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FERTILISER REQUIREMENTS OF GISBORNE-EAST COAST HILL COUNTRY

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Abstract

Soil fertility has a dominant influence on the productivity of many hill country pastures. In the Gisborne-East *Coast* hill country the dominant soil groups the yellow-brown earths (YBEs) from mudstone/argillite and the yellow-brown pumice soils (YBPs) from Taupo pumice tephra - show variations in response to fertiliser inputs. Results from a series of eight field trials, commenced in 1980, indicate widespread phosphorus (P) deficiency across both groups with optimum Olsen P soil test values being calculated as 11.5 and 20.1 respectively. Sulphur deficiencies appear less important, in the short term, than previously thought. Lime (L) and molybdenum (Mo) deficiencies appear widespread on YBEs with an indication on some sites that lime effects are over and above that due to increased Mo availability. Potassium (K) is the dominant deficiency (after P) on YBPs. Element deficiencies in decreasing order of importance were - YBEs, P > L/Mo > S > K; YBPs, P > K > S > L.

Keywords: Fertilisers, hill country, pasture production.

INTRODUCTION

The potential for increasing agricultural production on Gisborne-East Coast hill country is excellent. Estimated increases range from 3.1 million (O'Connor *et al.* 1981) to 4.7 million stock units (Ritchie, MAF Economics Division, *pers. comm.).* Such increases are possible utilising known technology of fertiliser, subdivision and management (Fitzharris 1982).

Soil fertility continues to have a dominating influence on the productivity of many hill country pastures (Mauger 1977) and the purpose of this paper is to assess the importance of a range of fertiliser inputs - including phosphorus, sulphur, lime, molybdenum and potassium - on pasture production. Two years' results from a series of trials in the Gisborne-East Coast hill country will be used.

METHODS

Trials were located at eight sites ranging from Gisborne to Te Araroa in the north across to Matawai in the west (Fig. 1). Four sites were on yellow brown earths (YBEs) derived from mudstone/argillite and four sites on yellow brown pumice soils (YBPs) derived from tephra material. Site details are given in Table 1. All sites were on established pastures, with previous fertiliser histories ranging from nil to 375 kg/ha superphosphate annually,

Trials were laid down in the summer of 1980/81. Each trial consisted of four rates of P (0, 20, 40, 80 kg/ha), four rates of lime (0, 1250, 2500, 5000 kg/ha), two rates of sulphur (0, 44 kg S/ha - mixture gypsum and elemental S), molybdenum (0, 140 g/ha sodium molybdate) and potassium (0, 160 kg K/ha) in a factorial arrangement. P was applied annually and K and S (elemental) at six monthly intervals. Lime and molybdenum were not reapplied. Pasture production measurements were made on a seasonal basis using a reel mower (six sites) or handclipped quadrats (two sites). Clippings were discarded. Pasture composition

