recommended rate (25 litres/ha) can be calculated and compared with the amounts of these nutrients required to maintain the soil productivity on a typical dairy farm.

Even at the highest recommended rate, Nitrosol provides only a fraction of the amounts of the nutrients required to maintain soil fertility. In fact, Nitrosol would need to be applied at between 10 to 100 times the recommended rate, to provide typical maintenance requirements, depending on which nutrient is considered. To claim that Nitrosol is a 'total replacement fertiliser to provide all the nutrients that healthy plants and animals need to survive and thrive' is therefore incorrect and misleading.

Note that Nitrosol is recommended to be diluted before application. If it is diluted by 1:50 then the NPK rating of the product as applied would be, 0.16. 0.05.0.12., not 8.3.6 as in the concentrated product, as sold. Farmers beware!

Nutrient	Typical Analysis[1]	Amounts of Nutrient Applied[2]	Typical Amounts of Nutrients Required for Maintenance
Nitrogen (N)	8 %	2 kg/ha	25-50 kg/ha
Phosphorus (P)	3 %	0.8 kg/ha	35-45 kg/ha
Potassium (K)	6 %	1.5 kg/ha	40-70 kg/ha
Sulphur (S)	2.7 %	0.7 kg/ha	20-30 kg/ha
Calcium (Ca)	1.3 %	0.3 kg/ha	100-150 kg/ha
Magnesium (Mg)	0.2 %	0.05 kg/ha	20-25 kg/ha
Sodium (Na)	0.3%	0.08 kg/ha	20-30 kg/ha
Copper	90 ppm	2.3 gm/ha	1000- 1500 gm/ha
Molybdenum	119 ppm	3.0 gm/ha	20 gm/ha
Cobalt	10 ppm	0.3 gm/ha	10-20 gm/ha
Selenium	60 ppm	1.5 gm/ha	10 gm/ha
Boron	192 ppm	4.8 gm/ha	1500 gm/ha

Notes: 1) from the company literature
2) when applied at 25 litres/ ha

Claim 2

Nitrosol contains two growth promotants – gibberrellic acid (GA) (concentration 0.01 ppm) and triacontanol (concentration not given).

Research shows that both of these promotants can increase plant growth if applied at sufficiently high rates. Results from field trials, on crops and pastures, shown variable and inconclusive results with GA applied at rates of between 1-280 gm GA/ha. If Nitrosol was applied at 25 litres/ha, it would supply only a fraction of this input of GA (about 0.00025g GA/ha).

Because the concentration of triacontanol is not given, no comment can be made on its possible contribution to enhancing plant growth. However, it is improbable, based on what the product is known to contain, that Nitrosol will have beneficial effects on plant growth in the field. Indeed this conclusion is consistent with field trial results.

The results below are from a pasture trial in the Manawatu.

Treatment	Pasture Production (kg DM/ha)
Control	2800
Nitrosol (7 litres/ha)	2900
Nitrosol (28 litres/ha)	3100

At first glance, it might appear that Nitrosol is having some, albeit minor, effect on production. In fact, these differences are not statistically significant indicating that the product is having no effect. We can be more confident with this conclusion given that other trials nationally and internationally, on similar products which make similar claims, also indicate no significant effects.

Claim 3

The company literature and advertising claims that Nitrosol works by feeding and stimulating the biological activity in soils, and that, this unlocks accumulated nutrients, particularly P, in the soil. There is no direct scientific evidence to support this claim. Indeed, the field trial evidence, such as that referred to above, provides indirect evidence that this claim is incorrect.

Furthermore, to prevent the product from decomposing during storage and transport,

(Remember it contains organic matter) it is stabilized by the addition of a preservative to stop any biological activity. What does this preservative do to the soil? Stimulate biological activity?

Claim 4

The claim that the product is organic, is also debatable. Nitrosol is made from an extract of blood and bone to which chemicals, such as those used and/or sold by the traditional fertiliser industry, are added to bring the NPK rating up to 8.3.6. These additives are not regarded as organic when sold or used singularly.

My advice? Not a product for the farmer looking to maximize his return from his fertiliser dollar.

SOIL TESTING: BASE SATURATION RATIOS

A recent correspondent sought my advice regarding a new soil testing service called Quantum Laboratories Ltd operated by Mr Peter Lester in the Hawkes Bay. The central issue raised by this correspondence is the use of base saturation ratios as a basis for making fertiliser recommendations.

