Proceedings of the New Zealand Grassland Association 47: 229-232 (1986)

ALTERNATIVE P-FERTILISERS FOR NORTHLAND SOILS

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ABSTRACT

Increasing material, processing, and distribution costs have raised superphosphate prices to a point where many farms cannot support the costs of meeting maintenance phosphate requirements Alternatives to superphosphate, particularly those that have lower processing costs and contain more P, may offer a solution to the problem provided they are agronomically as effective. Phosphate rock may indeed be such an alternative.

Preliminary results from a series of five trials in Northland show that on soils of moderate P fertility, with low phosphate retention (PR) and high pH (5.9-6.0), initial pasture growth responses to rock phosphates are smaller than those from single or triple superphosphate. On one soil of higher PR and lower pH, the differences in yield between the rock-phosphates and the super. phosphates were smaller. Of the rock phosphates tested, Sechura and North Carolina (unground and ungranulated) tended to be more effective than ground and granulated Chatham Rise phosphorite.

The effect on production of applying fertilisers once every three years, as opposed to annual applications is being investigated using triple superphosphate and Sechura phosphate rock. After two years, production levels appear largely unaffected by differences in application frequency.

A comparison of locally-produced superphosphate with a reference standard showed that both performed similarly, indicating that the local product was of satisfactory quality.

INTRODUCTION

Over the past 5 years, costs of application of fertilisers containing phosphorus (P) have risen rapidly, due to increasing costs of raw materials, processing, transport, and spreading. This trend has resulted in decreased fertiliser application and the likelihood of many farms receiving inadequate fertiliser inputs to sustain present production levels.

Two possibilities for reducing fertiliser costs exist. One relates to reducing processing costs, by directly applying unprocessed material; the other, to reducing transport and spreading costs by applying more concentrated fertilisers.

The use of reactive phosphate rock (RPR) materials, particularly those containing higher P-contents than superphosphate, offers potential savings in both the above areas. Elsewhere in New Zealand RPRs have shown potential as pasture fertilisers when used for maintenance applications (Quin 1981), particularly as they have greater residual effects than superphosphate (Scott and Cullen, 1965; Gregg and Syers 1982, Mackay et. al. 1985), and may be more efficient than superphosphate at supplying P to pasture plants when less than 80%-90% of maximum pasture production is required (Rajan and Upsdell 1981, M.B. O'Connor, pers. comm.)

As yet, there has been little work conducted to evaluate RPR materials as phosphate fertilisers in Northland. The present study was undertaken to compare a range of RPR and readily soluble P-sources under Northland conditions. This report presents data from the second year of this study. Results from the first year (Shannon 1984) showed that there was little response to any treatment.

The objectives of this study were to:

1. Compare responses to increasing rates of Sechura phosphate rock and triple superphosphate.
2. To compare the efficiencies of a range of different P-fertilisers at a common rate, in terms of pasture production.

3. To evaluate the potential of phosphate rock fertilisers for infrequent application.

MATERIALS AND METHODS

There were 5 trial sites in this study, located on a variety of soil-types selected to typify the range of soil properties — soil P retention (PR) in particular — found in farmed soils in Northland. Details of soil type, soil properties, and treatments are contained in Table 1. All trials were laid down in May 1983.

All sites used in this study were located on sheep and beef farms, and had been under a rotational grazing management system. The pastures at each site were predominantly a ryegrass and white clover mixture, with some paspalum present during the summer at sites 3 and 5. All sites had received annual applications of 375 kg/ha 15% potassic superphosphate for the two years prior to the commencement of the trials.

TABLE 1: Details of site soil types and soil properties.

Site No.	1	2	3	4	5
Soil Type:	Hukerenui silt loam	Warkworth clay	Whangaripo clay	Red Hill sand	Awarua clay
Soil group[1]	N Podz	NYBE	NYBE	YBS	BGC
P-retention	15	22	34	37	52
Olsen-P	23	14	14	21	15
Soil pH	6.0	5.9	5.9	6.0	5.5
Maintenance P (M)	33	33	33	31	36

[1]N Podz: Northern Podzol; NYBE: Northern yellow-brown earth; YBS: Yellow-brown sand; BGC: Brown granular clay.

Each site was laid out in a randomised incomplete block design, with three replicates. Each block contained two sub-blocks, 'A' and 'B'. 'A was a response-curve comparison between triple superphosphate (TSP) and Sechura phosphate rock (SPR), at 0.5, 0.75, 1.0 and 2.0 times maintenance (M) P rates, plus a zero-P control. 'B'contained a fertiliser material forms comparison, between TSP, SPR, North Carolina phosphate rock (NCPR), Chatham Rise phosphorite (CRP), locally-manufactured single superphosphate (NSSP), and a reference single superphosphate made from a 50:50 Christmas Island: Nauru phosphate rock blend (X/NSSP). All were applied at a basic rate of 0.75 × M to ensure that comparisons were made on a responsive part of the P-response curve at each site. TSP and SPR were also applied triennially at 2.25 × M, and there was a zero-P control. Thus, 'A' and 'B' both contained the control, 0.75 × M TSP and 0.75 × M SPR treatments in common.

Maintenance P requirements were estimated for each site using the MAF fertiliser recommendation scheme (Cornforth and Sinclair 1984), assuming that each site was being farmed at 90% of maximum carrying capacity.

Basal applications of sulphur (S) as gypsum were made to all, with the exception of the single superphosphate, treatments in May and again (to all treatments) in October of each year, at a rate equivalent to that in X/NSSP at 0.75 × M. Potassium (K) was applied at 50 kg/ha as KC1, also in May and October.