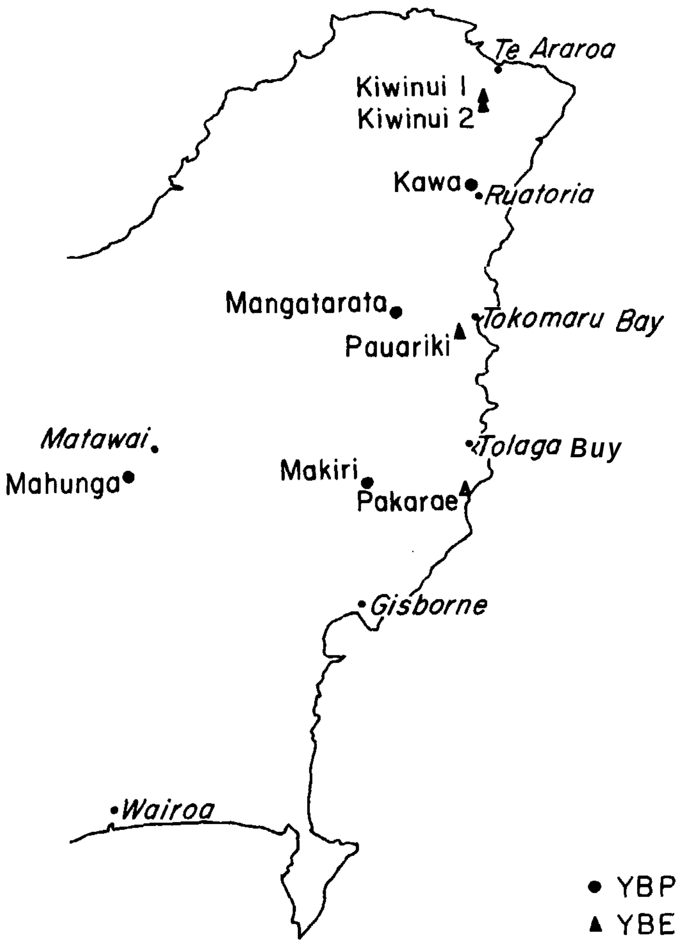

Figure I: Location of trial sites.

and vigour assessments were taken at each rut and herbage chemical analyses in the autumn cut. Trial sites were under normal farmer management between production cuts.

RESULTS AND DISCUSSION

Results will be presented on an individual element by soil grouping basis (YBE, YBP). For phosphorus and lime the mean of the three rates of application are given.

Phosphorus (P)

Soil testing is a useful and widely accepted means of measuring the P status of soils, but most soil test-pasture yield relationship information has been obtained

Table 1: TRIAL SITE DETAILS.

Site	Station	Alt. (m)	Rainfall (mm)	Soil	Fertiliser History (10 years)
1	Kiwinui (1)	50	1980	Waikura hill, YBE (argillite/mudstone)	125 kg/ha superphosphate Regular topdressing.
2	Pakarae	80	1500	Otamauri hill YBE/YBP (sandstone/pumice)	Nil
3	Pauariki	120	1790	Kurarau hill, YBE (mudstone)	250 kg/ha superphosphate Regular topdressing
4	Kiwinui (2)	200	1980	Mangaomeko hill, YBE (mudstone)	125 kg/ha superphosphate Regular topdressing
5	Kawa	120	1880	Matakaoa sandy loam YBP (rhyolitic tephra)	Nil
6	Makiri	460	1670	Makiri sandy loam YBP (rhyolitic tephra)	250 kg/ha superphosphate Regular topdressing
7	Mangatarata	550	1540	Makiri sandy loam, YBP (rhyolitic tephra)	250 kg/ha superphosphate Regular topdressing
8	Mahunga	610	1770	Matawai hill, YBP (rhyolitic tephra)	375 kg/ha serpentine super-phosphate Regular topdressing

