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TRIALS AND TRIBULATIONS WITH USE OF GA_3 ON PASTURES – WHAT DO LONGER TERM TRIALS TELL US?

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Abstract
Ballance carried out extensive field trials in New Zealand and Northern Ireland over the period 2012-2016 to evaluate the effectiveness of gibberellic acid (GA_3) applied with or without N-fertiliser. This research showed that GA_3 produced a consistent, rapid increase in pasture dry matter (DM) production at the 1st harvest, averaging an additional 217 kg DM/ha. However, this was followed by a consistent pasture growth 'lag' at the 2nd and/or 3rd harvests, reducing the total additional pasture DM generated over 2-3 harvests to an average of 119 kg DM/ha (i.e. approximately 55% of that at the first harvest). This lag following GA_3 application was consistent regardless of whether GA_3 was applied with or without N-fertiliser, indicating the effects of N-fertiliser and GA_3 were simply additive. The small improvements in pasture yield response from co-applying GA_3 and N (when measured over 2-3 harvests) must be weighed up against the practicality and cost of using liquid N, given that liquid N offers no efficacy advantage over granular N.

Introduction
GA_3 is a plant hormone that is known to influence plant growth behaviour through various means, including stimulation of stem elongation and leaf expansion, enzyme activation, and enhanced mobilisation of plant energy reserves (Matthew et al. 2009; Ball et al., 2012). Research into the use of GA_3 in New Zealand pastoral systems stems as far back to the 1950's (Scott, 1959). However application rates investigated at the time were very high (25-700 g/ha), and coupled with undesirable side effects (e.g. subsequent yield lags) these factors precluded its adoption on economic grounds (Matthew et al. 2009).

It was not until the mid-2000's with new research investigating lower application rates (8 g/ha) that economically-viable commercial use of GA_3 materialised. GA_3 is now widely used in the New Zealand pastoral industry, being used to increase pasture growth / feed availability when soil temperature limits pasture growth rate. Application of GA_3 typically occurs over the autumn to spring period, with GA_3 recommended to be applied within 5 days of grazing to pasture residuals of 1200-1500 kg DM/ha. Grazing is then recommended to occur within 3-4 weeks of application to ensure the maximum pasture response benefit is captured (DairyNZ, 2011).

Within its *Clearview Innovations* Primary Growth Partnership programme, Ballance set about investigating the potential for the use of GA_3 to increase pasture yield and fertiliser N use efficiency.

Methodology
Small-plot field trials were carried out on ryegrass-based pastures in New Zealand (10 sites, repeat applications in 3 seasons) and Northern Ireland (2 sites, spring application only) over

the period 2012-2016. GA_3 (foliar applied; 8-30 g a.i./ha, applied at 400-800 L/ha) and N-fertiliser (20-30 kg N/ha) were applied either in isolation or in combination. All treatments were applied within 5 days of a uniformity cut, with yield harvests occurring 21-25 days after application, mown to reflect grazing residuals of 1200-1500 kg DM/ha. In some trials, a repeat application of all treatments occurred following the first harvest. Total dry matter production was assessed over 2-3 harvests, recognising that there was little published information available on the longer term effects of GA_3 on total yield response when assessed over multiple harvests.

Results and discussion

All individual site-application data points were plotted as cumulative frequency distributions following the method outlined by Edmeades (2002). Using this technique, the additional DM yield (kg DM/ha) produced in GA_3 treated plots relative to control plots (Figure 1), and fertiliser-N + GA_3 plots relative to fertiliser-N only plots (Figure 2), is shown when assessed at the 1st harvest, as well as the total additional yield when assessed over 2-3 harvests.

