Northland Pastoral Extension Research Stocktake

Lime Responses in Northland

Contents

1.0 The Effects of Lime on Pasture Production on Soils in the North Island of New Zealand

D C Edmeades, R M Pringle, G P Mansell, P W Shannon
New Zealand Journal of Agricultural Research, Vol 27 (1984) Parts 1,2,3,4
349:382

Summary

In 1984 a major review of all lime trials was carried out, as the results of several trials carried out in the 1960s and 1970s had not been published. This review included the results of lime trials on the yellow brown earths and the yellow brown sands most of which were done in Northland. As part of this review a set criteria was used to select the trial data to be used in this review, as follows.

- Pasture production was measured using mainly mowing trials with dry matter determinations.
- All trials must have been in progress a minimum of three years, and pasture production from the first year following lime was not included as it takes up to 12 months for lime to be fully effective.
- Where the pasture production was measured using the occasional cut technique a minimum of four production cuts during the second and third years following lime application was required.
- Where rates of lime was applied at different rates of applied P the information was summarised separately for each level of applied P.

Note: Of the trials examined 126 met the criteria and 90% were mowing trials.

These trials also gave a comparison between techniques for measuring lime response in pasture and it is reasonable to conclude that mowing trials provide a realistic measurement of the effect of lime on pasture and animal production.

Seasonal Pasture Growth Responses to Lime Applications
From the above database the results from trials were selected where pasture production was measured continuously and the trials were of at least four years duration. There were 9 out of the 126 trials that met this criteria none of them in Northland. However these trials covered three soil types located in Taranaki, Waikato, and. Manawatu.

In general the largest responses were in the autumn or summer and the smallest or the largest depressions were in the spring. On average the summer response was 12% above the control plots, for the autumn it was 16%, for the winter it was 8.5% and in the spring was 4.5%. These conclusions are consistent with the Woodcock's comments on the 600-observation trials carried out in the 1930s.

The reasons for the seasonal response to lime are not clear. One possible explanation is the observation that lime applications usually results in a change in pasture composition and different pasture species have a different seasonal growth cycle hence would affect the overall seasonal growth pattern of the sward. Another reason is the fact that lime alleviates aluminium toxicity, which inhibits root growth of pasture plants. With improved root growth plant growth can be improved during times of moisture stress, as is the case in the summer months. While these selected trial sites were not in Northland the results are consistent with the observations made by other workers in Northland.

Interaction of Lime with Phosphorus

The study indicated that negative lime and P interactions occur on the majority of the clay and volcanic soils in Northland. The size of the interaction is related to the degree of response to lime, and, in soils derived from sedimentary parent material, it becomes increasingly negative as the soil pH decreases.

Although negative lime and P interactions are common, economically useful P-sparing effects from lime applications are rare and unpredictable. So the P-sparing effect should not be an important consideration when determining lime and fertiliser policies. The exception is the Kaipara clay and related soils of Northland (see summary below). These soils were not included in the 126 trial summary.

Predicting Lime Responses

Soil pH is a useful predictor of lime responses and can account for up to 60% of the variation in lime responses.

Soil texture, soil P status, and soil buffering capacity did not significantly affect pH change as a result of liming. On average 1 t lime/ha increased pH by 0.11 pH units across all soil groups.

The optimum pH is 5.8-6.1 for the mineral soils and 5.0 for the peats. Above these levels pasture responses to further lime applications are unlikely. Note that as peats mineralise (become more like a mineral soil) then their optimum pH becomes 5.8-6.1.

The Northern podzol soils are the most weathered soils in New Zealand and have naturally low pH levels. Although the response to lime was statistically similar to other mineral clay soils in the North Island (8-11%) more recent work (see Waiotira and Whakapai clay summaries) would indicate a much higher response (average 16%).

There were a limited number of trials on the coastal sands and it is assumed that they respond in a similar way to other mineral soils in Northland.

Lime Recommendation Scheme

A model was developed to provide a prediction of pasture production responses to a lime application to a soil with a known pH level. This model was then tested in a set of ongoing field trials not included in the database. These comparisons showed that there was a good agreement between the average measured responses. In the trials and that predicted by the model. As there is some variation in the pH/lime response relationship the model can be used as a guide with limitations but a useful guide all the same.

With the development of a model like this an important factor is the duration of lime responses and the effects of lime on soil pH over along period of time are scarce, and the available information is variable. However farmers that have a policy of regular soil tests from their indicator areas on their farm are able to accurately monitor the duration of lime responses.

The database of trials indicated that on the yellow-brown-earths in the central areas of the North Island showed a mean duration of a single application of lime as follows.

