RESPONSE TO NITROGEN FERTILISER APPLIED TO DAIRY PASTURES IN AUTUMN AND SPRING IN TARANAKI

N. A. THOMSON, A. H. C. ROBERTS
Taranaki Agricultural Research Station, Normanby

Abstract

Nitrogen response trials conducted in Taranaki on dairy pastures over a 10 year period are summarised. At both high and low altitudes responses were variable in winter but very consistent in spring (September and October) with the higher altitude pastures being more responsive.

Nitrogen applied in autumn (early April) at low altitudes gave consistent responses over a three year period at ONC site despite markedly different summer climatic conditions between years. Further investigations at a range of altitudes and climates throughout Taranaki indicated extreme variability, and the only consistent and worthwhile responses (> 11 kg DM/kg N) were obtained at the lower altitude sites.

The efficiency of response to nitrogen (kg DM/kg N) applied in autumn and winter declined little with increasing rates from 25 to 100 kg N/ha and responses to higher rates occurred over a longer period.

The occurrence of grass grub affected the relative responsiveness of pastures to nitrogen but the yield increments to nitrogen were similar on pastures of low and high grass grub numbers.

INTRODUCTION

The low cost of nitrogenous fertilizers in the early 1970's created a demand for information concerning its use on New Zealand grassland. The initial thrust came from dairy farmers particularly interested in nitrogen for promoting spring growth. As Taranaki is predominantly a dairying area the demand was high. More recently, following the 1978 drought, interest has been directed primarily towards using nitrogen in autumn to increase pasture growth for creating additional winter feed.

To meet these requirements trial work has been conducted over the past decade in a spasmodic manner, with the main objective of providing information on the responsiveness of pastures to nitrogen fertilizer applicable to a large proportion of dairy farms in Taranaki.

TRIAL DESIGN

The main influence on dairy management in Taranaki is altitude (i.e., the farm's position in relation to the summit of Mt Egmont), which has a marked effect on the pattern of pasture growth, especially as influenced by rainfall in summer and soil temperatures over the winter and early spring period. Thus, all work with nitrogenous fertilizers was conducted at both low and high altitudes to account for the contrasting climatic variables and at each site the following trial technique was adopted:

(1) A different site was selected for each time of application within the same environment.

(2) At least three rates of nitrogenous fertilizers were used, equivalent to, 0, 25, 50, 75 or 100 kg N/ha.

(3) Trial areas were laxly grazed 10-14 days before treatments were applied.

(4) Immediately before application of treatments the trial area was trimmed, clippings removed, and a basal fertilizer of 300 kg/ ha of 30% potassic superphosphate was applied.

(5) Trials conducted during 1981 were evaluated by taking only one cut 5-7 weeks after treatments were applied. For all subsequent trials two and usually three cuts were taken at six to seven weeks or when pasture reached 8-10 cm in height, whichever occurred the sooner.

(6) The form of nitrogenous fertilizer used in the trials varied over time, from nitrolime for the winter/spring trials and in the later autumn trials sulphate of ammonia or urea was used depending on which was the cheapest at the time. Initial trial work showed no difference between these forms (Thomson, unpublished) and as farmer use is dictated mainly by cost it seemed prudent to use the cheapest form for trial work and this policy has been adopted since 1978.

Trials run in Taranaki over the past ten years will be reviewed as a series of three:

4. Winter/Spring nitrogen.

B. Autumn nitrogen.

C. Grass grub effects.

Trial results will be presented as DM yield increases per unit of nitrogen applied, or the efficiency of nitrogen response (kg DM/ kg N).

RESULTS AND DISCUSSION

A. WINTER/SPRING NITROGEN

Nitrogen was applied as nitrolime at: 0, 25, 50 and 100 kg N/ha in the first week of each month, from May to October during 1971 and 1972.

The pattern of response over winter varied between sites and between years but spring responses (September and October) were consistent (Fig. 1) and greater at higher altitude than low. For instance, the efficiency of response to 25 kg N/ ha applied in September over the two years was 24 kg DM/ kg N and 17 kg DM/ kg N at high and low altitude respectively, while in October the high altitude site remained very responsive to nitrogen (22 kg DM/kg N) whereas at the low altitude the response was negligible (3.0 kg DM/kg N).

Results of the 1971 trials were assessed from only one cut and the most efficient response was recorded to the lowest rate of nitrogen, 25 kg N/ha. However in 1972 when up to three cuts were taken following the application of nitrogen, responses of equal efficiency were recorded to rates greater than 25 kg N/ha, especially with July and August applications (average response curve, Fig. 1). The responses to each cut are presented in Fig. 2. In July at both sites the high rate of nitrogen gave the most efficient response with more than

FIG. 1: Pasture responses to nitrogen fertiliser applied at monthly intervals in winter/spring over two years.

