COMPARISON OF THREE PLANT GROWTH REGULATORS AND UREA ON A CANTERBURY DAIRY PASTURE

S. Jiang[1, 4], P.L. Carey[1], A. Roberts[2] and G. Kerse [3]

[1]*Land Research Services Ltd, Art Workshops, Lincoln University, Christchurch*
[2]*Ravensdown Fertilizer Co-operative Ltd, Pukekohe*
[3]*Ravensdown Fertilizer Co-operative Ltd, Christchurch*
[4]*shuang.jiang@lrss.co.nz*

Abstracts
Two plant growth regulator (PGR) products currently available in New Zealand and a new Ravensdown PGR product-Express™*, all based on gibberellic acid (GA_3), were applied to a Canterbury dairy pasture in late winter (August) and early spring (September) and their effect on dry-matter (DM) yield was measured. PGR treatments were compared with both an application of liquid urea (20 kg N/ha) alone and a urea plus Express treatment.

In the first harvest of both winter- and spring-initiated trials, a month following PGR application, the PGR treatments produced significant increases in DM yield ranging from 18-51% over the control. These increases, however, did not extend to the second harvest in either trial for any of the PGR agents. The application of urea increased production in the 1st harvest by ~36% in both trials but this was increased to over 60% when combined with Express™. No effect of the PGR was apparent in the second harvest where the urea treatment alone was the highest DM producer.

These trials showed some benefit in the use of PGR products when there is a need to boost pasture growth in early spring but these benefits largely disappeared after the first month following application. Some future research may be useful to further optimise parameters for the use of PGR products.

Introduction
Gibberellic acid (GA_3) is a naturally occurring plant growth regulator found in most plant species. Since its discovery in the 1950's it has been well studied for its effects on plant growth (Morgan and Mees 1956; Morgan and Mees 1958; Scurfield and Bull 1958) including on pastures (Scott 1959; Scurfield and Biddiscombe 1959)

GA is produced by plants in higher quantities in warmer months. During the colder months, its production is low, hence plant growth is slower. The idea behind the application of the hormone is that it will stimulate cell expansion, resulting in leaf and stem elongation. Therefore, the optimum temperature for grass growth response to GA is in the cool season when days are shorter and the pasture is in this slow growth phase. Experimental evidence from the UK indicated that the most appropriate time for application in UK was March (early Spring) (Morgan and Mees 1958) and in Australia, June and July (Arnold et al. 1967; Biddiscombe et al. 1962; Williams and Arnold 1964).

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* Express™ is a trademark of Ravensdown
Fertiliser co-operative Ltd. It is registered pursuant to the ACVM Act 1991997, No.8341.

Boosting winter growth of pastures has been of interest in many countries but generally the cost of using PGR products was a disincentive to their more widespread use (Scurfield and Biddiscombe 1959). In the New Zealand dairying industry there has been interest in boosting mid-winter to early-spring pasture growth when the lactation season has just started. The use of PGRs could be another pasture management tool to increase feed availability during this time.

Two trials were set up on a Canterbury dairy pasture in late winter and spring 2010, respectively, to test the growth response of pasture to Ravensdown Express and two other PGR products (effective ingredient GA_3). The main objectives of these trials were to:

1. measure the size of any response in relation to application timing,
2. compare the effect of applying liquid urea alone and in conjunction with Express, and
3. measure how long any response might last.

Materials and Methods

A site was selected on a Canterbury dairy farm near Springston (43.63˚S, 172.42˚E) on an Eyre soil (Immature Pallic) (soil test values: pH 5.9, P 19, S 6, Ca 8, Mg 32, K 11) [†] with a mixed perennial ryegrass/white clover pasture.

The two trials were set out on a randomised block design with treatments replicated 6-times during later winter (August) and early spring (September) 2010, when the monthly 10 cm soil temperatures were 7.9° C and 9.5° C respectively.

Each plot was 5 m long by 0.5m wide with 0.5 m buffers between plots with grazing animals excluded. Basal fertilizer of 300 kg/ha single superphosphate was applied to all plots initially. All plots were mowed 2-3 days prior to application of treatments. Two harvests were taken for each trial at approximately four-weekly intervals.

