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GIBBERELLIC ACID APPLICATION IN SUMMER (APPLIED WITH WETTED, NBPT-TREATED PRILLED UREA) INCREASES PASTURE PRODUCTION ON FIVE IRRIGATED DAIRY FARMS IN VICTORIA, AUSTRALIA

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Abstract

The growth promotant gibberellic acid variant 3 (GA3) is widely used to increase ryegrass-dominant pasture production in late autumn and during winter, often in conjunction with fertiliser N. However, there is relatively little information available regarding its effectiveness in warmer months, especially in temperatures close to those that induce heat stress in ryegrass (>30^{o}C). Reduced pasture production at these temperatures have serious effects on farm profitability.

To specifically examine the potential of GA3 in these conditions, field trials were conducted on five irrigated dairy farms that were using ONEsystem® (wetted, nbpt-treated prilled urea) as their standard input of fertiliser N year-round. This form of fertiliser N had been demonstrated to be twice as efficient in earlier trials than granular urea throughout the year, but N efficiencies were markedly lower with both forms in the warmest months than in the remainder of the year.

The application of GA3 increased the N use efficiency by over 200%, increasing pasture growth rates from an average of 58 to 68 kg DM/day in the 15 days post-application. Nil N control achieved 46 kg DM/day. Other (unreported) trials demonstrated little or no benefit from GA3 in either the absence of fertiliser N or in the presence of granular urea.

There was no apparent suppression in DM yield from the use of GA3 in the month following the 15-day response period. The results suggest that GA3 may assist ryegrass to cope physiologically with heat stress, provided highly-efficient fertiliser N is co-applied. The higher water content of the GA3-treated pasture is indicative of higher soil moisture uptake and/or reduced transpiration losses.

Introduction

The growth promotant gibberellic acid variant 3 (GA3) is most commonly used to increase pasture production in late autumn and winter, usually in conjunction with fertiliser N forms such as granular urea or liquid N products. However, the high cost of the liquid nitrogen (per unit N), and the inefficiency of granular urea, has seen many farmers experiment - often unsuccessfully - with using GA alone. Earlier trials demonstrated the greater efficiency of wetted, nbpt-treated prilled urea.

There is little published research on the use of the GA outside the winter months. It is widely believed, especially in New Zealand, that the use of GA has little benefit in warmer months. However, most trials have been conducted in low fertiliser N use conditions. Few if any trials with GA have been conducted in conditions where daily maximum temperatures are regularly exceeding 30^{0}C, where heat stress limits ryegrass growth. Temperature-induced reductions in irrigated pasture production have serious effects on farm profitability, as increased bought-in feed must be used.

Following earlier trials which had demonstrated the greater efficiency of ONEsystem® (wetted, nbpt-treated prilled urea) compared to granular urea, in New Zealand (Quin et al. 2015) and confirmed in Victoria, ten irrigated dairy farms in the Gippsland area of eastern Victoria, Australia, are working collaboratively with the senior author (Spilsbury and Quin 2016) to increase pasture production and utilisation reduce their nitrogen inputs by using ONEsystem®, applied using fertiliser variable rate technology (VRA) technology, in conjunction with GA when requested. Over the entire year nitrogen (N) costs and N inputs are expected to be reduced by 30% and 50% respectively.

To specifically examine the potential of GA plus ONEsystem® under very warm conditions, trials were conducted on five of the farms (all irrigated) from late December – mid January, a 3 week period which included 7 days with maximum temperatures of 32-38^{0}C.

Farm conditions

The Australian summer is very hot, with consecutive days in excess of 30^{o}C common. This makes growing ryegrass pastures very difficult, even with irrigation. Ryegrass production is reduced due to heat stress at day and night maximum temperatures above 30^{o}C and 25^{o}C respectively, and sustained temperatures of 38^{o}C or above are fatal. Farmers therefore often need to increase the quantity of supplementary feed in high temperatures, reducing farm margins. In addition, the cows themselves become more susceptible to heat stress when fed high proportions of supplementary feed. Fig.1 shows pasture DM production for a typical irrigated dairy farm; large heat-stress depressions are seen in November and February. There is considerable interest in methods of minimising these depressions.