50% of the total response occurring at the third cut. No depressions in pasture growth were recorded at the high rate of nitrogen but by the third cut (approximately 120 days after application) depressions in pasture growth were recorded to the lower rates of nitrogen applied in July and August. However a slump in pasture growth to the higher rates of nitrogen may be more delayed and remain undetected by the technique of taking only three cuts following the application of nitrogen.

FIG 2: Efficiency of response of pasture to nitrogen fertilizer applied at three rates over three cuts.

In the 1972 trials, herbage from each cut was dissected into ryegrass (*Lolium* spp), other grasses, clovers and weeds. The application of nitrogen resulted in significant ($P < 0.01$) changes in the grass and clover components of the pasture and the results presented in Table I shows that the "other grass" component responded more to nitrogen than ryegrass, results contrary to the commonly reported statement that pastures most responsive to nitrogen are ryegrass dominant (Ball, 1970). Clover content at the low altitude site was markedly depressed but at the high altitude site the clover content was unaffected by nitrogen.

TABLE I: THE CHANGE IN BOTANICAL COMPOSITION OF GRASS/CLOVER PASTURE RESULTING FROM THE APPLICATION OF NITROGEN FERTILIZER (Results presented as % change from control).

Rate of Nitrogen kg N/ha	Low Altitude			High Altitude		
	Ryegrass	Other Grasses ^a	Clovers	Ryegrass	Other Grasses ^b	Clovers
25	+ 6	+35	-12	+16	+30*	+ 3
50	+10	+57**	-26*	+22	+42**	-13
100	+53**	+80**	-33*	+31*	+49**	+ 4

^a mainly cocksfoot, prairie grass, *Poa* spp.

^b mainly browntop, *Poa* spp.

Significance levels * $p < 0.05$. ** $p < 0.01$

B. AUTUMN NITROGEN

Following the 1978 drought a request was made by Taranaki farmers for a subsidy on nitrogen fertilizers. This was turned down due to the unreliability of autumn pasture responses to nitrogen. However, local farmers remained adamant that consistent and long term (continuing through winter into spring) responses did occur to nitrogen applied in autumn. Only small responses were observed in the winter/spring trials to nitrogen applied in May but as an autumn application this was considered too late. Farmer observation showed that pastures were most responsive to nitrogen over the period mid-March to mid-April. These ideas were investigated in a series of trials conducted over a three year period commencing in 1978. The trials were: 1978: Two trials conducted at the Taranaki Agricultural Research Station (120 m a.s.l., 1250 mm rainfall)

(1) Nitrogen applied immediately after 25mm of rain fell following a drought (29 March, 1978), and

(2) Nitrogen applied 19 days later when it was estimated that soil moisture was no longer a factor affecting pasture growth. (17 April, 1978).

1979: Trials were laid down (in the first week of April) at 10 different sites throughout Taranaki ranging from low rainfall, low altitude to high rainfall, high altitude.

1980: Following a very wet summer two trials were conducted on the Taranaki Agricultural Research Station investigating nitrogen applications in March and early April.

The results of all trials conducted on the Taranaki Agricultural Research Station over these three years (Table 2) are highlighted by two major points. (1) The very consistent level of autumn response recorded at this one site over three years following markedly different summer climatic conditions. This differs from the greater variability of autumn responses reported by O'Connor and Cumberland (1973), however, the authors may have been referring to variability between sites and not between years at the one site as was the case in the Taranaki trials.

TABLE 2: SUMMARY OF RESPONSES RECORDED TO NITROGEN APPLIED IN MID-MARCH 4ND EARLY APRIL ON THE TARANAKI AGRICULTURAL RESEARCH STATION OVER THREE YEARS. (Responses expressed as kg DM/ kg N)

Time of application	Rainfall January to application (mm)	Av. soil temp. at 10 cm for week following (°C)	Response to Nitrogen applied (kg N/ha)		
			25	50	75
1978 (1)*	62	15.4	11		8
1978 (2)	105	14.6	14	---	12
1979	237	12.1	11	13	12
1980 (1)	253	13.2	11	8	10
1980 (2)	383	12.1	15	10	11

* 1978 Trials only three rates of N; 0, 25 and 75 kg N/ha

(2) The efficiency of response declined little as the rate of nitrogen increased with the average response over the three years to 25 and 75 kg N/ha being 13 and 11 kg DM/ kg N respectively, which would result in average increases in DM yield of 325 kg DM/ ha to 25 kg N and 825 kg DM/ ha to 75 kg N.

The 1978 trial results showed little difference in the responsiveness of pasture to nitrogen over a three week period following the “break” of the autumn drought. Pastures tended to be more responsive to the later application which is contrary to the hypothesis presented by Field and Ball (1978). The authors reported that responses in autumn following a drought may initially be largely due to a temporary immobilization of soil mineral N but will decline over a 34 week period as mineralisation dominates the immobilization process.

