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RATIONALISING TOPDRESSING OF HILL COUNTRY

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Abstract

Measurements of Pasture production were made on both Easy (1 0-20° slope) and Steep (30-40° slope) strata of a yellow brown earth-brown granular loam hill soil complex of medium P retention status. Results showed that whereas maximum growth required 50 kg P/ha/year on Easy slopes (14,900 kg DM/ha) only 30 kg P/ha/year were needed on Steep slopes (7700 kg DM/ha). Efficiency of production (EP) in kg DM/kg P from Easy and Steep slopes was similar at the same relative production level but much higher from Easy slopes at any one fertiliser rate.

There was a poor relationship between soil Olsen P status and relative yield. However maximum production was obtained with mean Olsen P levels (O-7 cm depth) of 15, on Easy Slopes, and 10 on the Steep slopes.

A procedure is described to assist in setting fertiliser rates for topdressing hill country.

Keywords: hill country, phosphate fertiliser, pasture production, efficiency of production

INTRODUCTION

Over the last IO years results from grazing trials have provided recommendations for the long-term superphosphate requirements of hill soils in the King Country (O'Connor *et al.* 1973) and Manawatu (Lambert *et al*, 1982) districts of the North Island. In addition the New Zealand Ministry of Agriculture has promoted the concept of assessing the nutrient losses occurring over a year within any pastoral system, by taking account of both "animal" and "soil" incurred losses, and using this estimate as a basis for recommending fertiliser requirements (Cornforth & Sinclair 1982). In all three cases, recommendations are made on a soil-type basis and currently provide the foundation for recommendations for superphosphate use on much New Zealand hill country.

The usual aim in farming is to supply enough fertiliser to obtain near maximum pasture production. The target normally set is that which will produce 90% of maximum growth. This is on the understanding that pasture is relatively unresponsive above this level and usually requires high amounts of extra fertiliser to maintain maximum production.

In some situations where stocking rates are relatively low, targets of only 80% or less of maximum pasture growth may be aimed for. Consequently fertiliser recommendations are adjusted accordingly in order to optimise fertiliser use.

The above discussion relates entirely to topographic units or areas of one soil type of uniform production potential and large enough to be differentially fertilised on a practical scale. Any hill block contains pasture with a wide range of growth rates according to both soil and slope related factors. It is probable then that pastures from such contrasting sites also have differing phosphate (P) requirements to maintain 90% of maximum production, Similarly in many hill areas of the North Island in particular, pasture on the same land slope may conceal a number of contrasting soil types derived from either sedimentary or various volcanic ash parent materials with associated differing physical and moisture retention properties. This being so what options does a farmer have for achieving efficient use of fertiliser under such variable conditions.

At Whatawhata Hill Country Research Station measurements were made to determine the P requirements of pasture on both easy (10-20°) and steep (30-40°) slopes of a hill soil. These results together with those from other relevant situations will be used to discuss strategies for setting topdressing priorities.

METHODS AND MATERIALS

Whatawhata Phosphate Fertiliser Trial

A 14.2 ha area of developed pasture which had been topdressed at about 375 kg/ha of superphosphate for at least the previous 12 years was subdivided into 20 small paddocks. These ranged in size from 0.24 to 1.22 ha and each was formed to contain land of both Easy (10-20°) and Steep (30-40°) contour. Superphosphate was applied by helicopter according to treatment at 10, 20, 30 and 50 or 100 kg P/ha. There were four replicates of each treatment. Treatments were not self-contained farmlets and were grazed by sheep to maintain close pasture control. Pasture production was determined using calibrated visual estimates and incorporated a difference technique. Measurements were made at about 4 to 6 week intervals according to season (9 per year) and summed to provide total annual production.

Measurements of pasture species composition in spring 1982 showed the ryegrass dominance of the Easy slopes, in contrast to the predominance of lower fertility grasses (other than browntop and ryegrass), weeds, mossanddead matter on Steep slopes (Table 1). The higher legume content on Steep slopes indicates a probable lower available N status of these soils compared with those on Easy slopes.

Soil samples for routine analysis were taken prior to reapplying treatments in March-April each year. The trial commenced in March 1980 and results to May 1983 are used in this paper.

Table 1: PASTURE SPECIES COMPOSITION (% BY WEIGHT) IN OCTOBER 1982 ON CONTRASTING STRATA.

