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THE EFFECTS OF RESTRICTING OR STOPPING FERTILISER APPLICATION TO WAIKATO DAIRY PASTURES

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Abstract

Waikato dairy pastures were developed through large inputs of superphosphate and potassium chloride. Many farmers have continued to apply similarly large amounts of fertiliser in post-development situations. Trials to study the effects on the production of dairy pastures of restricting or stopping fertiliser application were started in 1978 and have continued to the present. The trials were conducted on 6 commercial dairy farms throughout the Waikato region. selected for high milkfat production and past fertiliser applications. Each trial included 3 fertiliser treatments: 1000, 500 and 0 kg fertiliser (30% potassic superphosphate)/ha/year, Pasture production was estimated through a trimming technique designed to cause minimal interference with management and use of the experimental paddock by the farmer and in later years through calibrated visual assessments and electronic probe readings of pasture dry matter. Pastures receiving 500 kg fertiliser/ha/year produced on average 2.5% less over an 8 year period than pastures receiving 1,000 kg fertiliser. Applying no fertiliser caused a slow reduction in pasture production in 3 of the trials but an immediate reduction of more than 10% in the other three trials. The latter effect could be partly explained by low soil test levels and high stocking rate.

Keywords: Yellow-brown loams, gley soils, maintenance fertiliser, phosphorus, potassium.

INTRODUCTION

Forty percent of the Waikato area's farmed land is used for dairying and carries one third of New Zealand's dairy cattle. Most of the soils used for dairying are yellow-brown loams and associated gley soils. Yellow-brown loams are formed from airfall or alluvial deposits of volcanic ash. They have physical properties that make them ideal for pastoral farming due to dominance of the clay colloid allophane. However, allophane has the ability to absorb large quantities of phosphorus (P) and sulphur (S), but has low potassium (K) reserves (During 1984).

Gley soils are often intermingled with alluvial yellow-brown loams and are formed under poor natural drainage. These soils are potentially some of the most productive in the country provided drainage problems can be overcome (During 1984).

Today's dairy pastures were developed using heavy applications of potassic superphosphates. Many pastures received 750-1000 kg fertiliser/ha/year for 20 or more years. Agricultural scientists have repeatedly questioned the need for such large inputs where only maintenance dressings are required (Elliott 1968, Karlovsky 1975).

A study of the effects on pasture production of restricting or stopping fertiliser applications was commenced in 1978 and has continued to the present. Results for the 8 years 1978-86 are reported in this paper.

METHODS

The study was conducted on 6 commercial dairy farms each representing a major dairy farming soil type (Table 1). High producing farms were selected to ensure a high level of management expertise, with optimal pasture utilisation and recycling of nutrients. The 6 farms produced 400-560 kg milkfat/ha/year over the 4 year period 1977-81, which was 20-70% more than the regional average. The average stocking rate of the farms was about 35% greater than for the region and all the farms had histories of liberal to excessive fertiliser applications (Table 1).

One paddock on each farm was selected as experimental paddock after soil type was confirmed. Soil pH of the experimental paddocks ranged from 5.5 to 5.9, soil calcium levels from 8 to 11 and magnesium levels from 14 to 22. Five of the six soil Olsen P levels were >25 and all six quicktest K levels were >10 (Table 1). Pastures of the experimental paddocks on the gley soils consisted of 50-60% ryegrass and 30-40% white clover. On the yellow-brown loams, pastures consisted of 20-25% white clover with up to 30% Poa species in spring and

Table 1: Soil types, stocking rates and fertiliser histories of the selected farms and initial Olsen P and quicktest K values of the experimental paddocks.

Trial	Soil type	Stocking rate (su/ha)	Fertiliser history (kg/ha/year) P	K	Soil tests Olsen P	Quicktest K
1	Horotiu fine sandy loam*	24	53	112	44	15
2	Te Kowhai silt loam**	24	53	112	30	15
3	Waihou fine sandy loam*	30	78	157	46	20
4	Waitoa silt loam"	24	53	105	27	11
5	Tirau fine sandy loam***	24	53	112	31	17
6	Ohaupo silt loam***	22	64	53	17	17

* Alluvial yellow-brown loam, ** Associated gley soil, *** Airfall yellow-brown loam

up to 50% paspalum in summer/autumn, with correspondingly reduced proportions of ryegrass (30-50%). All six experimental paddocks were rotationally grazed by the dairy herd at intervals of 14-24 days during lactation and block- or strip-grazed in winter at intervals of up to 60 days.