The PGR products used in the trials were as follows:

PastureGibb™ (PGR1) containing 90% of gibberellic acid (Orion Crop Protection Ltd. Auckland),

ProGibb®SG (PGR2) containing 40% of gibberellic acid (USA product), and

Ravensdown Express (Express)- containing 40% of gibberellic acid.

Thus six treatments were applied:

1. Control
2. PGR-1
3. PGR-2
4. Express
5. Urea
6. Urea plus Express

[†] P: Olsen P; Ca, K and Mg: Quick test units; S: ppm

All PGRs and urea were applied in dissolved form, the PGRs at the equivalent rate of 8g GA_3/ha and the urea at 20 kg N/ha, with a coverage of 200 L/ha. All products were applied with a surfactant or wetting agent as directed to aid application.

Results

PGR responses

PGR use increased DM production significantly overall (Table1; P<0.001) from the control for the first harvest from 18-36%, and 26-51%, for the winter and spring trials, respectively (Figures 1-2). In the second harvest, however, DM production for the PGR treatments was actually lower than the control but not significantly different from each other or the control for either trial.

Express plus N

The average DM yield for urea application for the first harvest increased by 36% and 23% in winter and spring trials, respectively, over the control (Figures 1-2). This increased to over 60% when combined with Express in both trials (P<0.001). In the second harvest, there were no significant differences between any of the treatments.

Table 1. Dry-matter yield for control vs. PGR treatments across both trials for harvests 1 and 2.

Treatment	Harvest 1	Harvest 2
Control	781 a	1485 a
PGR-1	1099 b	1413 a
PGR-2	959 b	1279 a
Express	1040 b	1399 a

Values with different letters are significantly different from each other (P<0.05)

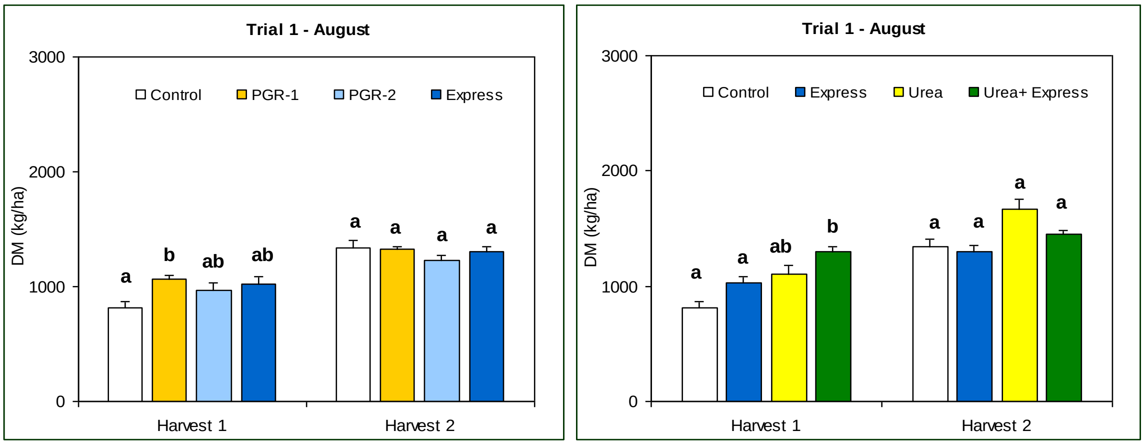

Figure 1. DM yield **c**omparisons for the August application between PGR products (left) and Express and/or urea (right) over two harvests. Columns with different letters are significantly different from each other (P<0.05)