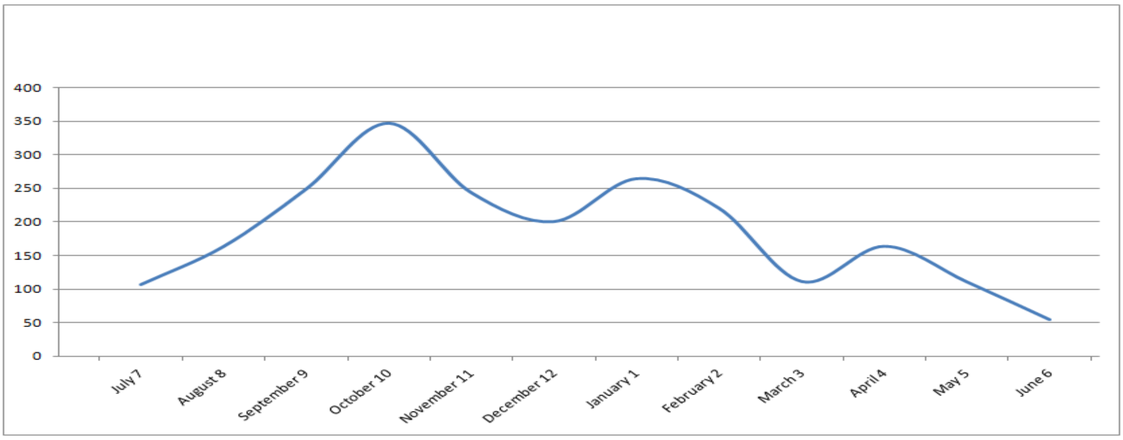

Fig. 1 Tonnes grown by month (Malmo farm)

Australian Bureau of Meteorology temperatures for Sale, Gippsland (Victoria, Australia) over the period of the trial are given in Table 1. There were a total of 7 days with maximum temperatures in excess of 30 degrees Celsius.

Table 1. Bureau of meteorology daily temperatures during trial period (Sale, Victoria).

Month	Date	Day	Temps		Rain
			Min	Max	
			°C	°C	mm
December	16	Fr	9.1	23.7	0
December	17	Sa	15.3	22.6	0
December	18	Su	7.4	20.5	0
December	19	Mo	6.4	27.4	0
December	20	Tu	13.3	22.5	0
December	21	We	13.4	22	0.4
December	22	Th	8.1	21.8	0
December	23	Fr	10.5	26.3	0
December	24	Sa	15.5	32.5	0
December	25	Su	13.9	34.8	0
December	26	Mo	14.7	35.4	0
December	27	Tu	17.5	24.4	12
December	28	We	19.4	34.7	1
December	29	Th	20.7	33.5	0
December	30	Fr	19.9	26.5	3.4
December	31	Sa	16.8	26.8	0.2
January	1	Su	15.9	21.9	0
January	2	Mo	14.6	22.8	1
January	3	Tu	13	22.9	0
January	4	We	14.5	25.9	0
January	5	Th	16.1	29.7	0
January	6	Fr	18.5	27.4	0
January	7	Sa	18.1	32.4	0
January	8	Su	18.8	38.2	0
January	9	Mo	14.9	23.1	0
Average			**14.7**	**27.2**	

Previous trials

Previous research demonstrated that the efficiency of fertiliser urea could be doubled by changing from the traditional use of granular urea to ONEsystem®, as shown in Table 2. This doubling in relative efficiency is maintained throughout the year, but NUE (nitrogen utilisation efficiency) and the EDMfactor (extra kg dry matter per kg N applied) still decline in summer due to heat stress.

Table 2. Granular urea vs ONEsystem® . Average of 19 short-term summer trials.

	Granular urea	ONEsystem®	
EDMfactor	2.9	6.3	P<0.01

Only 2 of the 19 trials gave no response to N as ONEsystem, compared to 7 with granular urea.

Trial design and protocol

Given the constraints in putting aside grazed pasture for trial purposes on commercial farming operations, it was decided to divide one paddock on each of the 5 farms into three plots, randomly assigned as (i) control, (ii) 18 kg N/ha applied as ONEsystem® (wetted, nbpt-treated prilled urea), and (iii) 18 kg N/ha ONEsystem plus gibberellic acid (20gm GA3/ha). The plots were measured and treatments applied as soon as possible after grazing. The treatments were applied using the contractor's tractor-mounted equipment (Fig.2), which also applies ONEsystem (and GA as required) to a portion of all ten client farms every week. The DM measurements were taken using a Sonar Automatic Pasture Reader (SAPR). Each farm is measured every week using the SAPR, including before the commencement of the trial.

Fig. 2 Kuhn spreader mounted on John Deere tractor and modified for ONEsystem® and GA application

Feed test samples were taken from treatments (ii) and (iii) on the last day of the trial for each farm. These were analysed to determine if there were any significant DM levels between the GA and non-GA plots so that the sonar readings could be adjusted accordingly.

The average length of the trials was only 15 days due to the average 18-day rotation on most farms this time of year. Growth rate measurements have been continued to be measured post-trial to determine if any post-trial suppressions from GA occurred.

Results and Discussion

Pasture quality results

Feed-test results from the plots on each of the five farms are shown in Table 3. 'P' in the sample name is ONEsystem® (wetted Prilled urea with nbpt) or treatment (ii); PGA indicates plots with gibberellic acid as well; treatment (iii). The ONEsystem + GA plots had slightly (8%) lower dry matter (DM) than the Prills plots (19.9% versus 20.7%). The sonar DM readings from the trials were therefore decreased by 8% on treatment (iii). No significant differences occurred in Protein, NDF or ME; however all farmers observed that the cows chose to graze the GA plots (treatment (iii)) to lower residual DM, indicating higher palatabili

Table 3. Feed test results from trials.