Rate of lime per ha tonnes	1.25	2.5	5.0
Duration of responses in years	7	8	9

The limited data from the yellow-brown-earths in Northland gave variable results and local experiences would suggest the following.

Rate of lime per ha tonnes		1.25	2.5	5.0
Duration of responses in years	YBE	3	5	7
	Volcanic & Sands	6	7	8

2.0 Lime Requirements for the Development or Improvement of Pastures

New Zealand Journal of Agricultural Research, 1984; Vol 2
Fertilisers & Soils in New Zealand Farming C During 1984

Overview – Summary

The use of lime to correct soil acidity and improve pasture production was widely advocated in the early days of soil development in Northland. These recommendations were largely based on English and American results and experience. By 1936 sufficient research had been completed to publish a summary of 600 observational field trials from throughout New Zealand including Northland. The conclusions made was that liming produced very varying results and that phosphorus deficiency, not soil acidity was initially the major factor limiting pasture growth on many of the soil types. It was suggested that there are three main soil groups.

- Soils where both phosphate and lime are needed for maximum production.
- Soils where phosphate is essential and lime beneficial.
- Soils where phosphate is essential and lime is not required.

It was also noted that soils mostly in the second group gave a lime response that was more obvious particularly in the autumn.

The above recommendations were confirmed by other research work during the 1960 to 1980s, and it was recognized that lime is not a substitute for fertiliser. It was recommended that priority should be given to correcting nutrient deficient especially of phosphate, potash and sulphur as well as applications of lime. During this time molybdenum deficiency was identified which modified some the recommendations concerning the use of lime so that now there were five main soil groups as follows:

A. Lime essential
B. Lime essential and Mo maybe required
C. Both lime and Mo essential for maximum production
D. Lime beneficial, but probably not economical if Mo is applied
E. Lime not necessary

The soils of Northland can be classified into six main groups:

- The Yellow brown earths developed on sandstone, siltstone, mudstone, and limestone.
- Yellow brown sands.
- Soils developed on andesitic rock flows & on dolerite-brown granular clays.

- Soils developed on basaltic rocks-red & brown loams.
- Peaty loams and peats.
- Estuarine gley soils & alluvial soils.

Note: All recommendations for molybdenum applications are for sodium molybdenum.

Yellow Brown Earths

<u>Group A - Steepland Soils: Atuanui, Te Ranga, White Cone</u>
Lime beneficial, but probably not economical if Mo is applied.

- Molybdenum* deficiency is widespread but not well mapped, and can be applied at 100-150gm/ha every 4 to 5 years.
- Optimum pH about 5.5 and lime maybe needed.
- If pH levels are below 5.5 then lime can be applied at 1.25 tonnes per ha every 4 years.

<u>Group B - Hilly Soils: Aponga, Marua, Mata, Omu, Puhoi, Waiotira, Whangaripo</u>

- Both lime and Mo* essential for maximum production.
- Molybdenum needed for maximum pasture production except maybe for the Omu soils, and could be applied at 50gm/ha every 4-5 years.
- Optimum pH 5.8 to 6.1 and lime is needed at 2.5 tonnes/ha every 4-6 years.
- Pasture responses to lime are most evident in the autumn.
- Initially lime is needed to reduce aluminium toxicity where pH is less than 5.5.
- The benefit of lime applications to lift pH levels above 5.5 may improve soil moisture conditions.

<u>Group C - Hilly to Easy Rolling Soils: Riponui, Waikare, Rangiora, Warkworth Clays</u>

- Pastures are responsive to molybdenum*, and maybe needed at 50gm/ha every 4-5 years.
- Optimum pH is 5.8-6.1. There is no evidence to suggest that pH levels above this are needed.

<u>Group D and E - Easy Rolling Country: Hukerenui Silt and Sandy Loams, Wharekohe and Kara Silt and Sandy Loams</u>

- Pasture maybe responsive to molybdenum*, and could require 50gm/ha every 4-5 years.
- Optimum pH is 5.8-6.1.

Yellow Brown Sands - Pinaki Suite

Pinaki Sand

- Pastures maybe responsive to molybdenum*.
- Lime is needed if the pH level is below 5.5.
- Too much lime can elevate the pH levels and pH of 6.5+ are likely to be copper boron and possibly zinc deficient in terms of pasture growth.
- Maintenance applications of lime would be 1.5-2.0 tonnes per ha every 4-6 years.

Red Hill and Tangitiki Soils

- Good responses in trial work to lime have occurred at pH levels of 5.5 and 5.6, a fleeting response at 5.7 and no response with pH levels of 5.8.
- Pastures maybe responsive to molybdenum*.