All but one of the New Zealand soil-testing laboratories is now presenting results in terms of base saturation ratios, together with the standard MAF Quick Tests. (For a full discussion see the booklet, 'A Pastoral Farmers Guide to Soil Testing) This is causing confusion for farmers and for this reason my reply to this correspondent is reprinted in full, with minor alterations.

The soil tests and fertiliser recommendations that you (the correspondent) sent me highlights, in a very clear manner, the differences between two very different soil testing philosophies which have been debated in the scientific literature for at least 50 years.

One philosophy, the **Ratio Theory**, argues that there is an ideal ratio of calcium (Ca), magnesium (Mg), potassium (K) and sodium (Na), and that, if this ratio is achieved the soil will be 'balanced', the soil pH will be ideal and plant growth will be optimized. It is also implied that this 'balanced' soil will be healthier for plants and animals.

The ideal ratios are expressed in terms of the base saturation - the proportion of the cation exchange capacity [CEC] occupied by a particular cation. The ideal is claimed to be 65-85% Ca, 6-12% Mg, and 2-5% K.

Although the philosophy strictly applies only to the major cations it is extended by implication to P, S and trace elements.

In contrast the **Quantity Theory** states that plant growth is optimized providing the minimum quantities of Ca, Mg, K and Na are present. For NZ soils these minimum levels have been determined in field experiments as Mg > 4.0, K > 6-10 (expressed in quick test units), and providing the pH is 5.8-6.0, the soil Ca will be optimal. Note that Na is not required for plant growth.

There has been much scientific effort comparing these two philosophies and their implications for plant growth and fertiliser advice.

The essential conclusions are as follows:

1. Plant growth is optimal over a wide range of base saturation ratios. In other words plants have the ability to take up the nutrients they require and exclude the others
2. The ideal ratios cannot be defined, and therefore the so-called ideal ratios are meaningless agronomically.
3. Plant growth is optimal providing the minimum quantities of the respective nutrients are present.
4. Fertiliser recommendations based on the Ratio Theory result in excessive amounts of some nutrients being applied, particularly Ca and Mg and K, which have no benefits on plant growth.

It is for these reasons that most science-based laboratories, soil scientists and agronomists worldwide use the **Quantity** approach to soil nutrition and fertiliser advice.

Within NZ two laboratories (Soil Testing Services Ltd (Tauranga) and Quantum Laboratories Ltd (Waipawa)) use the **Ratio Theory** for both soil testing and fertiliser advice. Other laboratories (Hill Laboratories, Hamilton, ARL, Hastings and National AgLab, Hamilton) present their results using both the Ratio Theory and the **Quantity Theory**, but are not involved in providing fertiliser advice. AgResearch's laboratory (Soil Fertility Services Ltd, Hamilton) uses only the **Quantity Theory**.

What does all this mean in terms of the information you provided?

The Table below summarizes the fertiliser advice offered to you from Quantum Laboratory Ltd, based on the **Ratio Theory**, with that which would follow from applying the **Quantity Theory** - in other words the traditional approach used in New Zealand. (This comparison is based on the soil sample 'Basin', although the same conclusion would result irrespective of which soil test result was chosen).

Nutrient	Recommendation	
	Ratio Theory	Quantity Theory
Phosphorus	17 kg/ha	Capital (say 30-40 kg P/ha initially then maintenance of 20-30 kg/ha/yr)[1]
Sulphur	Nil	Maintenance (20 kg S/ha/yr)[1]
Calcium/pH	5.7 tonnes/ha	Nil
Magnesium	87 kg/ha	Nil
Potassium	160 kg/ha	Nil
Sodium	Nil	Nil
Boron	1.9 kg/ha	Nil
Iron	327 kg/ha	Nil
Manganese	182 kg/ha	Nil
Copper	3.9 kg/ha	3 kg/ha
Zinc	4.2 kg/ha	Nil

Notes: 1) assuming a sheep & beef property at 15SU/ha on a sedimentary soil. The precise amounts would depend on the GM/ha of the property.

Why so different and is the difference of practical importance?

According to the **Ratio Theory** a large amount of lime is required because the Ca base saturation is only 42% and the theory says it should be 68%. In contrast the **Quantity Theory** says that the current soil pH is 5.9 is optimal (for pastures) and therefore no lime is required. Also the soil Ca level is 8 QT units, which is ample.

Similarly, the **Ratio Theory** requires large inputs of K and Mg to bring the base saturation ratios up to the desired levels of 5 and 15% respectively. In contrast the amounts of K and Mg present (12 and 47 QT units respectively) indicate there are sufficient **quantities** of both these nutrients in the soil without the need for fertiliser inputs at this stage.