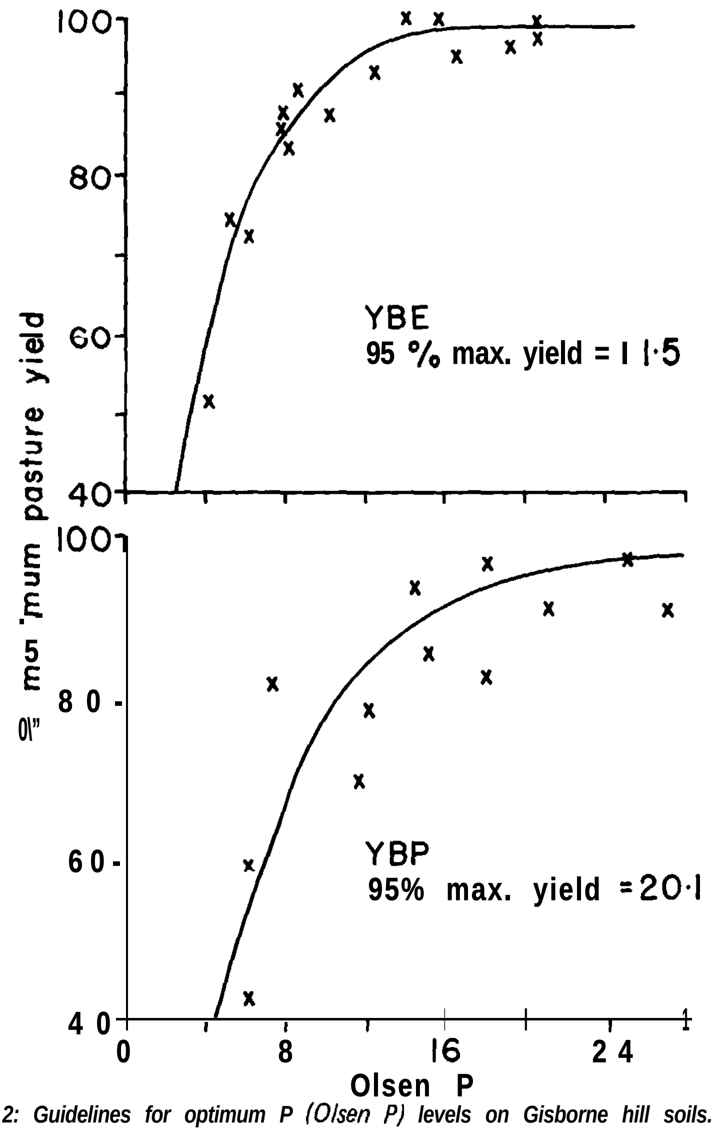

Figure 2: Guidelines for optimum P (Olsen P) levels on Gisborne hill soils.

on flat land (Grigg 1972) and little is available for hill country. Some indication of optimum P soil test (Olsen P) levels for Gisborne hill soils was obtained from the current series of fertiliser trials using 16 comparisons (four rates of P x 4 sites) for each soil grouping (Fig. 2). For 95% maximum pasture yield optimum Olsen P levels were calculated to be 11.5 for YBE and 20.1 for RBP. Although some variation could be expected in these values, particularly for YBP, relative pasture responses to P for individual sites lend support to the values of P deficiency in Gisborne hill country with five of the eight trials responding to P.

Table 2: RELATIVE PASTURE RESPONSES TO PHOSPHORUS, SULPHUR, LIME, MOLYBDENUM AND POTASSIUM AT EIGHT SITES IN 1981 AND 1982.

Element	Soil Group	Site	Soil Test 0-8cm	Relative pasture production 1981	1982
(a) Phosphorus			Olsen P'	No P = 100	
(Spring & Autumn Cuts)	YBE	Kiwinui (1)	12	113	118*
		Pakarae	6	165***	240***
		Pauariki	13	112	107
		Kiwinui (2)	11	102	104
	YBP	Kawa	4	170***	184***
		Makiri	9	106	124***
		Mangatarata	22	106	106
		Mahunga	7	124***	126***
(b) Sulphur			SO_4-S[12]	No S = 100	
(Spring Cuts)	YBE	Kiwinui (1)	4	99	109
		Pakarae	6	104	98
		Pauariki	1	113*	119***
		Kiwinui (2)	9	95	101
	YBP	Kawa	10	104	104
		Makiri	2	104	102
		Mangatarata	9	106	99
		Mahunga	11	102	108*
(c) Lime			pH[1]	No lime = 100	
(Autumn cuts) + Spring Cut	YBE	Kiwinui (1)	5.3	135*	152**
		Pakarae	5.4	123*	144***
		Pauariki	5.3	+108	123*

Sulphur (S)

Previous research has indicated the importance of S in North Island hill country (Blackmore et *al.* 1969; Crouchley & Sinclair 1982). Satisfactory responses have been obtained from S applied as gypsum (as in superphosphate) and only in high rainfall and more particularly on pumice soils (Toxopeus & Gordon 1971; Gregg 1982) has the need for elemental S (as in sulphur superphosphate) been recommended.