Te Kopuru Soils

- Pastures are responsive to molybdenum*, applied at 50gm/ha every 4-5 years.
- pH levels of 5.8 – 6.0 are adequate and can be maintained by using lime at 1.5 tonnes/ha every 3-4 years.

Semi Volcanic Soils - Brown Granular Clays

Te Kie steepland Soil and Awapuku Clay

- Lime beneficial, but probably not economical if Mo* is applied.
- The pH levels are usually in excess of 5.5.

Waimatenui, Waitakere, Kohumaru, Pakotai, Rangiuru, Tutamoe, and Awarua Clays

- Both lime and Mo* are essential for maximum pasture production.
- Lime is needed at pH levels below 5.5 but if molybdenum is applied every two years at 200gm/ha less lime is needed, at 1.5 tonnes per ha every 5-6 years.

Volcanic Soils Red and Brown Loams

- Lime has given slight responses.
- Molybdenum* maybe needed on these soils.
- The exception is the Okaihau soils, which are responsive to both lime and molybdenum.
- Lime is needed at pH levels below 5.5.

Cautionary note. Molybdenum deficiency needs to be determined before Mo is applied to pastures. Too much Mo can result in Cu problems in animals. Test by taking a clover only sample and having it analysed for %N and Mo (mg/kg)

3.0 Pasture Development Whakapai Clay – Brown Loam

M O'Connor (AgResearch, Ruakura)
Proceedings New Zealand Grassland Association 1996

Overview – Summary

Previous research work in Northland identified the capital requirements for superphosphate and lime for pasture development. The rates needed were undeveloped site consisting of Whakapai friable clay. The base soil test levels were pH 4.8, Olsen P 8, Sulphur 3, and the P retention was 64. The treatments were superphosphate and North Carolina RPR at rates of 0, 25, 50, and 100kg P/ha/annum. Lime was applied to produce pH levels of 4.8 to 6.1 with cultivation and oversowing. Pasture production, %P and annual soil tests were measured.

<u>Results Year One 1990/91</u>

The annual yield was about 10 t DM/ha with a 10% response to P. There was little response to lime. Pasture composition improved over the 12 months with an increase in the clover component.

pH	**Control**	**25kgP/ha**	**50kgP/ha**	**100kgP/Ha**
4.7	2650	4050	3800	4200
5.1	3400	4200	4200	4250
5.4	4150	4200	4300	5150

<u>Results Year Two 1991/92</u>

pH	**Control**	**25kgP/ha**	**50kgP/ha**	**100kgP/Ha**
4.7	5000	5800	5400	5750
5.2	5100	6150	5800	6000
5.8	5800	5550	5900	6100

<u>Results Year Three 1992/91</u>

pH	**Control**	**25kgP/ha**	**50kgP/ha**	**100kgP/Ha**
4.8	4500	5200	6000	5800
5.8	5100	6400	7600	8000
6.2	5200	7500	7400	8100

