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SMARTFERT

Background

It has been the "Holy Grail" of the international fertiliser industry for over 50 years – the development of a truly, cost-effective, controlled release nitrogen (N) fertiliser, suitable for the broadacre. Some have been developed but at present their cost limits their use to horticulture and turf-culture.

The theory is that if the rate of release of N from a fertiliser granule matched the plants demand for N, this should increase N use efficiency (NUE, e.g. more production per unit N applied) and/or reduce N losses to the environment (e.g. leaching).

Theoretically there are several types of controlled release N fertilisers:

1. N fertilisers, which are chemically modified to reduce the solubility of the N compound in the fertiliser (e.g. urea-aldehyde polymers). There are no examples of these products in New Zealand.

2. Soluble N fertilisers, which are coated with a material to slow or control the movement of the N from the granule to the soil solution (e.g. PhaSedN which is sulphur coated SustaiN).

3. Soluble N fertilisers, to which bio-active chemicals (e.g. urease and nitrification inhibitors) are added which slow down the transformations of the fertiliser N once it is in the soil.

In New Zealand there has been considerable interest in, and research on, the Type 3 products (e.g. SustaiN® – urea treated with a urease inhibitor, LessN – urea treated with an unknown bio-active material and EcoN – a solution containing the nitrification inhibitor DCD). Independent research on these products indicates that they are not as effective as claimed[1] or, in the case of the new product from Ballance AgriNutrients Ltd (PhaSedN), there is simply no field research.

[Note 1. For further reading go to Edmeades D.C. and McBride R.M. 2011. Evaluating the agronomic effectiveness of fertiliser products. Proceedings of the NZ Grassland Association 73: 119-124 and Fertiliser Review 15, 22, 24, 30].

A New Product

Six years ago I was retained[2] by an Auckland company (now called Eko360 Ltd) to provide them with scientific advice on how to evaluate and test a slow release N product they were planning to import from Malaysia.

[Note 2. I hasten to add that I have no pecuniary interest in the product or the company and my name cannot be used in any promotional material].

The first step was to establish whether this new product (now called SmartFert) was indeed a slow-release N fertiliser. We started in the laboratory[3] measuring the rate of release of N from different formulations (number of coatings on the product). The results (Figure 1) showed that, relative to urea, it is a slow-release fertiliser and that the number of coatings controlled the rate of release of N. At this laboratory level we could say that it is indeed a controlled release N fertiliser.

[Note 3. With any new product it is tempting to race straight into field-testing. However field trial results are not precise and the results are difficult to explain unless the basic chemistry of the product is known. See example on the product RePlenish later in this edition]

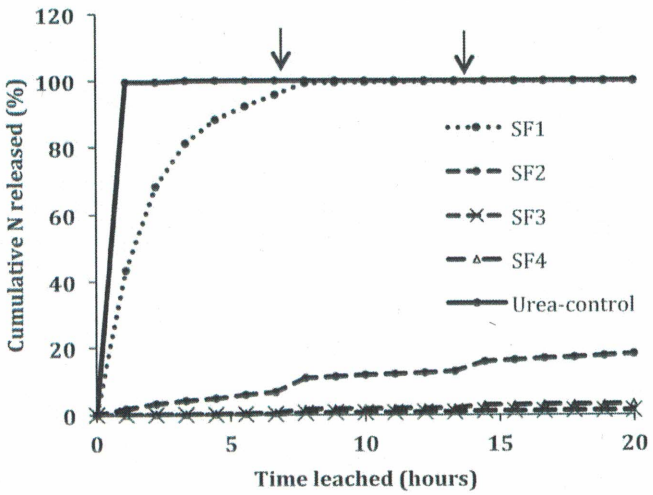

Figure 1. Cumulative nitrogen (N) released (% of total) over time from urea and 4 experimental controlled release products (SmartFert, SF) with differing manufacturing specifications. The arrows on the graph represent the over-night pauses in the leaching experiment.