Yield cuts were taken whenever pasture on the fastest-growing plots reached a height of 10-15 cm, using a rotary mower set to cut 4.5 cm above ground level. Green yields were recorded on site and a subsample was taken for subsequent dry matter determination.

RESULTS AND DISCUSSION

Very few responses to phosphate fertilisers occurred in year I (Shannon 1984), but during year 2, most of the sites became responsive to soluble P-fertilisers (Table 2). However, it was only on the highest PR site (Awarua, PR 52%) that increasing responses to increasing rates of Sechura phosphate rock occurred. This suggests that soil chemical processes were limiting the maximum rate of dissolution of reactive phosphate rock on the soils of lower PR, as demonstrated on low PR yellow-grey earth soils by Quin (1981). The lower pH on the Awarua soil is also a likely contributing factor, as acid conditions have been shown to increase the rate of dissolution of RPR materials (Khaswaneh and Doll 1978).

TABLE2: Pasture yields (relative to control = 100) from increasing rates of sechura phosphate rock and triple superphosphate for the 1984/85 trial year.

Soil type	Hukerenui silt loam		Warkworth clay		Whangaripo clay		Red Hill sand		Awarua clay	
	TSP[1]	SPR	TSP	SPR	TSP	SPR	TSP	SPR	TSP	SPR
Control yield (kg DM/ha)	7530		10900		11390		6600		5630	
0.5 M[2]	95	114	104	104	104	100	104	109	111	107
0.75 M	105	105	100	104	109	109	105	103	120	109
1.0 M	107	108	109	102	105	105	105	104	119	111
2.0 M	120	105	116	111	103	103	114	111	123	119
SED	8		5		3		12		10	

[1]TSP: Triple superphosphate; SPR: Sechura phosphate rock
[2]M: Maintenance rate of phosphate fertiliser

TABLE 3: Pasture yields (relative to control = 100) from different forms of phosphatic fertilisers, all applied at 0.75 maintenance, for the 1984/85 trial year.

Soil type:	Hukerenui silt loam	Warkworth clay	Whangaripo clay	Red Hill sand	Awarua clay	
Control yield (kg DM/ha)	7180	10310	11370	5760	5770	
Fertiliser		**Forms comparison (all at 0.75 M)**				**Mean**
a CRP'	91	110	101	105	109	103
b NCPR	98	103	104	122	120	109
c SPR	102	111	102	125	120	112
Mean a-c	97	108	102	117	116	108
d X/NSSP	103	111	106	137	125	116
e NSSP	106	113	106	130	130	117
f TSP	99	111	100	117	151	116
Mean d-f	103	112	104	128	135	116
			Forms × frequency			
SPR 2.25 M	102	113	104	127	126	
TSP 2.25 M	97	110	109	116	128	
SED	7	5	5	15		
Signs of forms × frequency interaction	**NS**	**NS**	**NS**	**NS**	P 0.05	

'Refer to text (Materials and Methods).

Of the different reactive rocks compared at the 0.75 M rate, finely-ground granulated Chatham Rise phosphorite appeared to be slightly less effective than the unground and ungranulated North Carolina and Sechura phosphate rocks (Table 3). As

Chatham Rise is thought to be equally reactive as the North Carolina and Sechura material, this suggests that the granulation process has reduced the rate of dissolution of the Chatham Rise material. On average, plots where reactive phosphate rocks were applied at 0.75 M rates produced less pasture than soluble phosphate fertilisers applied at the same rate (Table 3).

Single superphosphate from the local source performed in a similar manner to a standard 'Christmas/Nauru' superphosphate produced by the FMRA (Table 3), indicating that the locally-produced product is of satisfactory quality.

In the rates × frequency comparison, few consistent trends emerged. The exception is at the Awarua clay site, where annual applications of Triple superphosphate at 0.75 M are already, in only year 2, out-yielding the triennial application at 2.25 M (Table 3).

The gradual development of responses to reactive phosphate rocks is in keeping with the relatively high soil pH (5.9-6.0) in four of the five sites. The soil showing the greatest responses to reactive rock had both the lowest pH (5.5) and the highest PR; both factors would be expected to increase the rate of rock-phosphate dissolution.

It remains to be seen how long it will take for reactive rock to become equally as effective as soluble phosphate fertiliser on the higher pH soils, if this happens at all. For the present, the results suggest that soil factors, such as pH, are limiting the dissolution-rate of reactive rock applied at rates greater than 0.75 M. If this is the case, one way of overcoming this problem may be to combine RPR material with a readily soluble P-source, such as in partially-acidulated phosphate rock (PAPR) fertilisers. Comparison, of results from the present trial series with those from similar trials elsewhere in New Zealand (B.F. Quin, pers. comm.) which include PAPR materials, suggests that, in Northland, PAPR fertilisers may well provide the best compromise between cost and effectiveness in the medium term.

Tentative conclusions

1. Reactive rock phosphates may provide a more cost-effective alternative to single or triple superphosphates on Northland soils, but more data are required before a firm conclusion can be drawn.
2. On two soils (Red hill sand and Awarua clay), ungranulated North Carolina and Sechura phosphate rocks tended to be superior to granulated Chatham Rise phosphorite as P-sources. As the rocks have similar reactivities, it is thought that granulation has reduced the performance of Chatham Rise phosphorite.
3. Infrequent application of P-fertilisers at high rates does not appear, generally, to be less effective than annual applications.

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