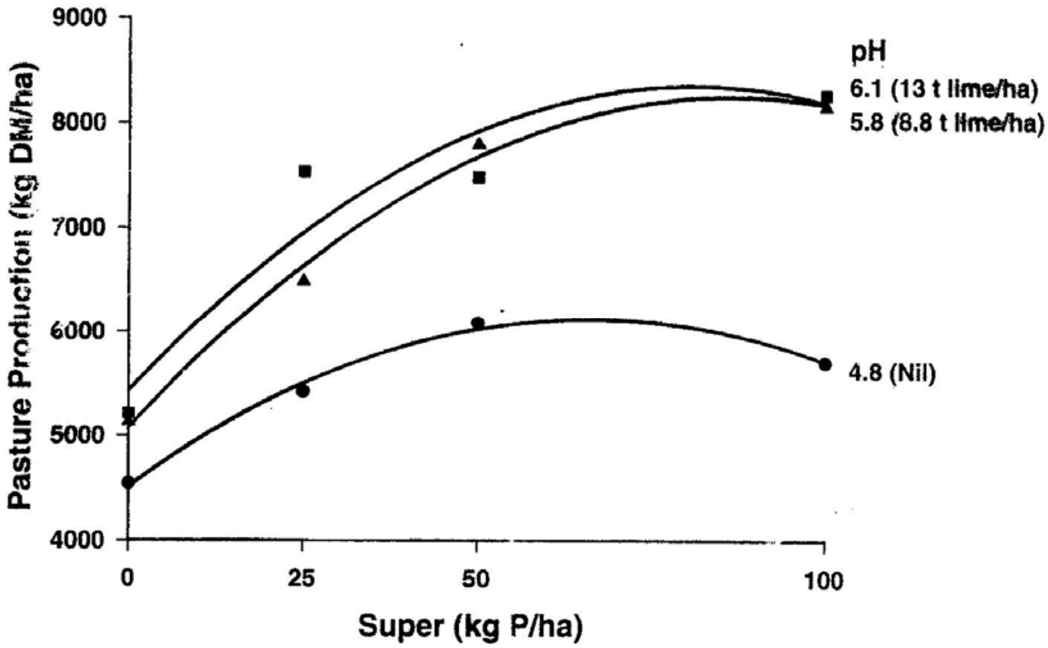


Figure 1: Pasture production in the third year

Summary

- The results indicate that provided pH is 5.8+ then near maximum pasture production is achieved with an Olsen P of 25-30, (NB data not shown) which equates to a total P input of approximately 200kgP over three years (100+50+50).
- Pasture response to lime allow was about 100kgDM/1000kg of lime applied, and 130-140kgDM/1000kg when applied with phosphate.

4.0 Pasture Improvement Waiotira Clay – Yellow-Brown Earth

M O'Connor (AgResearch Ruakura)
Proceedings New Zealand Grassland Association 1996

Overview – Summary

Previous research work in Northland identified the capital requirements for superphosphate and lime for pasture development. The rates needed were usually 1.8-2.0 tonnes of superphosphate and 2.5-5.0 tonnes of lime per ha during the first 18-24 months of pasture establishment.

Method-Lime & Phosphate Waiotira-Gunson Trial: July 1991
The trial was initiated in July 1991 at Waiotira on a site consisting of Waiotira that had received little or no fertiliser for 8-10 years. The base soil test levels were pH 5.6, Olsen P 8, Sulphur 5, and the P retention was 38. The treatments were superphosphate and North Carolina RPR, Longlife super and Parrhos 18, at rates of 0, 25, 50, and 100kg P/ha/annum., with and without lime. Pasture production, %P and N in herbage and annual soil tests were measured. A basal application of elemental sulphur, gypsum, potassium and trace elements was made.

<u>Results Year One 1991/92</u>
The effect of superphosphate with and without lime on pasture production over the three years is as follows.

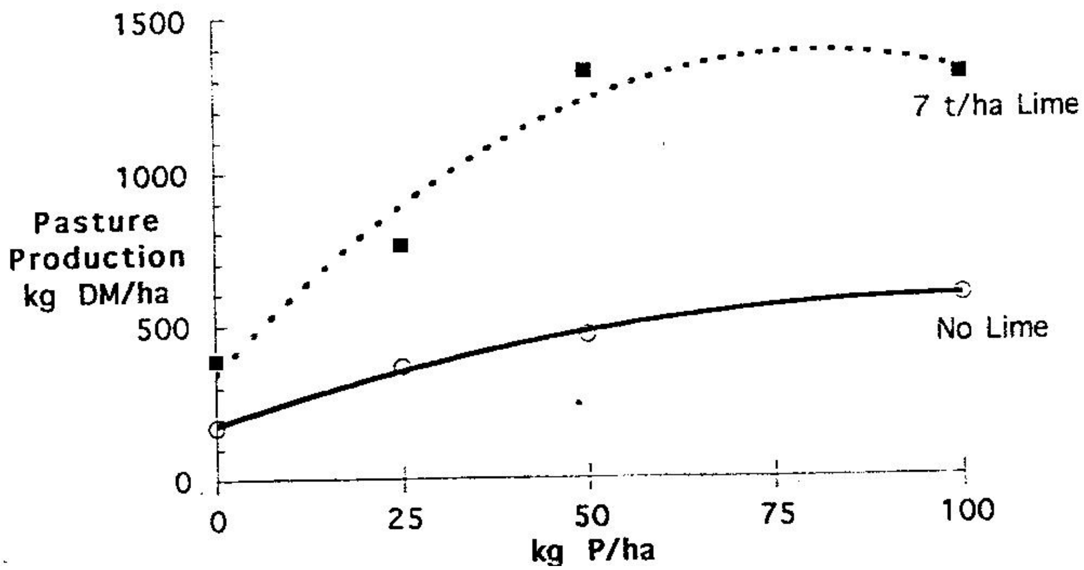
pH	Control	25kgP/ha	50kgP/ha	100kgP/Ha
5.5	5600	5300	5100	5700
6.5	6000	5800	7100	6700

<u>Results Year Two 1992/93</u>

pH	Control	25kgP/ha	50kgP/ha	100kgP/Ha
5.5	5100	5900	6600	7100
6.5	5800	7500	8600	8700

<u>Results Year Three 1993/94</u>

pH	Control	25kgP/ha	50kgP/ha	100kgP/Ha
5.5	5000	6100	8100	8800
6.4	5600	8500	9500	9200



Forms of Phosphate

The effect of the forms of phosphate used both slow and quick release over the three years is as follows.