Within each experimental paddock, a trial consisting of three fertiliser treatments replicated four times in randomised blocks, was conducted. The treatments were: 1000 kg 30% potassic superphosphate (6.5% total P, 5.5% citric soluble P, 13.2% K, 8.8% S) /ha/year, 500 kg, or no fertiliser. Individual plot sizes ranged from 350-500 m^2. Half of the annual fertiliser was applied in March and the other half in October each year with the first application taking place in March 1978. The zero fertiliser plots were topdressed annually with 200 kg gypsum (40 kg S) /ha/year to prevent S becoming deficient. Areas of the experimental paddocks not included in the trials were topdressed annually with 500 kg 30% potassic superphosphate/ha.

The pasture measurement technique adopted for the project was designed to cause minimal interference with normal use and management of the experimental paddock by the farmer. Two 3m x 4m quadrats per plot were trimmed after grazing and pasture regrowth on 4.5m^2 from each of these quadrats was harvested before the next grazing. The quadrat positions were changed after each grazing according to a predetermined random sequence. There were two sets of 12 positions in each plot so that each area was trimmed and harvested once in 12 grazings. Annual pasture production was estimated by accumulation of the measured regrowth plus an amount calculated for the few days between the previous harvest and the trim. These latter amounts were derived by extrapolation of the daily regrowth rate over the measured periods. Pasture production years were taken from 1 May to 30 April of the following year.

The technique described above was employed for four years (1978-82). For the next two years pasture production was estimated by calibrated visual assessments of dry matter present before and after each grazing and for the final two years (1984-86), pre-grazing dry matter was estimated by calibrated pasture probe readings on six occasions throughout each pasture production year.

RESULTS AND DISCUSSION

Pasture dry matter production estimated by the trimming technique (1978-82) ranged from 8.0 to 11.2 t/ha/year. Such low pasture production is incompatible with the milkfat production on the farms because it takes about 25 kg pasture dry matter to produce 1 kg milkfat (Hutton & Bryant 1976). This suggests that the trimming technique underestimated dry matter production. Effects of differing fertiliser application rates on pasture production were therefore expressed relative to pasture production with 1000 kg fertiliser/ha/year (Fig. 1), which is regarded as maximum pasture yield for the purposes of this study. Pasture production estimated by visual assessments before and after each grazing (1982-84), ranged from 12.4-19.3 t DM/ha/year.

Pastures receiving 500 kg fertiliser/ha/year produced 2.5% less than maximum on average. This difference was significant in only 2 of the 8 years (Fig 1). In the trial where treatment differences were greatest (trial 6), 500 kg fertiliser maintained pasture production at an average of 95% of maximum, dropping below 90% in one year only. These results indicate that few well developed dairy pastures will require more than 500 kg 30% potassic superphosphate (30 kg citric soluble P and 70 kg K)/ha/year for pasture maintenance. Soil test P values confirm that the 500 kg/ha/year rate was adeauate to maintain soil P status (Fia 2). The different fertiliser rates had little effect on soil test K levels probably due to rapid uptake of the applied K in pasture and removal through grazing.

Stopping fertiliser caused a gradual reduction in pasture production at a rate of just over 1% per year in three of the six trials (Fig 1). In the other three trials (3, 4 and 6) stopping fertiliser reduced pasture production by 11% in the first year and 14% in the second. The rapid effect of stopping fertiliser in trial 6 can be explained by the low Olsen P soil test (Table 1) and in trial 3 it may have been a consequence of the high stocking rate. Trial 4 had the lowest quicktest K value and the second to lowest Olsen P value (Table 1), but both were above generally accepted critical levels.