Quantum Laboratory Ltd recommends a small input of P but no S. The quantity of P present (Olsen P 12) indicates that a capital input of P is required - say 30-40 kg/ha/yr - to get the levels up to Olsen P 15, on this sheep and beef property on a sedimentary soil, followed by maintenance inputs of about 20-30 kg P/ha/yr). Furthermore the quantities of soil S (6 for sulphate and 8 for organic S) indicate that, at least, an input of maintenance S fertiliser is required (20-25 kg S/ha/yr).

Most scientists familiar with the chemistry of these soils would agree that the trace elements boron (B), iron (Fe), manganese (Mn), and zinc (Zn) are not required at all on these soils, at least for pastures. There may be a need for B if a brassica or lucerne crop was being grown, but Fe, Mn.and Zn are rarely required on NZ soils, except perhaps on coarse textured soils which had been over-limed.

It is clear then, that at the practical level of offering fertiliser advice the two philosophies have very different outcomes. Given that the fertiliser recommendation based on the Quantity Theory is based on field trial results in New Zealand I have no doubt about which is correct in the scientific sense.

What about the costs?

Based on ex-works costs excluding GST, it can be estimated that the cost of the Quantum fertiliser recommendation, based on the **Ratio Theory** is about $320/ha. The conventional recommendation, based on the **Quantity Theory** would cost about $70/ha initially followed by $60/ha/yr thereafter.

What are the likely outcomes of the two recommendations, given that one costs about **four times** the other?

In my view the recommendation from Quantum would not result in any increase in productivity and in fact may have a deleterious in the longer-term, including potential toxicity's of B and Mn and a loss in pasture production due to S deficiency and overliming. It certainly could not be claimed that the soil would be better balanced, a frequent claim made about the **Ratio Theory** approach to fertiliser advice.

In contrast the traditional fertiliser recommendation arising from the application of the **Quantity Theory** is likely to result in a modest increase in pasture production of 5-10%, which if utilized, would result in improved animal performance and economic outcome.

In short, it is my opinion that the advice offered by Quantum Laboratories Ltd should be ignored – it ignores current scientific knowledge, it ignores local experience, it would cost more in terms of fertiliser inputs and is unlikely to result in any production or financial benefits - indeed it may result in a decrease in production. It is a risk that does not and need not be taken.

My advice?

- Avoid the ratio theory if you are concerned about optimizing soil fertility, plant and animal production
- Avoid the ratio theory if you what to maximize the efficiency of your fertiliser dollar.
- Use laboratories that do not use the ration theory.
- Demand that your laboratory use only scientific soil tests and procedures.

PRICE WATCH: NITROGEN FERTILISER

Product	Brand Name (if given)	Company[1]	Indicative Retail Price[2] ($/tonne)[1]	Cost of N ($/kg N)[3]
Urea	N Rich	BOP	286.30	0.62
		Ravensdown	277.10	0.60
DAP		BOP	470.70	1.23
		Ravensdown	437.80	1.04
Sulphate of Ammonia (granular)		BOP	276.04	0.86
		Ravensdown	278.10	0.87
Sulphate of Ammonia (standard)[4]		Ravensdown	193.70	0.47
Nitrogen superphosphates	Ammoniated superphosphate[5] (7.7.0.15)	BOP only	209.09	0.88
	Nitro superphosphate[5] (6.7.0.15)	Ravensdown only	171.75	0.40
	Pasturemag[6] (7.6.0.7.4)	BOP only	191.43	0.79
	Supermag[6] (7.6.0.7.4)	Ravensdown only	175.25	0.56
	PastureZeal[7] (3.10.0.11)	BOP only	194.67	0.85
DAP mixtures	DAP Sulphur Super (11.15.0.13)	BOP only	343.87	0.95
	DAP 13 S (13.16.0.13)	Ravensdown only	372.30	0.94

Notes:
1) Summit-Quiphos Ltd declined to provide information on their products and prices stating that they "will prepare a costed fertiliser recommendation for any farmer at any time at the request of the farmer"
2) All prices are bulk ex works and excluding GST. Effective 28 Feb 2000 for BOP and 1 Feb 2000 for Ravensdown. Actual prices may depend on variations in agents margins
3) After deducting where necessary the value of the other nutrients (S @ $0.40, P @ $1.25, Mg @ $0.82)
4) Standard ammonium sulphate, unlike the granulated product, has a fine particle size and is not recommended for mixing with other granulated fertilisers
5) These products are mixes of ammonium sulphate and superphosphate. Care is required when spreading to ensure even distribution. They may go lumpy during storage – prompt spreading is advised
6) These products have better physical and storage characteristics than the ammoniated and nitro superphosphates
7) PastureZeal is compound fertilisers and its use is not limited by the problems associated with the other blended nitrogen fertilisers