Year One 1991/92

Form of P	Control	25kgP/ha	50kgP/ha	100kgP/Ha
Super	4500	4600	5750	5600
Parrphos	4500	5100	5600	4800
Longlife	4500	5150	5200	5150
NCR	4500	5200	4500	4800

Year Two 1992/93

Form of P	Control	25kgP/ha	50kgP/ha	100kgP/Ha
Super	5750	7450	8600	8700
Parrphos	5750	7450	7750	8600
Longlife	5750	6850	8000	8500
NCR	5750	7100	6000	6500

Year Three 1993/94

Form of P	Control	25kgP/ha	50kgP/ha	100kgP/Ha
Super	5600	8500	9500	9200
Parrphos	5600	7300	8400	9600
Longlife	5600	7300	8000	9500
NCR	5600	7300	6000	7000

Summary

- There was a marked response to lime even with an initial pH level of 5.6.
- Both lime and superphosphate are required to maximise pasture production.
- Superphosphate was superior to the other products in terms of increased pasture production.

5.0 Pasture improvement– Waiotira Clay 2 – Yellow Brown Earth

M O'Connor (AgResearch Ruakura)
Proceedings New Zealand Grassland Association 1996

Overview – Summary

Previous research work in Northland identified the capital requirements for superphosphate and lime for pasture development. The rates needed were usually 1.8-2.0 tonnes of superphosphate and 2.5-5.0 tonnes of lime per ha during the first 18-24 months of pasture establishment.

Method-Lime & Phosphate Waiotira-Lovegrove Trial: June 1993

The trial was initiated in June 1993 at Waiotira on a site consisting of Waiotira clay with base soil test levels of pH 5.3, Olsen P 10, Sulphur 5, and the P retention was 39. The treatments were eight rates of lime (0, 250, 375, 750, 1500, 3000, 6000 and 9000kg/ha) applied once only or annually at 4 rates (125, 250, 500 and 1000kg/ha) for 3 years. Pasture production, %P and N in herbage and annual soil tests were measured. A basal application of elemental sulphur, gypsum, potassium and trace elements was made.

<u>Results Year One 1993/94</u>
There was no response to lime in the first year of the trial and this was attributed to a drier than normal year with rainfall only 62% of the norm for the district.

<u>Results Year Two 1994/95</u>

Rate of Lime	**Control**	**2000Kg/ha**	**4000kg/ha**	**6000kg/ha**	**9000Kg/ha**
DM/Ha	6320	6500	6700	6850	7150

