Repeat applications of Gibberellic Acid on Northland pastures

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Summary
A field plot trial was conducted in Northland to determine the effects of single and multiple applications of gibberellic acid (GA) with or without nitrogen.

A single application of GA (20 g/ha) plus nitrogen (37 kg/ha) in July produced 1066 kg DM/ha more than the control treatment while nitrogen alone produced 539 kg DM/ha more than the control treatment. The addition of GA provided extra pasture growth at a very low cost (approximately 7¢/kg DM).

Plots receiving two applications of GA without nitrogen (June and July) produced no additional pasture immediately after application, but showed a negative effect later in the season. Plots receiving three applications (June, July and August) of GA with nitrogen or nitrogen alone grew significantly more pasture than the control during spring. Though the addition of GA changed the timing of production, it had no effect on the total amount produced. Responses to GA may have been compromised by extreme weather conditions and lack of leaf cover at the time of application.

This trial showed that GA can be used to alter feed supply for short periods though responses depend on conditions at the time and therefore can be unreliable. One-off applications may be more effective than multiple applications and may have lower risk of ‘post GA depression’. Applying GA with nitrogen appeared to increase GA response and minimise ‘post GA depression’.

Introduction
Extra pasture production is of great value to farmers during winter and early spring where growth rates are low and feed demand usually exceeds feed supply. Some farmers use gibberellic acid (GA) to boost pasture production when a feed shortage is forecast, either on its own or in combination with nitrogen.

Gibberellic acid is a plant growth promotor, causing an increase in tiller size through leaf and stem elongation. It is naturally produced by plants in warmer months, so by applying it during cool weather pasture growth is increased. Literature suggests the best time to apply is early spring, however this has not been well studied in Northland where winter temperatures are higher.

Many studies have compared the effect of nitrogen, GA and a combination of both on short term pasture production. One in particular carried out by Massey University in 2008 (Matthew et al., 2009) found that after four weeks of growth, measurements showed responses of +195 kg DM/ha for GA alone, +355 kg DM/ha for urea alone (40 kg N/ha), and +645 kg DM/ha for GA and urea combined compared with the control. Although responses vary between studies, the general trend
was that the greatest DM yields were achieved when GA and nitrogen were applied together (Ball et al., 2012; van Rossum et al., 2012; Zaman et al., 2013; Matthew et al., 2009). This is due to the combined benefits of GA increasing tiller size and nitrogen increasing tiller density, resulting in more pasture.

The immediate effect of GA use is a short term fix to feed shortages, however there is evidence to suggest that repeat applications of GA without nitrogen reduces DM production later on in the season (Jiang et al., 2011). A common factor in previous trials has been a decrease in DM production following the first harvest where GA was used to replace nitrogen over repeat applications. In fact, some studies found that the rate of decrease in DM production was in direct proportion to the rate with which nitrogen was omitted. While most of these studies found that the decrease did not ever go below the control in the single harvest, yield decreases of -200 kg DM/ha compared with the control have been observed. The reason for this difference in response is that GA utilises plant nitrogen and carbon stores for stem elongation, so if these nutrients are not topped up with fertiliser applications, it eventually results in what is known as the ‘post GA depression’. A current study at Lincoln (Miller, Bryant, Hague & Edwards unpublished) found that the way to rectify this result was to apply nitrogen at the same time, as no negative effect on pasture production was observed for up to 10 repeat applications of GA plus nitrogen.

From these studies it can be concluded that the extra DM initially observed in response to application of GA can be the result of the alteration in the seasonal distribution of DM, not due to extra DM production overall. However, there is still very little evidence to indicate the effect of repeat applications of GA on total pasture production as most of the research conducted to date is only on the effect of single applications. Many of the farmers that use GA apply it over successive applications and do so with little knowledge of the true effect on total pasture production. Also, as the majority of studies conducted so far have been in Canterbury or Waikato, there is little information relevant to farming within the Northland environment. The purpose of this trial is to test the long term DM response to repeat applications of GA within a Northland farming context.

**Methods**

A trial was conducted over winter and spring of 2014 on the Northland Agricultural Research Farm in Dargaville. The site selected was on a Kaipara clay soil which had been resown into permanent pasture in autumn 2013 following a turnip crop. Eight treatments were replicated five times on plots measuring 4 m x 1.5 m. The treatments were:

1. Control
2. Liquid urea applied at 37 kg N/ha in June, July and August
3. Gibb acid (GA - ProGibb) applied at 20 g/ha plus surfactant in June and July
4. Granular urea applied at 37 kg N/ha plus GA with surfactant in June and July
5. Liquid urea applied at 37 kg N/ha plus GA with surfactant applied in June, July, August
6. Liquid urea applied at 37 kg N/ha in July
7. Liquid urea applied at 37 kg N/ha plus GA with surfactant in July

GA and liquid N were dissolved in water. Water application rate was 400 l/ha. The trial site had two pre-trial mows to remove any dung and urine effects. Treatments one to six were first applied 7 days after the second pre-trial mow on 11th June. All later treatments were applied at the time of harvest (mowing).
During early July very high rainfall resulted in the trial being under flood water for 3 days. This did not appear to directly impact on the trial results. However it did delay the first harvest and likely lead to significant leaching of nutrients at that time.

The first harvest was 18th July which was 37 days after treatments were applied. Plots were mown to the initial residual height, harvest material weighed, subsampled and dried to calculate dry matter production. Treatments were reapplied or re-applied immediately after harvest.