Comments:

1. With the exceptions noted below, urea, from either of the major companies, is the cheapest from of N at present.
2. The compound products (eg DAP and granular Sulphate of Ammonia) and the mixes with these products are more expensive per unit N relative to urea, after the value of the other nutrients is deducted.
3. Standard ammonium sulphate, and mixtures of this product with superphosphate (Nitro Superphosphate), available from Ravensdown, have a lower cost per unit N relative to urea, but extra care is required when storing and spreading these products.

My Advice?

Choosing the appropriate N fertiliser requires careful consideration of the trade-offs between a) the cost per unit N, b) management flexibility c) transport and spreading costs and d) ease of storage and spreading.

1. If you wish to apply frequent small tactical applications of N, separate from the strategic inputs of P, K S etc, and you apply the N fertiliser at your own expense, urea is the cheapest option at present.
2. When N is purchased and applied in a mix with other nutrients, the higher cost per unit N may be offset by the savings in transport and spreading costs. However, flexibility in terms of deciding the optimal time to apply N may be compromised.
3. Standard ammonium sulphate and its derivative mixtures, require extra care when storing and spreading.
4. Applying the spirit of caveate emptor, if subscribers wish to obtain a second opinion regarding fertiliser recommendations and prices offered by Summit Quinphos Ltd, this will be undertaken by The Fertiliser Review free of charge.

ORGANIC v CHEMICAL FERTILISER

There is a view that chemical fertilisers are bad for the environment. They cause, it is said, pollution through runoff and leaching, they destroy soil organic matter and are harmful to soil microbial life. These views are typically expressed by those who also claim that organic fertiliser, such as manures (eg farm yard manure, animal slurries and green feed crops) do not cause these harmful effects.

Fortunately, there are a good number (14) of long-term trials (> 50 years) that have compared the effects of chemical fertilisers and manures on soil productivity and quality.

Many of these trials were started in the late 1800s, when the chemical fertiliser industry was in its infancy. Scientists and farmers at the time were delighted by the prospect that these new chemical fertilisers would overcame the need to load, cart and spread large quantities of animal waste and the associated risks from diseases. They were also rightly concerned that chemical fertilisers may not sustain production as manures had done for centuries.

The results (see Table) show that the chemical fertilisers are no better, or worse, than organic manures, in terms of sustaining crop production. The average difference in plant yields, between the fertiliser and manure treatments, was about 4% in favor of fertilisers.

Other results from these trials showed that:

1. Both fertilisers and manures increased soil organic matter levels. In the long-term, soil organic matter levels were higher in manured soils relative to the fertiliser treatments. This is because they supply an additional external source of organic matter. However this additional soil organic matter did not improve the long-term productivity of the soils.
2. Relative to where fertilisers were used as a source of nutrients, the long-term application of manures results in the accumulation of P, K, Ca and Mg in topsoils and nitrate N, Ca and Mg in subsoils. This problem is a consequence of the inappropriate, and fixed, ratio of nutrients in manures and cannot be readily overcome unless they are mixed with fertilisers. Thus, manured soils have greater potential to decrease water quality through leaching (particularly of nitrate N) and runoff (particularly of P).
3. The long-term use of some manures, particularly sewage sludges and farmyard manures, are likely to result in the accumulation of heavy metals in soils, particularly of Pb, Cd, relative to fertilisers.
4. The long-term application of manures improves some soil physical characteristics such as bulk density, hydraulic conductivity and aggregate stability, through the addition of organic matter. These effects do not appear to confer any benefit to the soils in terms of their productivity and could possibly result in greater permeability of soils to water and hence result in greater leaching losses of nutrients.

If soil quality is defined as the sum of those properties that affect soil productivity, and includes a soils potential to affect water quality, and its loading with pollutants, then it must be concluded that, in the long-term, manures decrease soil quality relative to the use of fertilisers.

These results suggest that all chemical fertiliser should be classified as “organic”, in the sense that, when used wisely, they have beneficial effects on soil biology, soil chemistry and soil physical properties. Sounds outrageous I know but then that is what the facts show.