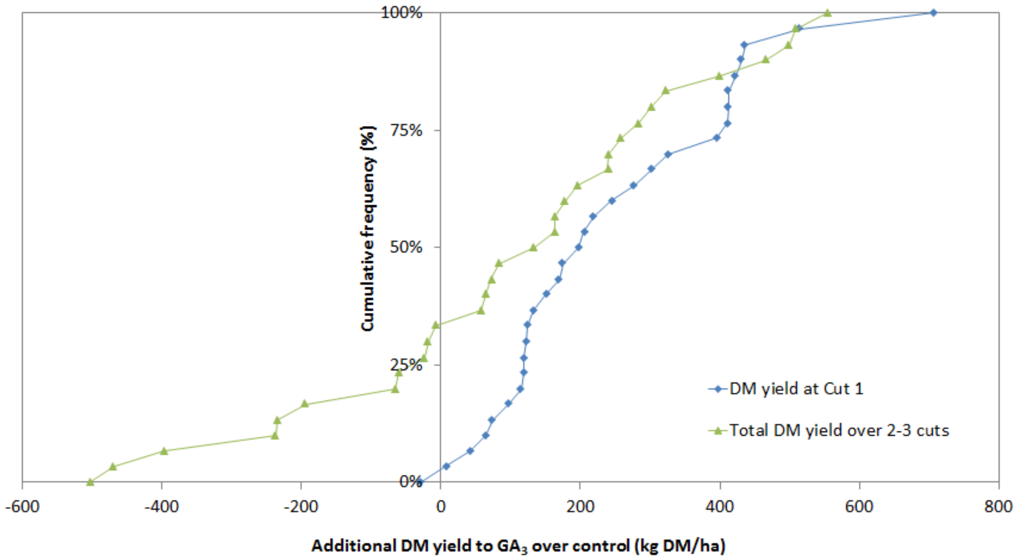

Figure 1. Cumulative frequency distribution of additional pasture DM yield (kg DM/ha) from GA_3 over control (*n* = 31).

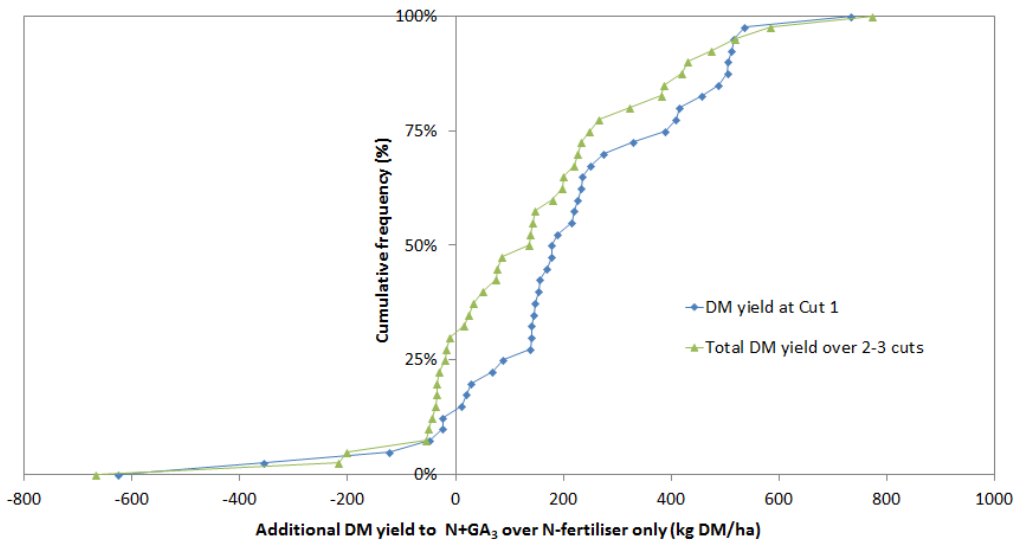

Figure 2. Cumulative frequency distribution of additional pasture DM yield from fertiliser-N + GA_3 over N-fertiliser only (*n* = 41).

While there was a wide range in the additional pasture yield generated from GA_3 alone or in combination with N fertiliser, in both cases, application of GA_3 drove a sharp increase in additional pasture growth at the 1st harvest. For GA_3-treated plots relative to control plots, the mean additional DM yield at harvest 1 was 239 kg DM/ha, while for fertiliser-N + GA_3 plots relative to fertiliser-N only plots, the mean additional DM yield at harvest 1 was 201 kg DM/ha.

However, total additional DM yield decreased when assessed over multiple harvests, indicating a lag effect from GA_3. For example, the mean additional DM yield in GA_3-treated plots relative to control plots decreased from 239 kg DM/ha at harvest 1 to 96 kg DM/ha when total additional yield was assessed over 2-3 harvests. Similarly, the mean additional DM yield in fertiliser-N + GA_3 plots relative to fertiliser-N only plots decreased from 201 kg DM/ha at harvest 1 to 137 kg DM/ha when total additional yield was assessed over 2-3 harvests.

This lag in growth rate following an initial GA_3 growth pulse was very consistent in these trials, as indicated by a shift to the left on the cumulative frequency graphs for the curves representing the total additional yield over 2-3 harvests, relative to curve representing the additional yield at harvest 1. This effect was consistent at GA_3 application rates of 8-30 g a.i./ha, despite suggestions this effect has been largely overcome with the lower application rates now being used. Notably, data presented from a trial run by Massey University (Matthew et al., 2009) also suggested a decrease in pasture growth rate in GA_3-treated pasture relative to the control at the 2nd harvest, however this was not statistically significant and further harvests were not pursued to determine whether this effect persisted.

The DM growth rate ‘pulse’ and ‘lag’ phases associated with GA_3 application are exemplified by the trial in Figure 3. In this trial, fertiliser-N + GA_3 provided an additional ~400 kg DM/ha at the 1st harvest relative to N-fertiliser only. However, this was directly offset by an equivalent reduction in yield at the 2nd harvest, such that overall, the only pasture yield response was to N-fertiliser (700 kg DM/ha, equivalent to 28 kg DM/kg N applied).