	Easy	Steep
Ryegrass	46.0	9.8
Browntop	11.8	9.1
Other Grasses	14.8	25.5
Legumes	17.0	31.7
Weeds and Moss	3.5	11.7
Dead Matter	6.9	12.2

RESULTS

Pasture Response

Annual pasture production on Easy (10-20°) slopes increased to 14,900 kg DM/ha with rates of P to 50 kg/ha. By contrast pasture growth on Steep slopes (30-40°) was about half that on Easy slopes (i.e. 7700 kg DM/ha) and did not respond to more than 30 kg P/ha (Fig. 1). These production responses occurred

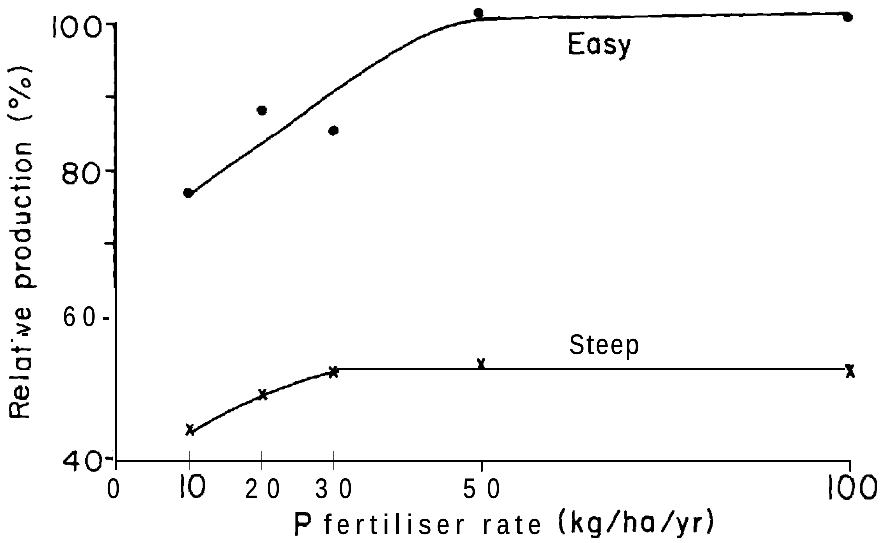

Figure I: Relative pasture production on Easy and Steep slopes (mean for years 798 1-83).

without any significant pasture species composition modifications by fertiliser treatment.

Soil P

Soil Olsen-P status after two years was not affected by P application rates of 30 kg/ha or less (Table 2). On both easy and Steep slopes Olsen-P levels showed similar increases to rates of 50 or 100 kg/ha/year.

There was apparently no relationship between soil Olsen P status and pasture production at levels less than maximum. On this soil maximum yields on Easy slopes were achieved with mean Olsen P levels of 15 and on Steep slopes with a level of IO.

DISCUSSION

The differing P requirements of pasture on contrasting strata appear related to the associated factors limiting potential pasture production. On steep slopes which dry out relatively rapidly during spring and rewet slowly in autumn compared with easier land, 30 kg P/ha is sufficient to satisfy the demands of the browntop-ryegrass-subterranean clover-lotus species based pasture. On sites of higher growth potential with associated higher P uptake a heavier fertiliser rate is needed to allow expression of potential.

Such contrasting conditions are present on all hill farms, usually assembled in arrangements too complex to allow differential fertiliser treatment. What do these differing sites represent in terms of pasture production per unit of fertiliser applied? Using the results in Fig. 1 estimates of the efficiency of dry matter production per unit of P fertiliser used to achieve that production (EP), have been calculated (Table 3). The various fertiliser rates used (kg P/ha) are shown in

Table 2: SOIL CHARACTERISTICS (O-70mm); OLSEN P (MARCH 1982) AND PHOSPHATE RETENTION (PR).

Fertiliser P Rate	10	20	30	50	100	SED
Olsen P (μg/ml)						
Easy	10	10	11	15	21	0.9[1]
Steep	9	9	10	14	20	
PR (%)						
Easy	66	65	57	65	71	7.9[2]
Steep	60	54	54	58	59	

[1] P rate effect significant at $P < 0.01$; strata, non significant.
[2] P rate effect non significant, strata significant at $P < 0.05$.

Table 3: AVERAGE EFFICIENCY OF PRODUCTION (KG DM/KG P FERTILISER) AT DIFFERING TARGET LEVELS ON CONTRASTING HILL BLOCKS.

	Maximum production	Relative Target Level 100%	90%	85%	77%
All Easy	**14,900**	300 (50)[1]	480 (28)	635 (20)	1145 (10)
All Steep	7,700	255 (30)	435 (16)	655 (10)	–
50/50 Easy/Steep	**11,300**	225 (50)	460 (22)	645 (15)	–

[1] Bracketed figures indicate fertiliser rate (kg P/ha) used.

brackets. It is evident, at the same relative level of production, that EP is similar on both Easy and Steep slopes and higher at lower production targets. However at any one fertiliser rate EP is much higher from Easy land. Where a 50/50 mixture of land zones are present the EP figure lies between that for Easy and Steep slopes. The exception is where near overall 100% production is aimed for and fertiliser is applied at a level in excess of that which provides maximum production from the Steep zone (i.e. 30 kg P/ha). In such situations the EP is lower than for either of the contributing strata if they could be topdressed separately (Table 3).