Trial	Crop[1] and Measurement Period[2]	Average Annual Yield[3] (tonnes/ha)		Difference[4] (%)
		fertiliser	manure	
Morrow	Corn (1985-93)	8.4	6.0	-28
Sanborn	Wheat (1970-90)	2.7	2.6	-4.1
	Corn (1970-90)	7.5	3.8	-50
Magruder*	Wheat (1988-94)	32.8	28.3	-14
Pendalton	Wheat (1982-92)	4.9	5.6	+14
		4.5	4.3	-4
East Lansing	Corn grain (1974-82)	10.5	10.5	0
	Corn grain (1974-82)	7.3	8.0	+10
Nebraska*	Corn (1976-91)	4.8	4.7	-2
	Soybean (1976-91)	2.4	2.3	-4
	Oats (1976-91)	2.2	2.4	+9
Breton*	Wheat (1982-92)	3.1	2.9	-6
	Oats (1982-92)	4.4	4.1	-7
	Barley (1982-92)	3.3	2.7	-18
Broadbalk	Wheat (1985-90)	8.3	7.9	-15
	Potatoes (1985-90)	35.6	32.9	-8
Barnfield	Pasture (1983-90)	8.4	9.4	+12
Hoosefield	Barley (1984-90)	5.5	6.4	+16
Park Grass	Pasture (1986-90)	6.4	6.7	+5
Cockle Park*	Pasture (1897-1975)	5.3	5.3	0
Hillsborough	Pasture (1970-85)	12.1	13.4	+11
	Pasture (1970-85)	12.1	12.2	+1
Askov*	Various crops in rotation	3800	3350	-11
	Various crops in rotation.	5890	5460	-7

Notes: 1) all continuous cropping or pasture unless stated otherwise

2) years from which given yields recorded

3) where treatments are not balanced the yields from the nearest comparable N treatments are given

4) (fertiliser – manure) / fertilizer as %.

5) * indicates that the trial is balanced wrt N inputs

SUMMIT-QUINPHOS: MISUSE OF SCIENCE?

A correspondent recently sent me an advertising pamphlet produced by Summit Quinphos Ltd. It presents a summary of results from a study conducted by Professor Syers and Dr Alec MacKay (Massey University.

The results from the original research paper, quoted in the Summit Quinphos advertising pamphlet are as follows:

Soil	Phosphate Retention	Drop in Availability of Superphosphate P (%)[1]	Increase in Availability of RPR P (%)[1]
Tokomaru	22	22	60
Wainui	35	30	56
Konini	50	42	44
Taupo	73	38	180
Ramiha	86	47	100
Egmont	91	50	33

Notes: 1) as measured by the change in Olsen P over the first 10 days.

These results appear to support the view of Summit Quinphos, that the availability of soluble superphosphate P declines rapidly when added to soils, and that, the opposite occurs with slow release RPR P. The inference is that soluble P is rapidly fixed and unavailable for plant growth and that this does not occur with slow release P.

In fact, this laboratory experiment (note it was not a field experiment) ran for 90 days. The Olsen P levels in the soils at the end of the experiment are given below:

Soil	Phosphate Retention	Initial Olsen P	Olsen P @ 90days for Super	Olsen P @ 90days for RPR
Tokomaru	22	6	80	27
Wainui	35	7	89	35
Konini	50	4	70	32
Taupo	73	16	60	22
Ramiha	86	3	35	20
Egmont	91	3	20	10

At the end of the experiment the levels of plant available P (Olsen P) in the superphosphate treated soils are much higher than where the same amount of P was applied as RPR indicating that, because it is soluble, superphosphate P has an immediate positive effect on plant available P. RPR is slow release – it takes time to dissolve and increase the amount of plant available P.

These laboratory results are consistent with what happens in the field. Because they are slow release there is an associated lag effect when RPR is used, relative to a soluble fertiliser. The science shows that this effect is about 4-6 years for the best RPR (like Sechura) and 10-15 years for the worst (like Egyptian).

This example demonstrates the danger of selecting bits of information to support a particular point of view. It is bad scientific practice and should not be tolerated in our industry. Unfortunately this practice in now becoming common as the competition between the fertiliser companies increases. It only make matters worse that most scientists become more restricted in their public utterances.

The Fertmark Code of Conduct in relation to the use of scientific data in advertising and promotion states that such data ‘ must not be used out of context or in such a manner that does not accurately reflect or portray the overall conclusions of the research".

In my opinion the above example is in breech of this standard. **Let the buyer beware!**