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Review of Donaghys Industries Limited LessN Field Trials

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This report reviews the New Zealand field trials conducted by Donaghys Industries Limited, 16 Sheffield Crescent, Harewood, Christchurch to evaluate pasture responses to the application of LessN in association with urea. This report considers the design, conduction of the field trials, analysis and reporting of results.

Background

Donaghys have brought to the pastoral sector in New Zealand a urea additive, LessN, that enhances the uptake of Nitrogen (N) by ryegrass and clover pastures, such that a lower rate of N-based fertilizer can be applied. Urea is a very common N fertilizer used to boost pasture production, particularly by dairy farmers during the spring and autumn growing seasons. Up to five applications of urea at a typical rate of 80 kg/ha can be spread per year. There is mounting concern over the environmental consequences of leaching of excess N into ground water. There is also economic pressure on farmers to increase the efficiency of their production systems, including reducing input costs whilst maintaining outputs. LessN, when applied with dissolved urea in a spray formulation at a rate of 40 kg/ha, is purportedly able to boost pasture growth to a level superior to that achieved with a typical granular spread application of 80 kg/ha urea, and to a level equivalent to that achieved with dissolved urea alone sprayed at a rate of 80 kg/ha. This report critiques the field trials conducted to evaluate this claim.

Trial protocol

The study design for each farm trial was based on a complete randomised block design (CRBD), with four treatments (including a control) per block, and five replicates (blocks) on each farm, for a total of 20 plots per farm. Each treatment plot was a 4 m wide strip of pasture, a minimum of 50 m long. Treatment plots were randomised within each block. The overall plot layout was held constant across different farms.

The four treatments were:

1. Control: 200 litres water / ha
2. U40: Urea 40 kg/ha (dissolved in 200 litres water / ha)
3. U40 + LessN: LessN (3 l/ ha) plus Urea 40 kg/ha (dissolved in 200 litres water / ha)
4. U80: Urea 80 kg/ha (dissolved in 200 litres water / ha)

Site selection on a given farm looked for areas of relatively uniform grazing within a recently grazed paddock. Flat paddocks were preferred to sloped paddocks. Where possible, blocks were all contiguous within the same paddock; however, on farms with border dyke irrigation, blocks may have been separated into adjacent dykes.

Pre-trial remaining pasture dry matter (DM / ha) was estimated for each plot using a Grass Master Probe. An operator walked down each plot taking 25-30 readings. Each reading was recorded into a Dictaphone for later transcribing into a spreadsheet and calculation of mean pasture DM / ha per plot.

Treatments were then applied, starting with the water control. All control strips were sprayed in turn, followed by all U40 strips, then U40 + LessN strips, and finally U80 strips.

Post treatment pasture DM / ha was most commonly estimated at Day 21 after treatment by the same technique (Grass Master Probe), although timing varied slightly from farm to farm to fit in with farmer grazing rotation schedules.

The above trial protocol has been conducted on 53 farms to date, throughout a number of regions of New Zealand. Pasture DM estimations on some farms used mowing and oven drying in addition to Grass Master Probe readings.

Soil temperature and rainfall were also recorded for each farm site during each trial.

Statistical Analysis

All data was transcribed from Dictaphone into a spreadsheet. Pasture DM growth was calculated by subtracting residual mean pasture DM at Day 1 (pre-treatment) from final mean pasture DM at Day 21 (post-treatment) for each plot. This was subsequently converted into Pasture DM / ha / day based on the number of growing days. N response was calculated from the kg N applied.

Statistical analysis of data was initially conducted at a farm level, with significance of any differences between treatments tested using one-way analysis of variance (ANOVA) specifying block as replicate variable. Only plot means were used. Hence 4 treatments were compared, with 5 block means per treatment submitted to the analysis. Pairwise comparisons were conducted using a form of the least significant difference test (LSD), with α set at 0.05 %. An overall two-way ANOVA has also been conducted incorporating plot means without blocking from the thirty-four most recent Donaghys conducted farm trials (five from the summer of 2007-8 and twenty-nine from 2008-9), with farm included as a variable.

Tests for normality of raw plot readings and plot means were conducted using Minitab, and Genstat was used to conduct the ANOVAs and LSD tests.

Results

Detailed results will not be presented here, as Donaghys have made the individual farm trial results available on their Web site (http://www.donaghys.co.nz/192.html). However, in summary, twenty-four of the twenty-nine 2008-9 trials showed that U40 + LessN produced significantly better pasture growth than U40 alone ($p < 0.05$), and perhaps as importantly, U40 + LessN was not significantly different to U80. In the combined analysis using the data from the thirty-four above mentioned farm trials, the mean figures for total DM growth by treatment were:

Treatment	Total Dry Matter growth (kg / ha)
Control	817.8
U40	977.5
U40 + LessN	1275.7
U80	1281.2

Overall, these differences were highly significant ($p < 0.001$), and the LSD revealed that U40 + LessN was significantly different to U40 alone, and U40 + LessN was not significantly different to U80 alone.

Comments

The overall trial protocol follows accepted agronomy trial practices for CRBD studies and the statistical analysis is robust, using highly respected software. The recording of individual pasture reading data points allows for checking the distribution of the data within each plot to assess its normality and whether there are any aberrant data points. This also leads to greater transparency in the results for peer reviewing. Submission of plot means rather than raw plot readings into the ANOVA assumes that the true mean value for each treatment plot has been adequately captured, and plot means within treatment are normally distributed. These assumptions have been tested, and should continue to be monitored to ensure robustness of the analyses.

A degree of blinding was aimed for by using two operators – one to conduct the spraying and the other to conduct the pasture DM measurements. Ideally, treatment order within block layout should be completely re-randomised for each farm to avoid any criticism that the blinding of the pasture reading operator might be compromised over time.

Donaghys have demonstrated transparency and integrity in making all of the farm trial results accessible to the public on their Web site, as it is important to report apparent failures or non-significant results as well as those where LessN has been shown to be beneficial.

If further trials are conducted, I would recommend that an overall combined analysis should be conducted using a generalised linear mixed model, with farm as a fixed effect, and additional covariates included in the model building process (eg. time of year, soil temperature, rainfall) to improve knowledge of conditions under which LessN is beneficial and not beneficial.

Conclusions and recommendations

Firstly, I would like to congratulate Donaghys for embarking on a rigorous and comprehensive series of trials to evaluate the benefits of the LessN system. Overall, the adopted trial design and statistical analyses are scientifically robust.

The take home message from trials to date is that U40 + LessN produces significantly better pasture growth than U40 alone, and U40 + LessN is not significantly different to U80. This means that the LessN system presents a viable option to achieve required pasture growth with half the current industry standard application rate of urea.

To date, trials have been mainly conducted during the spring and autumn, although roughly a quarter of trials have been during the summer. To improve the generalisability of the results, I would recommend that additional trials be conducted in the summer and winter, to improve knowledge of conditions under which LessN is beneficial and not beneficial, particularly with respect to soil type, temperature and rainfall (or ground moisture) conditions. Trials should also be repeated across multiple years. An overall statistical analysis should be conducted using generalised linear mixed effects modelling allowing for additional explanatory covariates (eg. soil temperature) to be tested for significance at the same time.

Finally, I would recommend that a paper on the overall trial results be submitted for publication in an appropriate peer-reviewed journal.

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