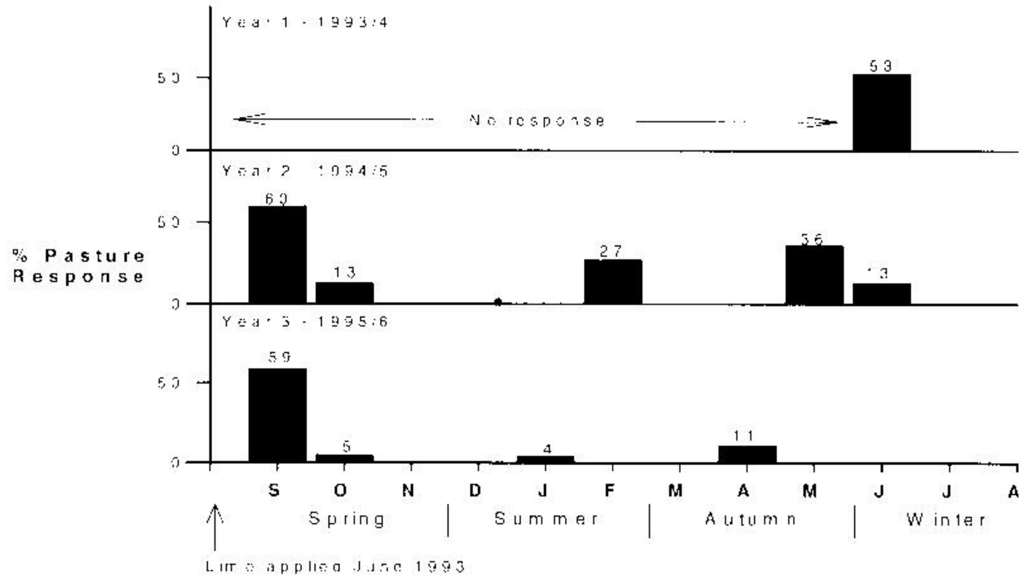


Figure 1: % pasture responses to lime in different seasons over 3 years

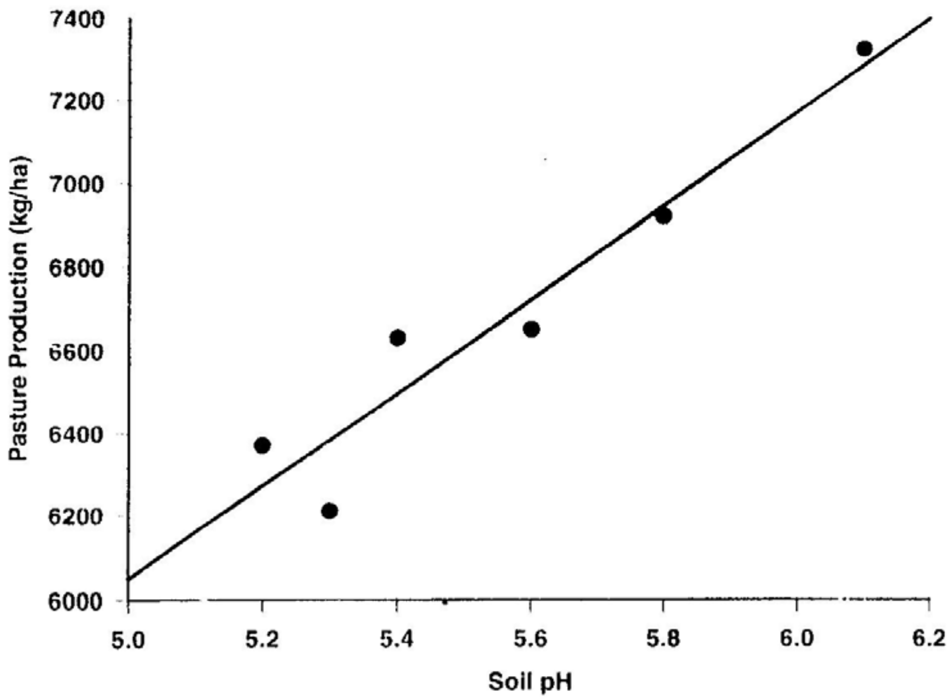
Pasture responses occurred mainly in the autumn-winter-early spring periods over the 3 years.

pH Changes With the Addition of Lime

Rate of Lime	**0**	**250**	**375**	**750**	**1500**	**3000**	**6000**	**9000**
pH	5.2	5.2	5.2	5.3	5.4	5.6	5.8	6.3

This data indicates that to lift the pH level by one point of this soil type requires about 800 to 1000kg lime per ha.

The trial also clearly indicated that the quicker the pH was raised to 6.0 – 6.0 the better in terms of pasture production (Figure 2 below).



Summary

- The response to lime on average was 100kgDM/ha for every 1000kg of lime applied per ha, and the response did not decline at the highest rate of lime.
- The quicker the pH was raised to 6.0 the greater the response.
- Pasture production response to the lime was greatest during the autumn/winter/early spring period.

6.0 Phosphate and Lime Requirements of Kaipara Clay Soils

M O'Connor (AgResearch, Ruakura)

Overview – Summary

Lime is seen as important for Kaipara clay soil and farmers use lime on a regular basis even when pH levels seem to be optimum. Phosphatic fertilisers have been used sparingly as Olsen P levels have tended to be high. For more intensive farming the P levels are falling and it has become important to determine the need for P. Also where the pH levels are considered optimum the maintenance requirement for lime needs to be determined.

Field Trial Phase One: 1996-1999

In December 1996 a trial was laid at Ruawai on a Kaipara clay soil with a pH of 5.8 and an Olsen P of 16. The trial consisted of six rates of P at 0, 20, 40, 60, 80, 100kg/ha with or without lime at 5.0 tonnes/ha. The fertiliser was applied as superphosphate and all plots got a base dressing of, potash, gypsum, elemental sulphur, copper and molybdenum. The trial was fenced from stock and cut regularly throughout the year. DM matter yields, %P and P uptake and pasture composition were assessed. The plots were re-topdressed after 12 months except for lime.

Pasture production kg DM per ha

	1996/97		**1997/98**		**1998/99**	
Rates of P	**No Lime**	**Lime**	**No Lime**	**Lime**	**No Lime**	**Lime**
0	9,370	10,460	9,1700	11,040	9,020	12,120
20	10,630	10,160	10,000	10,940	10,480	11,350
40	10,520	10,650	9,8600	10,590	10,540	11,280
60	10,990	10,950	10,780	11,390	10,440	11,800
80	11,320	11,400	10,690	10,960	11,110	10,740
100	11,340	10,950	11,450	10,520	11,350	10,660
SED	441		558		664	