Other Examples

The response curves from the Whatawhata trial are probably typical of those which could be measured on many blocks of hill country. Using the tables of recommendations in the recent MAF Fertiliser Recommendations bulletin (Cornforth & Sinclair 1982), examples of comparative response curves can be

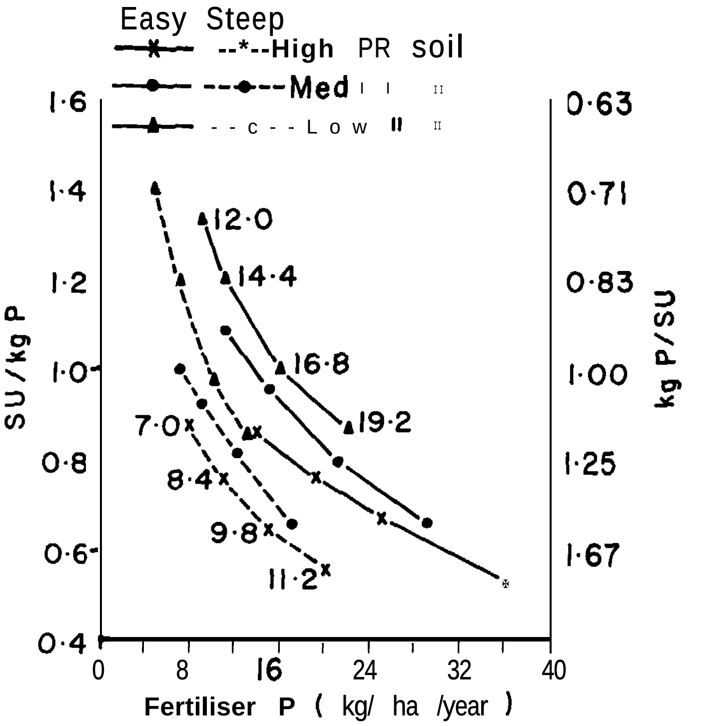

Figure 2: Efficiency of production (su/kg P fertiliser, orkg P/su) from contrasting hill soils. Carrying capacity (cc) of Easy = 24 su/ha; cc of Steep = 14 su/ha. Annual pasture utilisation assumed to be 80% overall. Stocking rates shown (in parenthesis) for 50, 60, 70 and 80% cc levels of production for each soil. Animal loss factor for Easy = 0.9, and for Steep = 1.1 kg P/su/year (Corn forth & Sinclair 1982).

constructed for land classes and soil types with contrasting carrying capacities or potential production. From such curves can be derived estimates of EP (su per unit of P applied, or conversely kg P/su) at given production levels (Fig. 2). The Fertiliser Recommendation model for P assumes, since pasture dry matter production is related to P application rate, that a similarly varying stocking rate will result in a constant level of pasture utilisation (e.g. 80%) over a range of pasture production levels. In Fig. 2 the effect of maintaining an overall lower pasture utilisation level would be to depress and move each curve slightly to the right. i.e. more fertiliser is required to support the same stocking rate and consequently EP falls.

'A logical approach towards setting fertiliser rates on either separate or mixed soil types within a farm would be to equalise the efficiency of production levels. For example from Figure 2, to topdress medium PR soils on a hill farm at 0.8 su/kg P (1.25 kg P/su) would require 12 kg P/ha on the Steep areas, 21 kg P/ha on the Easy and about 16 kg P/ha on a 50:50 Easy/Steep block. Such a strategy could support an average of 13.2 su/ha. However because of the similarity in slopes of the response curves in Fig, 2 the total farm production would also be about the same if the whole property was topdressed at the 16 kg P/ha rate, i.e. at the mean of that designated for the Easy and Steep soils. This occurs because of compensating changes in production as fertiliser rate changes from 21 to 16 kg/ha on the Easy and from 12 to 16 kg/ha on the Steepland soil. Such compensation is in fact more effective where extremes of production occur within a farm, e.g. more than 80% of maximum on Easy and less than 50% on Steepland areas. In such situations higher total production will be obtained by applying a mean rate overall.

CONCLUSIONS

The usual approach to setting fertiliser recommendations according to individual relative yield production targets (e.g. 90% of maximum) on separate soils or slopes is generally not practicable, or necessary to obtain efficient fertiliser use, on hill country.

The following procedure can be used for areas receiving the same type of fertiliser.

(1) Select fertiliser rates so that efficiency of production (EP) in su/kg P or kg P/su on contrasting blocks are the same. Equalised relative yields can be used but is slightly less satisfactory especially where separate blocks have different soil types.

(2) Derive a mean rate for topdressing all areas.

(3) If this mean rate exceeds that providing maximum yield on the lowest producing soil or strata then apply the excess fertiliser to separate blocks where the EP is lower.

(4) Within a farm avoid extremes in relative productivity between blocks.

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