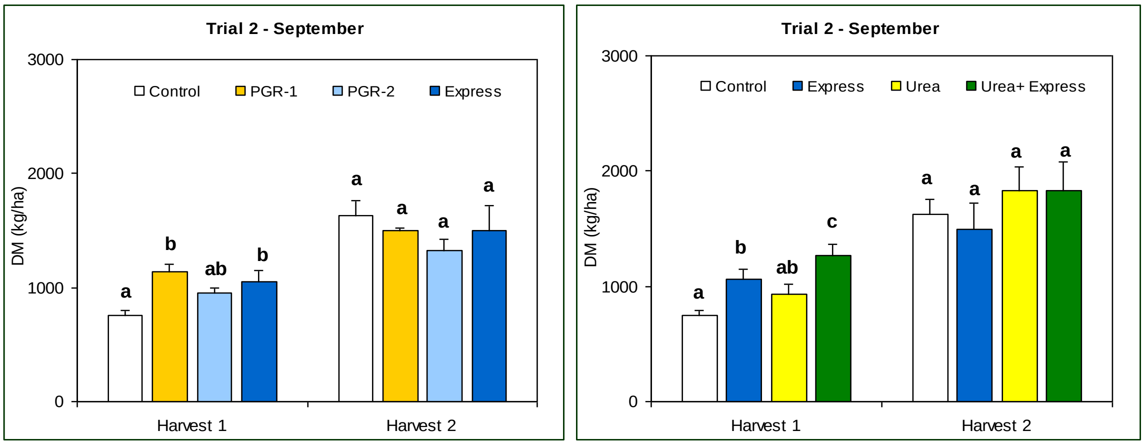

Figure 2. DM yield **c**comparisons –for the September applications between PGR1, PGR2 and Express (left) and/or urea (right) over two harvests. Columns with different letters are significantly different from each other (P<0.05)

Discussion

PGR rates used in previous pasture research often used rates ranging from 25-700g/ha of active ingredient but it was noted that, at these higher rates, subsequent growth was depressed to the point than the increase in DM yield obtained from the use of GA_3-based PGRs in the first harvest could be exceeded by the loss of production in the subsequent harvests (Scott 1959). Currently the recommended application rates are much lower at 5-10 g/ha active ingredient and these seem to the produce the most cost-effective responses with reduced side effects (Matthew et al. 2009). Whilst PGR treatments significantly increased DM yield in harvest 1 of both trials, there was a trend for a slight depressive effect to PGR use alone in the second harvest although these differences were not statistically significant.

Because the initial increase in DM yields is probably associated with an alteration in the distribution of dry matter rather than with a change in carbon fixation (Williams and Arnold 1964) a depressive effect could follow if this DM increase has been at the expense of root growth and nutrient uptake whilst soil temperatures remain low.

In reviewing earlier work of the responses of pastures to $GA_{3,}$ the optimum reaction temperature is between 10.5-11.6 ˚C in Australia and 2.7-10.5˚C in UK. Reported trials in NZ were either for autumn (Otago; Scott 1959) or mid-winter (North Island; Percival 1980) so a paucity of data existed for Canterbury for late-winter/early-spring prior to these trials. Instructions for application in New Zealand provided by Nufarm (2009) are to apply at soil temperatures from 5- 16°C (Matthew et al.2009). Our results show that responses were as great for the second as first trials so the suggested range for soil temperatures at which responses will occur are not contradicted by our data.

DM yields for our Express+N treatments showed much higher responses than urea or PGR alone treatments, which was at odds from previous NZ data (Matthew et al. 2009; Percival 1980; Scott 1959) but different application rates were used or in different regions. Our results show that Canterbury pastures will be responsive to GA-based PGRs, especially in conjunction with N use, over the winter-spring shoulder months but this may change depending on the prevailing climatic conditions. The practicalities of using GA-based products also have to be considered in that applications are recommended to be made no more than 1-5 days after grazing.

Conclusions

Increases in DM yields from 18-51% were achieved with the use of the three PGR products with means for Express increasing from ~30% to over 60% in conjunction with N use. Generally, PGR effects only lasted a single harvest with no significant responses recorded in the second harvest. Whilst the cost of PGR products has decreased in relative terms and they are now more affordable, their use is probably a stop gap measure for late winter or early spring when temperatures are still relatively low, sunlight hours are short and there is an immediate feed requirement. PGR products provide another tool to boost pasture growth the in the early part of the lactation season but these should not substitute for good feed and pasture management. Further research is probably needed to optimise the performance of GA_3-based products for local weather conditions and soil nutrient status.

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