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# Effects of frequency of maintenance phosphate fertiliser application on dry matter production from permanent pastures

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## Abstract

In a series of 12 field trials located throughout New Zealand annual application of phosphate(P) fertiliser was compared with triennial application using rates which applied the same total amount of P over 6 years. Test materials were triple supetphosphate (TSP) and Sechura phosphate rock (SPR), both of which were applied annually at rates which provided 0.75 times the calculated maintenance P requirement (0.75 M) and triennially at 2.25 M.For the 12 sites combined there was a significant response to P fertiliser each year. Application frequency had no significant effect on total DM yield over the 6 year period with either TSP or SPR. A cyclic effect with triennial applications was apparent for both fertilisers, with approximately 2-4% higher yields in the first year and 2-4% lower yields in the third year of both 3 year cycles. These results indicate that on well developed pastures a change from annual to triennial application frequency of phosphate fertiliser, with either TSP or slow release SPR, will have little effect on DM production providing the same total amount of P is applied. This gives farmers the opportunity to make some adjustment to P fertiliser application frequency according to fluctuations in availability of finance. However, these conclusions do not apply to other nutrients such as sulphur, potassium and trace elements for which annual applications may he necessary.

**Keywords** triple superphosphate, Sechura phosphate rock, phosphate fertilisers, annual application, triennial application, application frequency, reactive phosphate reck

## Introduction

Marked annual fluctuations in the net income of pastoral farmers raises the question of whether the frequency of maintenance fertiliser application can be modified to accommodate fluctuating availability of finance without detriment to pasture production. In particular, what effect does the frequency of application have on production provided the same total amount of fertiliser is applied over several years?

It is often suggested that soluble phosphates are likely to be more susceptible to loss through luxury uptake and fixation in the soil when applied infrequently in large quantities than from smaller regular applications. It is also claimed that slow release fertilisers, particularly reactive phosphate rocks, are better suited to infrequent large applications than soluble phosphates.

There has been little work done to study effects of frequency of application of phosphate fertilisera on developed pasture in New Zealand. During (1984) noted this, and postulated that topdressing at 15- 18- or even 24-month intervals may not be inferior to annual application. He also reported that twice-a-year applications of soluble P fertilisera did not increase pasture production compared with annual application.

Annual and triennial P applications. giving the same total application of P, were compared in three field trials (Grigg & Croucbley 1980; Grigg et al. 1982; Grigg & Thomson 1982.) Total dry matter yields over the trial periods (3 or 6 years) did not differ significantly, but there was generally a small cyclic effect with triennial applications.

On hill country it is often economically desirable to have intervals between topdressing of more than one year. During (1972) reported results from a developing hill country pasture near Wellington where applying 1692 kg/ha superphosphate in six equal annual applications, or a single initial application, or an intermediate application in 4 of the years resulted in similar total production from all treatments *over the 6 years. The* single initial treatment gave highest production in the third and fourth years.

Gregg *et al.* (1988), in a comparison of application strategies for SPR on Manawatu hill pastures. were. unable to detect any significant differences in DM production over 3 years between 50 kg P applied in year 1 and 16.7 kg P applied annually.

In this paper we report on an examination of annual and triennial application of two P fertilisera in a major series of field trials.

Table 1 Annual and total DM yields (kg/ha) - means of 12 sited

| Treatment | Year(s) 1 | 2 | 3 | 4 | 5 | 8 | 1-3 | 4-6 | I-8 |
|---|---|---|---|---|---|---|---|---|---|
| Control | 8194 | 9028 | 7701 | 8208 | 7104 | 8239 | 24923 | 19551 | 44474 |
| TSP Annual | 8602 | 9910 | 8830 | 7375 | 8331 | 7430 | 27142 | 23135 | 50277 |
| TSP Triennial | 8875 | 9733 | 8288 | 7788 | 8348 | 7155 | 28896 | 23270 | 50188 |
| SPR Annual | 8348 | 9582 | 8408 | 7247 | 8387 | 7898 | 28314 | 23331 | 49845 |
| SPR Triennial | 8559 | 9881 | 8315 | 7421 | 8519 | 7458 | 28538 | 23398 | 49932 |
| SED | 117 | 122 | 104 | 174 | 141 | 159 | 250 | 327 | 477 |

## Methods and materials

The trials reported on were part of a national series of forms of phosphate fertiliser trials conducted by the Ministry of Agriculture and Fisheries between 1982 and 1989. Full details of sites, treatments and design are given by Smith et *al.* (1990) and Sinclair et al. (1990a). In 12 of the 19 trials in the series, triple superphosphate (TSP) and Sechura phosphate rock (SPR) were each applied (a) annually for 6 years at 0.75 times the calculated P maintenance (M) rate, and (b) at 2.25 M at the beginning of Years 1 and 4 of the 6-year trial period. Maintenance phosphate rates for each site were calculated using the MAF phosphate maintenance model (Comforth & Sinclair 1984). SPR contained 12.8% total P and 5.7% citric-acid-soluble P and was applied unground (60% passing through a 150 mm sieve). TSP contained 20.6% total P. 19.4% citric acid soluble P and 18.8% water soluble P.