The second harvest was 21st August which was 34 days after the first cut. Only treatments two and five were re-applied after the second harvest. The third harvest was 18th September, 28 days after the second cut and no treatments were re-applied. The fourth harvest was 16th October, 28 days after the third cut and the fifth harvest was 13th November, 28 days after the fourth cut. Harvests four and five were carried out to determine treatment carryover effects.

Trial response being observed in late June

**Trial Results**

Trial results are reported in two sections to assist explaining treatment responses, being the response to a single application (in July) and then the response to multiple applications. The full trial results and statistical analysis is shown in Table 1.

**Table 1.** Harvested pasture (kg DM/ha). Superscript letters that are different indicate statistical differences.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Cut 1 18-7-14</th>
<th>Cut 2 21-8-14</th>
<th>Cut 3 18-9-14</th>
<th>Cut 4 16-10-14</th>
<th>Cut 5 13-11-14</th>
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<td>774&lt;sup&gt;a&lt;/sup&gt;</td>
<td>731&lt;sup&gt;abc&lt;/sup&gt;</td>
<td>985&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>Liquid N - Jun, Jul, Aug</td>
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<td>1055&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>1482&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2038&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1243&lt;sup&gt;c&lt;/sup&gt;</td>
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<tr>
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<td>1789&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>808&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>532&lt;sup&gt;a&lt;/sup&gt;</td>
<td>642&lt;sup&gt;a&lt;/sup&gt;</td>
<td>785&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>Granular N &amp; GA - Jun, Jul</td>
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<td>1178&lt;sup&gt;c&lt;/sup&gt;</td>
<td>825&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>972&lt;sup&gt;b&lt;/sup&gt;</td>
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**Single application of GA and Nitrogen in July**

Figure 1 shows the effect of a single application of nitrogen and nitrogen plus GA in July compared with the control treatment. The first harvest after the July application resulted in a significantly greater response to both nitrogen (+426 kg DM/ha) and nitrogen plus GA (+921 kg DM/ha) treatments compared to the control. Though there was a small advantage to these treatments at the second harvest, these differences were not statistically significant. There was no negative post-GA depression from this one off application. This indicates that farmers wanting a quick fix to a short term feed deficit can use a single application of GA plus nitrogen and not worry about it affecting pasture production later in the season.

**Figure 1.** Harvested pasture (kg DM/ha) from application on 18\textsuperscript{th} July of nitrogen in liquid form and nitrogen with Gibberellic acid

Overall, the response to July application of nitrogen (compared to the control) was 539 kg DM/ha or 15 kg DM/kg N. Nitrogen plus GA response was 1,066 kg DM/ha or 29 kg DM/kg N (+GA) an additional response to GA of 527 kg DM/ha. The material costs of GA application are very low at approximately $8/ha. Application costs vary, contractors may charge around $30/ha. Given a total cost of applying GA at $38/ha the cost extra pasture provided was 7c/kg DM. Many farmers could do this cheaper than this. GA provided additional pasture lower cost than other options. At $800/tonne applied for urea, the cost of pasture provided by the nitrogen only treatment was 12c/kg DM. Based on this component of the study the application of GA with nitrogen should be considered where feed is required to fill a short term gap.

**Repeat applications of GA and Nitrogen**

Figure 2 shows the effect of repeat applications of nitrogen, GA, and nitrogen plus GA on DM production. Harvests 1 and 2 showed no significant difference in DM response between the four treatments. Pasture production was higher than expected during the first response period and the first harvest was delayed due to a flood therefore all treatments were approaching maximum yield (ceiling level) at the time of the first harvest. This likely compromised the response of the nitrogen and GA treatments relative to the control treatments.
The response to GA was also poor at the second harvest. This treatment may have been compromised by the application of GA occurring immediately after the first harvest when there was little leaf to absorb the treatment, thus compromising the response. The response may have been greater with a few days regrowth at the time of application.

Overall, GA on its own showed no greater pasture production than the control treatment at any stage. Despite this there was a significant ‘post GA depression’ shown at the third, fourth and fifth harvests, ranging from -200 to -340 kg DM/ha/harvest. Other studies also found this effect, where GA causes more erect pastures and less tillering, grazing has a more severe effect resulting in less leaf area and reduced regrowth post grazing. Because GA utilises plant nitrogen and carbon, this trial along with others suggests that the best response to GA occurs when nitrogen is not limiting.

Nitrogen plus GA had significantly greater pasture production than nitrogen only in harvest 3 (+350 kg DM/ha), however it was significantly lower in harvest 4 (-370 kg DM/ha) likely due to post-GA depression. Both treatments were significantly greater than the control at around +900 kg DM/ha for harvests 3 and 4, overall response is assumed to be more of a nitrogen response then a GA response. The fifth harvest was cut to determine if there was a carryover effect for each of the treatments however all treatments were statistically similar to the control, except for GA which was significantly lower.

Overall, the response to three applications of nitrogen (treatment 2, total 111 kg N/ha) was 2,235 kg DM/ha or 20 kg DM/kg N. Most of this nitrogen response occurred after the third application. Overall the response to the three applications of GA plus nitrogen was similar at 2333 kg DM/ha. The addition of GA with nitrogen changed the timing of the pasture growth but had little effect on the total amount of pasture produced. Based on this study repeat applications of GA should not be considered, however trial conditions may have compromised responses during winter.

Granular nitrogen plus GA was applied as one of the treatments, responses were similar to liquid nitrogen plus GA.
References


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