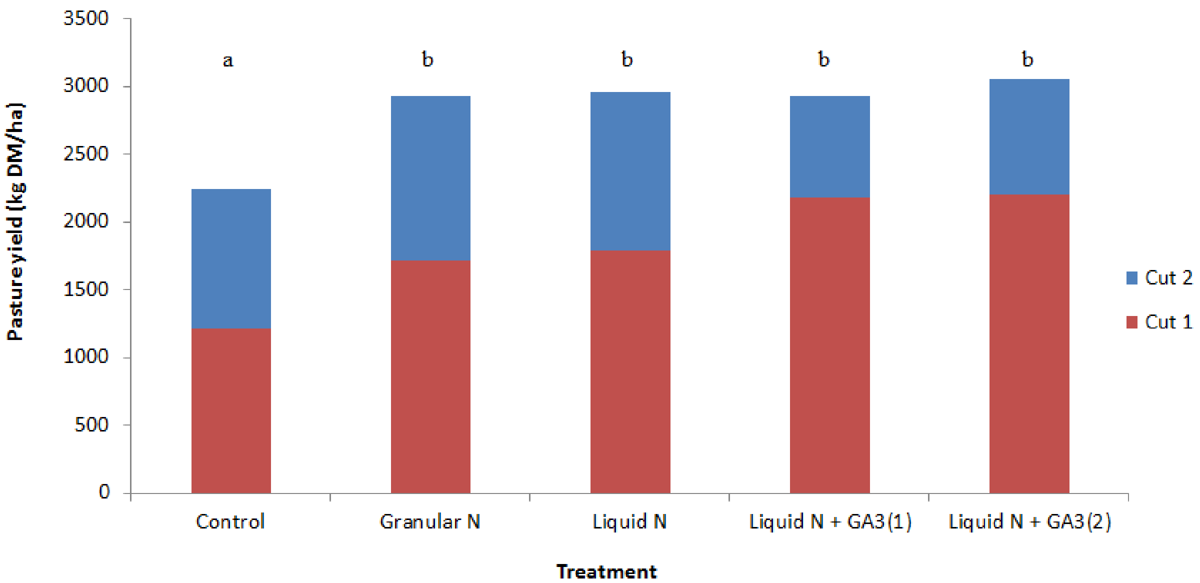

Figure 3. Pasture dry matter yield assessed over two harvests. N-fertiliser applied as urea at 25 kg N/ha. GA_3 applied in two different forms (GA_3(1) and GA_3(2)) both at 30 g a.i./ha.

The sharp increase in pasture DM yield at the first harvest following GA_3 application suggests that GA_3 may still be a valuable tool for bringing forward feed availability to fill an immediate feed deficit. However, given the subsequent lag in pasture growth rate that appears to occur over subsequent harvests, consideration should be given to longer-term growth rate projections, and likely feed supply versus demand in the subsequent grazing rounds. It is possible that an immediate feed deficit may just be shifted to a subsequent grazing round, if base pasture growth rate does not lift to compensate for the apparent "post-GA_3" pasture growth rate lag.

Summary

GA_3 applied with or without N fertiliser drove a sharp increase in pasture yield assessed at 21-25 days post-application. However, a lag in pasture growth rate over subsequent harvests meant that total additional feed grown over 2-3 harvests was approximately 50% of that grown at the 1st harvest. The longer response period to N application may mask some of this 'post-GA_3 lag'; however, the responses appear additive. It is possible that mowing height (and grazing management) could influence this pasture lag by increasing stem removal in GA_3-treated pastures, which may influence subsequent regrowth due to increased depletion of plant energy reserves. More research may be warranted to evaluate this effect. However, this is likely to be difficult to manage in a practical sense in a livestock grazing system, and Ballance does not intend to take this product development research further.

References

Ball, C.C., Parsons, A.J., Rasmussen, S., Shaw, C., Rowarth, J.S. 2012. Seasonal differences in the capacity of perennial ryegrass to respond to gibberellin explained. Proceedings of the New Zealand Grassland Association 74, 183-188.

DairyNZ. 2011. DairyNZ Farmfact 1-26 ProGibb® SG. Updated April 2011. 3 p. https://www.dairynz.co.nz/media/253660/1-26_ProGibb_SG.pdf

Edmeades, D.C. 2002. The effects of liquid fertilisers derived from natural products on crop, pasture, and animal production: a review. Australian Journal of Agricultural Research, 53, 965-976.

Matthew, C., Hofmann, W.A., Osborne, M.A. 2009. Pasture response to gibberellins: A review and recommendations. New Zealand Journal of Agricultural Research, 52, 213-225.

Scott, R.S. 1959. Effect of gibberellic acid and nitrogen on winter growth of pasture. New Zealand Journal of Agricultural Research 2, 1203-1210.