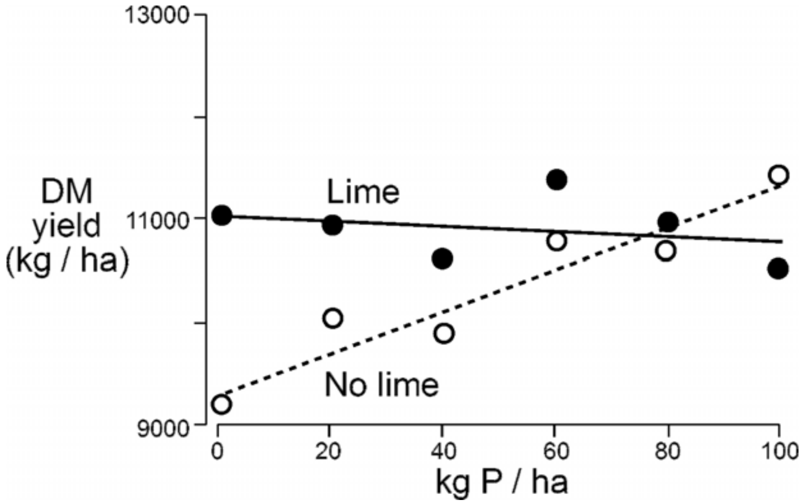


Figure 1: Pasture production responses to lime and P in 1997/98

You need to put Figure 1 in as well as the table. It has high visual impact.

In the absence of lime there was a pasture production response to increasing rates of P. In the presence of lime however the P response did not occur and this was consistent over the three years.

The lime no P treatment gave a response equivalent to P at 50-60kg/ha. This indicates the lime was having a strong P-sparing effect. Also the Olsen P levels were similar over the three years on all treatments indicating that no soil P release was occurring as a result of liming.

	Rates of P (kg P/ha/annum)					
	0	20	40	60	80	100
No Lime	13	15	21	24	31	32
Lime	15	19	26	26	32	35

Field Trial Phase Two: 2000-2003

Trial plots were split in half with one half getting lime to give a range from 5.6, 6.1, 6.5 and 7.0, while the other half were left in the original state. All plots received P as for phase one.

Pasture production kg DM per ha with increasing pH

	pH level				
Year	5.6	6.1	6.5	7.0	SED
2000/01	6,330	6,390	6,520	6,520	161
2001/02	12,140	12,610	12,920	13,000	379
2002/03	9,190	9,560	9,290	9,400	338

There was no benefit to increasing the pH above 6.1. However marked P responses continued over the three years with the maximum benefit for rates of

P at 40-60kg per ha as below. By this time the Olsen P level on the control plots had declined to 11-12 and responses to P would be expected.

Pasture production with increasing P rates 2000-2003

	Rates of P (kg of P per ha per year)						
Year	0	20	40	60	80	100	SED
2000/01	5,760	6,180	6,490	6,820	6,600	6,780	243
2001/02	11,900	12,300	12,400	13,020	13,130	13,240	612
2002/03	8,700	8,620	10,050	9,350	9,450	9,980	542

Summary

- The trial has highlighted some important interactions between lime & superphosphate on Kaipara clay soils and it is emphasised that these results apply only to the Kaipara clay and related soil types in Northland.
- These soils are naturally high in P but with more intensive farming P levels are falling.
- Liming produced a marked P-sparing effect, which was equivalent to P applied at 50-60kg per ha.
- There was no evidence that the lime was releasing P directly or making P more available.
- It is suggested that the reason for the response is due to the lime mineralising N in the soil. This in turn leads to an improvement in plant root penetration of the soil enabling more aluminium and iron held P to be released to the plants on the lime plots. This was confirmed by Laboratory studies.
- An improvement in soil moisture levels as a result of liming may have been a factor as has been suggested by other research workers.
- The effect of lime took 12 months to develop.
- There were marked responses to P at Olsen P levels of 16.

7.0 Lime Summary

The multitude of soil types that can be found in Northland can be classified into four main groups as follows.

Soil Group		Area ha	PR%
Yellow brown earths	YBE	560,000	20-40
Brown granular clays	BGC	240,000	50-60
Red and brown loams	RBL	77,000	60-70
Yellow brown sands	YBS	40.000	30-40

Note: PR-phosphate retention

Role of Lime

The important component of lime is calcium carbonate, which in Northland ranges from 60-75% pure. These levels are lower than that usually found in other parts of New Zealand. The calcium carbonate reacts with the acids in the soil and in this way increases the soil pH.