The next step was to establish whether a similar pattern of results would occur when the products were in contact with the soil. A glasshouse experiment was conducted using the N uptake by ryegrass plants over time, as the measure of the release rate of N, ensuring that there were no losses of N to the atmosphere or via leaching. The pattern of the N release as measured by N uptake was similar (Figure 2) confirming that, in the presence of soil, the product behaved as predicted from the laboratory tests.

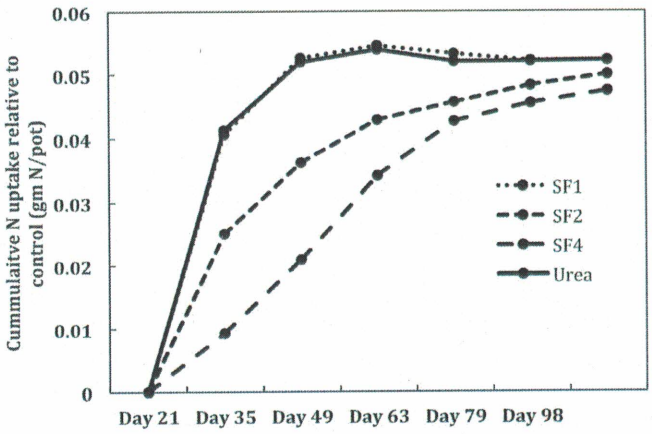

Figure 2. Cumulative nitrogen (N) uptake by ryegrass after single applications of urea and SmartFert (SF 1, 2 & 4) over time in the glasshouse study in the spring.

To the Field

Would we get similar results in the field where other factors, such as soil temperature and moisture, cannot be controlled? Three field trials, all on pasture, were conducted in the spring of 2014. Single applications of different rates of N applied as urea were compared with the same rates of N as SmartFert 4 (SF 4).

The results were encouraging. Typically pasture responses to urea occurred within the first 2-3 months after the initial application and then declined over time out to six months. The effects of the SmartFert took time to develop and were at a maximum 3-5 months following application (see Figure 3 for example).

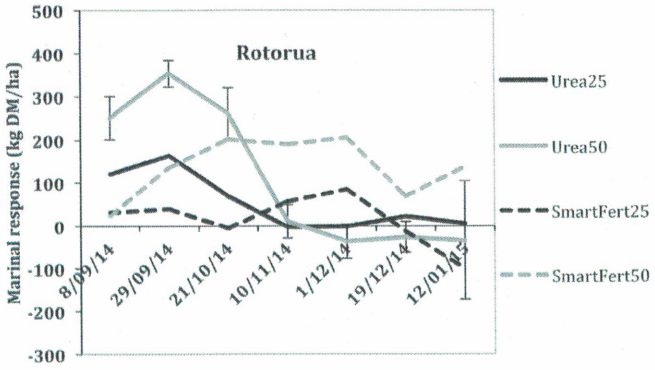

Figure 3 Marginal pasture responses (kg DM/ha) relative to control over time after applications at 2 rates of urea and SmartFert (25 and 50 kg N/ha applied once) on a pumice soil near Rotorua. The error bars are +/- standard error of the difference (SED) for each harvest.

One of the three trials included a comparison of SmartFert applied once at 90 kg N/ha, with urea applied once at 90 kg N/ha, and urea applied in 3 applications of 30 kg N/ha (Figure 4). Intriguingly the cumulative yields for these three treatments were similar raising the question – could a single large application of the controlled release product SmartFert do the same job as small frequent additions of the same total amount of N applied as urea?