Subsidiary trials to determine the effects of P and K separately showed that the reduction in pasture production in trial 3 was due to K deficiency, in trial 4 to deficiencies of both P and K and in trial 6 to P deficiency. Development of S deficiency in these trials was prevented by applications of gypsum to the zero fertiliser plots. Similar soils, also with long

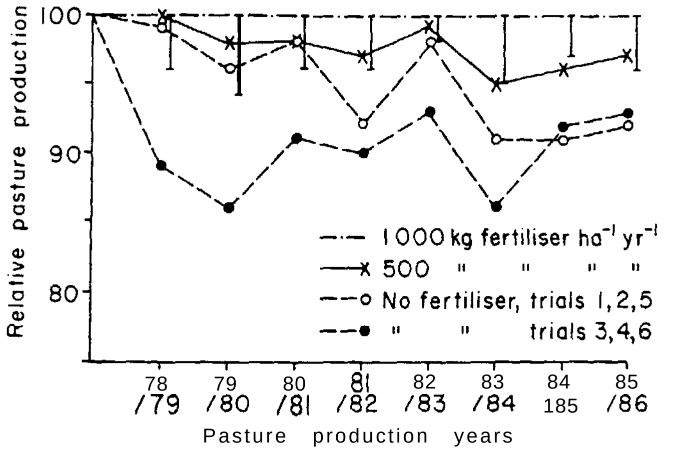

Figure 1: Annual pasture production with 500 kg fertiliser/ha/year (6 trials) and with no fertiliser (2 groups of 3 trials each), relative lo that with 1000 kg fertiliser. Vertical bars show LSD (5%) for means of the 6 trials.

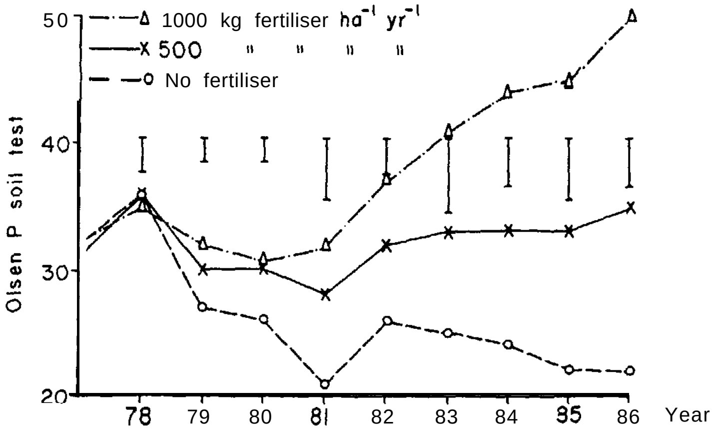

Figure 2: Mean (6 trials) Olsen P values for different fertiliser application rates from soil samples (0-80mm) taken in September of 9 Consecutive years. Vertical bars show LSD (5%).

histories of superphosphate application, were shown to have sufficient S reserves to maintain pasture production for at least four years (W. H. M. Saunders pers. comm.). This suggests that the S status of such soils needs to be considered only if P fertilisers with no or very low S contents are used for extended periods.

Stopping fertiliser in trials 3, 4 and 6 affected mainly the ryegrass and clover components of the pastures and thus reduced pasture quality as well as the quantity grown. Results from these trials may underestimate long term effects of not applying fertiliser because dung and urine returned to zero fertiliser plots through communal grazing were likely to have higher nutrient concentrations than if the whole farm had received no fertiliser. However, the effects in the initial 2 or 3 years resemble real situations where a farmer stops applying fertiliser after having done so regularly for a number of years.

Fertiliser at 500 kg/ha/year was reapplied to parts of the zero fertiliser plots in trial 6 after four years without fertiliser. These areas recovered rapidly and after a further three years were producing as well as plots that had received 500 kg fertiliser continuously. In one other trial, time of fertiliser application was superimposed on the existing treatments for a three year period. This showed that 500 kg 30% potassic superphosphate/ha/year was equally efficient when it was applied in a single dressing in either spring or autumn as when application was split between the two seasons.

Results of this study show that well managed, well fertilised dairy pastures have nutrient reserves that can be temporarily exploited in times of financial stress. Regular savings can be made by restricting‘ fertiliser inputs to reasonable levels. Optimal application rates for individual farms will vary with stocking rate and soil nutrient status. These factors are taken into account in fertiliser recommendations provided by the New Zealand Ministry of Agriculture and Fisheries (Cornforth & Sinclair 1984).

CONCLUSIONS

1. The average effects of restricting or stopping fertiliser on pasture production were small, indicating that soils under well topdressed, well managed Waikato dairy pastures have large reserves of plant nutrients.
2. Five hundred kg 30% potassic superphosphate/ha/year maintained near maximum pasture production in all cases.
3. The effect on pasture production of applying no fertiliser for two years was negligible in half the cases but resulted in a reduction in pasture production of more than 10% in the other half. The latter effects were partly predictable from low soil test levels or a high stocking rate.

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