Sample Id	Product	Sample Name	Dry Matter	Crude Protein	Neutral Detergent Fibre	Est. Metabolisable Energy (Calculated)
S2017-00519	**Pasture Fresh**	**Steve R83 (P)**	27.6	19.9	50.1	11.2
S2017-00522	**Pasture Fresh**	**Steve R83 (PGA)**	23.1	18.7	51.8	11
S2017-00520	**Pasture Fresh**	**Tackens B (P)**	18.3	20.5	50	10.6
S2017-00526	**Pasture Fresh**	**Tackens B (PGA)**	15.2	22.4	48.5	10.9
S2017-00528	**Pasture Fresh**	**Finch 29 (P)**	22.2	25.3	48.6	10.9
S2017-00521	**Pasture Fresh**	**Finch 29 (PGA)**	22.2	24.8	47.2	10.9
S2017-00523	**Pasture Fresh**	**McRae 3 (P)**	16.9	16.9	60.2	9.4
S2017-00524	**Pasture Fresh**	**McRae 3 (PGA)**	16	14.3	61.8	9
S2017-00527	**Pasture Fresh**	**Gannon 10 (P)**	18.5	23.8	51.3	10.5
S2017-00525	**Pasture Fresh**	**Gannon 10 (PGA)**	18	23.9	53.1	10.5
	Averages	**Prills + NBPT**	20.7	21.28	52.04	10.52
	Averages	**Prills + NBPT + GA**	18.9	20.82	52.48	10.46

Pasture growth results

Pasture growth results are given in Table 4. As stated, the GA plots have had their sonar DM readings reduced by 8% in-line with the feed-test results above.

Table 4. Pasture (kg DM/ha) at start and end of trial from control and wetted, nbpt-treated prills (ONEsystem®) alone and in conjunction with gibberellic acid GA3.

Farm Data

Farm	Start		Finish	
McRae	Control	2463	Control	3212
	Wetted Prills 40kg/Ha	2568	Wetted Prills 40kg/Ha	3422
	Wetted Prills 40kg/Ha + GA 20gm/Ha	2283	Wetted Prills 40kg/Ha + GA 20gm/Ha	3368
Tackens	Control	2089	Control	3047
	Wetted Prills 40kg/Ha	1924	Wetted Prills 40kg/Ha	2778
	Wetted Prills 40kg/Ha + GA 20gm/Ha	2029	Wetted Prills 40kg/Ha + GA 20gm/Ha	3341
Malmo	Control	1950	Control	2239
	Wetted Prills 40kg/Ha	2418	Wetted Prills 40kg/Ha	2613
	Wetted Prills 40kg/Ha + GA 20gm/Ha	2920	Wetted Prills 40kg/Ha + GA 20gm/Ha	3134
Finch	Control	1969	Control	2104
	Wetted Prills 40kg/Ha	1804	Wetted Prills 40kg/Ha	2029
	Wetted Prills 40kg/Ha + GA 20gm/Ha	2179	Wetted Prills 40kg/Ha + GA 20gm/Ha	2335
Gannon	Control	1580	Control	2853
	Wetted Prills 40kg/Ha	1580	Wetted Prills 40kg/Ha	3078
	Wetted Prills 40kg/Ha + GA 20gm/Ha	1580	Wetted Prills 40kg/Ha + GA 20gm/Ha	3520

Summary Days 15

Plots	Treatments	Rotation Start	Rotation Finish	DM inc	Kg DM increase v control	KG DM per unit N	Kg DM per Day	Units N
5	Control	2010	2691	681			46	
5	Wetted Prills 40kg/Ha	1979	2784	805	124	6.7	54	18
5	Wetted Prills 40kg/Ha + GA 20gm/Ha	2198	3140	942	261	14.2	64	18

The addition of GA increased the DM response to N as ONEsystem® by 210%, increasing daily growth rates from 54 to 64 kg DM/day. This represents an important improvement in the high temperatures. The higher moisture content (lower DM) of the GA-treated pasture indicates that GA either increases the efficiency of soil water uptake by the plant and/or reduces transpiration.

Results of other GA trials with and without N have indicated that these benefits to GA application in hot summer months are less likely to occur when either no N, or N as granular urea, is applied, indicating that it is essential to apply an efficient form of N, probably one that allows a degree of foliar N uptake, in conjunction with GA.

The much higher DM responses achieved with GA combined with ONEsystem® compared to ONEsystem® alone suggests that GA assists ryegrass to cope physiologically with heat stress and continue growth, provided fertiliser N is being applied in an easily utilised form. The higher water content of the GA-treated pasture is indicative of higher moisture uptake and/or reduced transpiration losses.

Conclusions

- This trial has confirmed earlier indications that GA can be used to substantially increase pasture production in the middle of the Australian summer when pastures are normally suffering heat stress. This is a radical departure from current recommendations regarding the use of GA.
- Results from other trials indicate that this benefit is only achievable when N is applied concurrently, and in a relatively efficient form such as ONEsystem® which permits some foliar uptake of N.

- Pasture growth has continued to be monitored (for a month to date) to determine any post-application DM depression occurred after the response to GA had finished. No suppressions have been noted to date.
- Production from the use of GA plus ONEsystem® is being compared to that previously obtained with granular urea on a seasonal and annual basis on all 10 farms.

Acknowledgements

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