TABLE 3: RESULTS OF NITROGEN RESPONSES RECORDED AT 10 TRIAL SITES THROUGHOUT TARANAKI IN AUTUMN 1979. (Nitrogen applied to all sites in the first week of April)

Major variable between trial sites	Average Responsiveness of sites (kg DM/kg N at 50 kg N/ha)	Average
Low Rainfall/Altitude < 1250mm, < 100 m a.s.l.	8.0*, 12.5**, 11.6**, 9.1*	10.4
Medium Rainfall/Altitude 1250-2000mm, 100-260 m a.s.l.	8.0*, 6.2	7.1
High Rainfall/ Altitude > 2000mm, > 260 m a.s.l.	6.4*a , 2.1, 3.7, 1.3	3 . 4

a the highest site; 3250 mm rainfall and 430 m a.s.l.
Significance levels: *p < 0.05, **p < 0.01

The 1979 trials investigating the effects of variable climate (Table 3) show a variable pattern of nitrogen responses between sites, similar to that reported by O'Connor and Cumberland (1973). Responses were apparently related to altitude and rainfall with worthwhile responses occurring only on pastures at the lower end of the altitude and rainfall sequence. No relationship between

rainfall and soil temperature at 10 cm for the week following laying down and the level of response could be found.

These trials have highlighted a very important aspect of nitrogen fertilizer and its use, that is, trials conducted in one area may not apply to other localities within the same district. The factor apparently affecting response in this series was either altitude or rainfall but the reason for this could not be clearly identified and it can only be postulated that soil temperatures over the long term and pasture growth rates were affecting the responsiveness of pastures to fertilizer nitrogen.

C. GRASS GRUB EFFECTS

Grass grub is a selective feeder on white clover (Kain and Atkinson, 1977) and in autumn this could create a greater deficit in plant available nitrogen than would occur if grass grubs were not present. To investigate this aspect, two trials were laid down in April 1980 and in order to highlight an important aspect of interpretation, the trial results (Fig. 3) are presented in two ways:

(i) percentage increase in pasture growth to nitrogen.

(ii) efficiency of nitrogen response (kg DM/kg N).

On the high grass grub area (120 grubs/m² in May) growth on the untreated plots from April to the first cut in May was 68% less than that recorded on the low grass grub area (13 grubs/m²). This resulted in differential responses occurring depending on the method by which the results were expressed. At the high rate of nitrogen (75 kg N/ha) pasture growth was increased by 100% on the high grass grub area but only by 42% on the low grass grub area, but the yield increase per unit of nitrogen differed little. By visual assessment, the grass grub damaged pasture appeared to be much more responsive than the grass grub controlled area. From these results it is concluded that under such situations a visual assessment of nitrogen responses would give misleading conclusions.

A small increase in efficiency of the nitrogen response was recorded on the area with a high grass grub population but the differential was insufficient to recommend nitrogen specifically for grass grub damaged pasture on that basis.

SUMMARY

- (1) Large and consistent responses to nitrogen (> 18 kg DM/kg N) occurred in September with both low and high altitude pastures.
- (2) In October pastures at high altitude continued to show marked responses to nitrogen but not at the lower altitude.
- (3) Overall, nitrogen responses were greater at the higher altitude sites in winter and spring but not in autumn.
- (4) Reasonable (13 kg DM/kg N) and consistent pasture responses were recorded on the Taranaki Agricultural Research Station in autumn over three successive years following markedly different summer climatic conditions.

FIG 3: Influence of high and low grass grub numbers on the pasture response to nitrogen fertilizer applied in autumn.

(5) Pasture at higher altitudes showed little response to nitrogen applied in autumn.

(6) The presence of grass grub had little effect on the responsiveness of pastures to nitrogen in autumn.

(7) In areas where worthwhile nitrogen responses were recorded in April and again in July there was little decline in the efficiency of response with high rates of nitrogen (75-100 kg N/ha). Thus, the rate recommended to farmers could be adjusted according to the amount of pasture required.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the technical assistance given over the years by M. R. Laurence and C. G. T. Morgan for the early trial work and S. Fordham for all the autumn nitrogen work. They also appreciate the assistance given by the many farmers who co-operated with this series of trials.

REFERENCES

Ball, R., 1970. *Sheep fmg A.*: 11-28.

Field, T. R. O.; Ball, R., 1978. *Proc. Agron. Soc. N.Z.*, 8: 129-133.

Kain, W. M.; Atkinson, D. S., 1977. *N.Z. Jl Agric. Res.* 20: 507-517.

O'Connor, M. B.; Cumberland, C. L. B., 1973. *Proc. Ruakura Fmrs' Conf.*: 137-144.