The 12 trial sites were located in Northland (5). Waikato (2), Canterbury (2) and Southland (3). They were on established pasture which had been regularly topdressed with superphosphate. Basal dressings of sulphur, potassium and magnesium and some trace elements boron, zinc and copper were applied where considered necessary to prevent their deficiency, At the Waikato and Canterbury sites molybdenum was applied but it was not applied at the other sites.

Small plots were established and managed by mowing with clippings returned. There were three replicates of each treatment in a randomised block design. Herbage DM was recorded at each cut. Methods of statistical analysis have been described elsewhere (Johnstone & Sinclair 1992).

## Results

Differences between DM yields from annual and triennial treatments were so small that they were hardly ever statistically significant at individual sites. It is only by combining all the trials that there was sufficient power in the experiment to show significant, albeit small, overall effects. From the results there was no reason to believe that the effects of application frequency differed significantly at different sites. although logic dictates that effects should be greater in the more responsive sites. Discussion is therefore limited to general effects for the 12 sites combined.

The cyclic nature of the DM response when fertiliser was applied triennially as compared to annually is illustrated in Figure 1. In the first year of a cycle triennial application of fertiliser resulted in greater DM production than annual application. In the third year of a cycle the situation was reversed. This reversal is highly significant. There is no significant difference between the first and second cycles. However, the size of the standard errors is such that the possibility of quite large differences in the cyclic pattern of the two fertilisers in

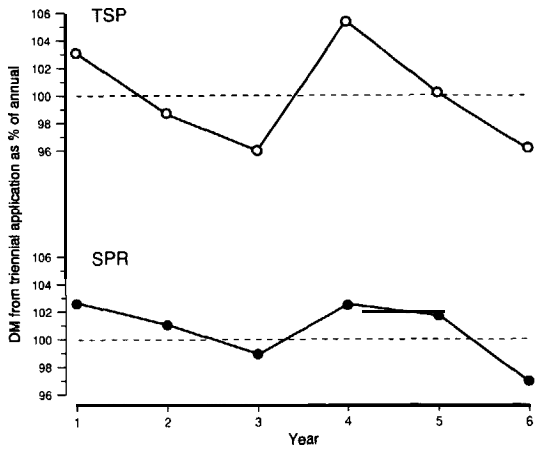


Figure 1 Effect of P fertiliser application frequency on pasture DM production averaged over 12 sites.

the two cycles cannot be ruled out.

Averaged over all 12 sites and the two 3-year cycles, the triennial TSP application produced approximately 4% more DM than annual TSP in year one of the 3-year cycle, and approximately 4% less in year three (Table 2). The corresponding percentages for SPR were approximately 2.5% and 2% respectively. However, the difference in the amplitudes of the cycles was not significant.

## Discussion

Differences between annual and triennial treatments

Table 2 Percentage difference (Triennial-annual application) in DM yields averaged over 2 3-year cycles.

| Year in 3 year cycle | 1 | 2 | 3 |
|---|---|---|---|
| TSP | +4.2 (SE 1 .56) | -0.9 (SE 1.20) | -3.8 (SE 1.20) |
| SPR | +2.5 (SE 1.59) | +1.3 (SE 1.23) | -2.1 (SE 1.20) |

would be expected to be greater in the more responsive sites and could also be affected by site properties such as phosphate retention. However, experimental variability was too great to allow conclusions to be reached as to the effects of these factors on annual versus triennial differences. Consequently discussion must be limited to general effects for the 12 sites combined.

Direct comparisons should not be made between DM yields from TSP and SPR. Sinclair et *al.* (1990b) reported that SPR contained sufficient Mo to remedy Mo deficiency and that some of the 8 sites not receiving basal Mo had apparently deficient Mo concentrations in clover herbage in TSP treatments but not in SPR treatments. Thus some of the response to SPR could be due to its Mo content. Valid comparisons are therefore confined to different application frequencies of the same fertiliser material.

The results indicate that provided the same total amount of fertiliser P is applied, the pattern of application within 3-year periods has negligible effect on total pasture production. This supports and extends the observations of During (1972) and Gregg et al. (1988). Also the cyclic effect from infrequent application is small, much smaller than the year to year fluctuations of up to 30% in DM production due to climatic variability which farmers must cope with (Baars 1981, Radcliffe 1974). Thus provided total P input is maintained in the longer term. farmers have considerable scope to adjust P fertiliser application frequency according to the availability of finance, which has fluctuated sharply over recent years.

These conclusions apply to P only, and not to sulphur, potassium and trace elements which are often incorporated in P fertilisers. Sulphur. in the sulphate form present in single superphosphate. and potassium are much more subject to loss by leaching than is P, so infrequent application is not appropriate where these are essential components in the P fertiliser. However, elemental sulphur is a slow-release fertiliser suitable for infrequent application.

## Conclusion

Provided the same total amount of maintenance P fertiliser is applied to well-developed pastures there is negligible difference in total pasture DM yields between annual and triennial application. There is a small cyclic effect on DM production with triermial application but it is much less than fluctuations caused by climate. These conclusions apply both to soluble P fertiliser (triple superphosphate) and to reactive phosphate. rock, but they do not apply to other nutrients which may be incorporated in phosphatic fertilisers.

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