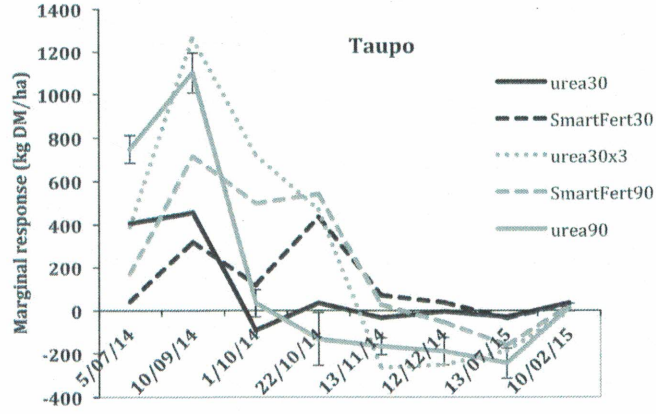

Figure 4 Marginal pasture response (kg DM/ha) relative to urea over time after applications of 2 rates or urea or SmartFert (30 and 90 kg N/ha applied once) and a split application of urea (30 kg N/ha x 3) on a pumice soil at Taupo. The vertical bars are +/- SED for each harvest.

Given these results - from the laboratory to the glasshouse and into the field - it was concluded that proof of concept had been attained – the product could be classed as a controlled release fertiliser but further research was required.

More Trials

At this point Ballance AgriNutrients Ltd became interested in SmartFert and conducted their own trials comparing it with their proprietary product SustaiN (urea treated with urease inhibitor). Two trials were conducted in the spring of 2015. The results from these trials with SustaiN in place of urea (Figure 5 for example) showed the same trends as found with urea (see Figure 3).

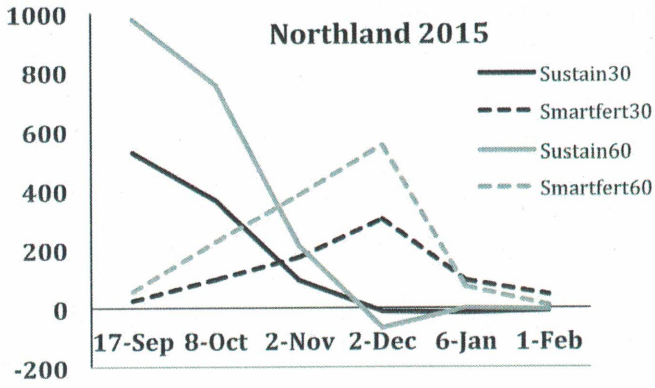

Figure 5 Marginal pasture responses (kg DM/ha) relative to control over time after single applications of two rates of Sustain and SmartFert (30 and 60 kg N/ha) in 2015.

Three further trials were conducted in 2016 and compared a single application of SmartFert applied at 100 kg/ha with 3 applications of SustaiN applied at 33 kg/N/ha (Table 1). These results confirmed the earlier results shown in Figure 4. Single large applications of Smartfert were as effective as multiple applications of the same amount of N, in this case, SustaiN.

Site	Control	SustaiN (100 x 3)	SmartFert (100 x 1)	SED
Northland	5141	6246	6456	263
Rotorua	3707	4799	4623	164
Canterbury	5824	6363	7610	442

Table 1. Cumulative pasture production (kg DM/ha) at three sites comparing SustaiN applied in three applications of 33 kg N/ha with a single application of SmartFert applied at 100 kg N/ha.

Effects on Pasture N Concentrations

The mixed-pasture N concentrations, expressed as the difference from the Control was measured in some trials. The results (see Figure 6 for example) suggest that large increases in pasture N concentrations can occur immediately following application of urea and that this effect was much less for SmartFert. This occurred on some but not all of the trials.

Given that a) most of the N leached from pastures arises from the urine patch and that b) there is a linear relationship between N intake and urine N, these results suggest the possibility that SmartFert at least in some situations may decrease N leaching.