A chemical analysis of a range of sample of limestone from Northland was as follows:

	%		ppm
Calcium carbonate	60-75	Copper	14-27
Silica	15-30	Cobalt	10-14
Iron	0.6-1.1	Manganese	100-600
Magnesium	0.1-0.15	Molybdenum	0.2-0.8
		Zinc	22-39
		Cadmium	3-5

The silica in lime is an inert material and has very little agricultural value. The other elements such as molybdenum, copper and cobalt are often required either for pasture production or to improve animal performance. However the low concentrations of these elements means that a normal application of lime at 2.5 tonnes per ha would supply less of these elements than what is required to correct a deficiency of that element.

Animal grazing trials carried out in other districts would indicate that an animal response to lime applications is due to extra pasture production and not due to any changes in pasture composition. The fact that pasture responses occur mostly in the summer and autumn and can have a benefit in terms of extra cow days in milk or a higher body weight for ewes at mating can result in an increase in animal production that can be a carryover effect from an increase in dry matter production at an earlier stage.

Lime for Pasture Development

Lime is needed on almost all soil types in Northland for pasture establishment in addition to phosphate, sulphur, molybdenum and occasionally potash and copper. The initial objective should be to obtain a pH of at least 5.4 and this would be achieved by an application of 5.0 tonnes per ha of lime applied in a single application.

Optimum pH Levels

The optimum pH for pasture production is 5.8 to 6.0 On the coastal sandy soil (YBS) there is some evidence that excessively high pH levels of 6. 5+ can induce deficiencies of cooper and boron that could adversely affect animal production.

Frequency of Lime Applications

The frequency of lime applications can be determined from soil test results and for most soil groups in Northland an application of 2.5tonnes per ha every 4-6 years will maintain the soil pH level. The limited research work done on the comparison between annual lime applications at an equivalent rate to one application every 4-6 years indicated no advantage to annual applications of lime. In terms of maintaining pH levels either approach can be adopted and it may be more economical to apply lime less frequency at the heavier rate due to less application costs.

The research work also indicates that the different soil groups in Northland respond to lime in a similar way in terms of lifting the pH level. For all soil groups there fore to lift the pH level by one point requires 1 tonne of lime per ha. Once the lime has been applied it takes up to 12 months or more for the maximum lift in pH status to be achieved. Often the response to lime is not evident in the first 12 months following application especially when the weather conditions are very dry.

Pasture responses to lime tend to be seasonal and most of the additional pasture growth occurs in the summer autumn and winter. Research results show that where as an application of lime may increase annual pasture production by 4-5% the actual increase in the summer months has been up to 20-30% greater. While in the spring either no increase in production or even a slight depression in pasture production.

Lime Interactions With Other Elements

The beneficial effect that lime has is to increase pasture production by virtue of the change in the pH status. There can be a separate and additional benefit by way of interaction with other elements principally aluminium and manganese.. Aluminium toxicity is often associated with acid soils. The limited trial work done in Northland on Marua clay with pH status of 5.2 gave pasture responses of 10-13% by the use of lime. The aluminium levels were above the threshold for Al toxicity and the response achieved to lime applications was partially due to a reduction in the Al levels in the soil.

Likewise it is known that high levels of Mn can be toxic to pasture plants but in one extensive study of over 3400 New Zealand wide sites had only 6 that had Mn concentrations above the threshold. So it is assumed that it is unlikely that Mn is a factor limiting pasture production in Northland.

Liming is able to make some elements more available to the plant and molybdenum is an example of this. As the pH level improves soil molybdenum is more available to the plant and so molybdenum deficiency on some soils can be overcome by liming. This is of particular importance on steep land soils where lime applications can be expensive and an application of a few grams of molybdenum is a lot cheaper than several tonnes of lime.

The possibility that lime can make phosphate more available is of particular interest. The trial work on this has given inconsistent results. One recent trial in Northland on a Kaipara clay soil indicated that a phosphate sparing affect was measured as a result of applying lime at a pH of 5.9. This effect was due to lime mineralising N and allowing plants to grow better and explore more soil and uptake more P. It is possible that this effect could occur on the other similar marine soil types in Northland. The sedimentary soils are most unlikely to show a P sparing effect and the lime response obtained will be due to a reduction in the aluminium toxicity factor particularly around pHs of 5.3-5.4..

Lime and Organic Matter

Mineralisation of organic matter by soil microorganisms is one of the ways by which inorganic N is made available for plant growth. Many laboratory studies have shown the beneficial effect liming has on the mineralisation of organic matter. However limited work in the field has been done on this and and only a few field measurements of increased pasture N uptake made on lime trials carried out in Northland. Neverthe less indications are that lime will be beneficial in this way on many Northland soils.

Lime and Soil Moisture

There is evidence from several trials some of which were done in Northland that lime can result in increased soil moisture levels, especially after rainfall in March-April period. The reason for this may be due to the fact that lime reduces the hydrophobic conditions generated by the organic matter formed by herbage senescence over the summer period.