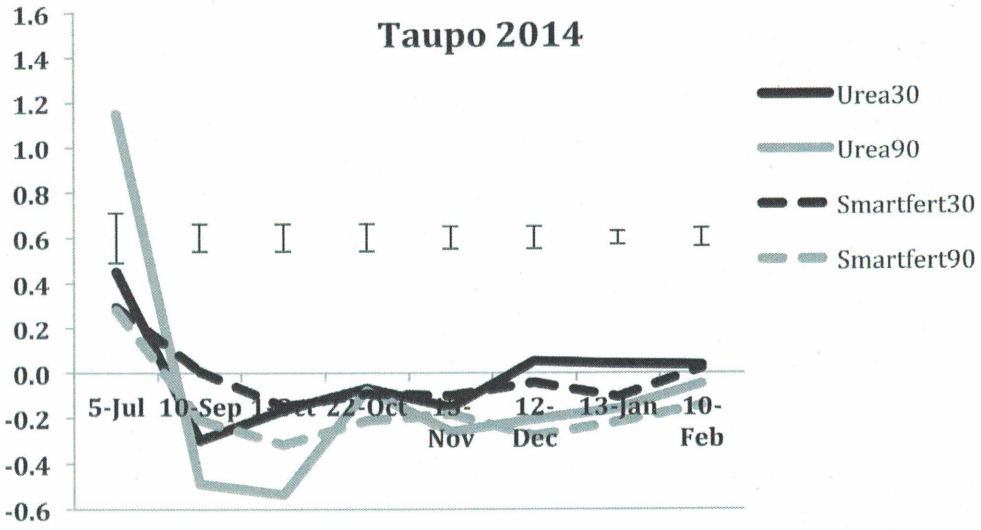

Figure 6 Marginal pasture nitrogen concentrations (N%) relative to control over time after single applications of two rates of urea or Smartfert (25 and 50 kg N/ha). (The vertical bars are the s.e.ds.)

Future Research

In theory if the rate of release of N from a fertiliser N granule better matches the plants demand for N, this should increase NUE and/or reduce N losses to the environment. Increases in NUE, relative to urea and SustaiN, were measured in some of the trials and on a few occasions they were large enough to be statistically significant but they were not consistent across all trial sites. This raises the question: in situations were SmartFert increases NUE relative to urea, does this mean that N losses (leaching and/or volatilization), are lower. This requires further investigation.

Similarly, the possibility that SmartFert reduces the N concentration in pasture relative to urea, and hence could reduce the N concentration in urine and consequently reduce leaching losses of N from the urine patch, also requires quantification.

What about cropping? Can one large application of SmartFert eliminate the need for multiple applications of N as the crop develops? Will it be possible using this technology to develop N products with different release characteristics that better match the unique demands of different crops?

Advice to Farmers?

The results to date confirm that SmartFert is indeed a controlled release source of N relative to soluble urea and SustaiN. Its effects on pasture production are slower but last longer and a single application of SmartFert is as effective, in terms of total pasture production, as multiple, smaller applications of SustaiN or Urea.

SmartFert is now on the market and is available from Ballance AgriNutrients Ltd and via the proprietors Eko360 Ltd.

[This article is based on results published in a) Edmeades, D. C. 2015. Evaluation of a controlled release nitrogen fertilisers. Journal of the NZ Grassland Association 77:147-152 and b) Edmeades D. C. and McBride, R.M. (2017). Further field evaluation of the controlled release nitrogen fertiliser SmartFert™. Journal of the NZ Grasslands Association 79: 73-78]

FERTILISER ADVICE

Time for a little disruptive technology?

Fertilisers are typically the largest item of discretionary expenditure on most Sheep & Beef farms and many Dairy farms. Despite this most farmers are lackadaisical when it comes to setting the fertiliser policy. A range of justifications exist:

1. Do what Dad did, after all he was successful, wasn't he?
2. Adjust last years fertiliser budget up or down depending on a gut feel about the market forecasts. After-all we had a good year last season.
3. Copy the neighbour – he is a good farmer, isn't he?
4. Do what the accountant says – he wouldn't put me crook?
5. Do what the fertiliser salesman recommends – seems like a genuine bloke, doesn't he?