Two years' results from Gisborne (Table 2b) indicate S deficiency is occurring on only two of the eight trials although visual assessments of % clover and clover vigour suggest one other site (Kiwinui (1)) may be potentially deficient. Mean annual rainfalls differed little between sites and were generally high, 1500-2000 mm (Table 1). However, there was marked rainfall variation between years; 1981, 19% above normal (winter +23%); 1982, 22% below normal (winter - 68%) and hence advice based on mean rainfall could be suspect. Likewise, soil 'sulphate (SO_4-S) measurements (Table 2b) do not appear to give a reliable guide to responsiveness although the presence of higher SO_4-S at depth may assist in explaining a lack of response in particular trials. Identifying S responsive areas then is difficult and further research into S requirementsof hill country is urgently needed.

The evidence suggests S deficiency is much less important than P occurring as it does on only two trials out of eight over two years. This result suggests the short-term use of high analysis, S-free fertilisers could have a definite place in the Gisborne-East Coast region.

Lime and Molybdenum (Mo)

Recently, emphasis has been placed on the role of lime in pasture production in hill country (O'Connor *et al.* 1981; Edmeades et *al.* 1984; Syers, *pers. comm.*). In trial work lime and molybdenum must be considered together as there can be strong interactions between the two (Lambert & Grant 1980). Seasonal responses to lime are also well documented with best responses occurring in the summer/ autumn period (Edmeades 1982).

Results from Gisborne trials (Tables 2c, d) show good responses to both lime and Mo on YBEs but no responses (except for Makiri) on YBPs. Lime responses on YBEs are shown in terms of immediate effects on pasture production. This contrasts with delayed responses observed elsewhere (O'Connor *et al.* 1981). These sites also show significant lime effects on clover density and vigour and also grass vigour (results not presented) indicating a total pasturegrowth response to lime. In contrast, lime has had little effect on pasture production or species composition on YBP sites with the exception of Makiri, which showed a lime response in the second year. This response was confined to the grass component.

Molybdenum effects occurred on three of the four YBE sites (Table 2d). In general, responses were smaller than the lime responses. Lime-molybdenum interactions occurred but were more apparent in pasture composition (particularly in the clovers) than in pasture yield.

The evidence from two of the three lime responsive trials on YBEs is that there is both a lime response and a molybdenum response occurring. This is illustrated in Table 3 from the Pakarae site. The correction of molybdenum deficiency by the use of molybdic superphosphate is the more attractive economically but there may well be enchanced long-term benefits to the addition of lime as shown by O'Connor *era/.* (1981).

Molybdenum is not required on YBP sites and may in fact be detrimental. Pasture analyses indicated that plots without Mo contained 1.1 ppm Mo, and those with Mo, 4.3 ppm. In contrast YBE plots with or without Mo contained 1.29 ppm and 0.31 ppm Mo respectively. Optimum levels for pasture are 0.30 – 0.40 ppm (Cornforth 1979).

Table 3: EFFECT OF LIME AND MOLYBDENUM ON PASTURE PRODUCTION (Kg DM/ha) PAKARAE, AUTUMN 1982.

Lime (kg/ha)	No Mo	Mo
None	1000	1330
1250	1520	1560
2500	1540	1730
5000	1930	1890
LSD < 0.05	254	

Potassium (K)

A knowledge of the clay mineralogy of YBE and YBP soils together with previous trial results (During 1972; Toxopeus & Gordon 1971) suggests YBP soils will become K deficient soon after development whereas YBEs are likely to have good K reserves.

Results from the Gisborne trials (Table 2e) confirm that the K status of YBP soils is low after development and responses to K are likely. Although the quantity of K required will vary depending upon such factors as stocking rate, stock type and soil K status (Campkin 1982) absolute deficiencies can have a drastic effect on the clover component of swards. For example, the Mahunga trial had a mean clover content of 11% (no K) and 30% (plus K) over two years. Responses were absent on the YBEs, with the exception of one site (Table 2e), confirming that K reserves are generally adequate on these soils.

CONCLUSIONS

1. Phosphorus is the most widespread deficiency on Gisborne-East Coast hill country.
2. Guidelines for optimum P soil test levels for the two major soil groups in the region are given as YBE 11-12, YBP 20.
3. Yellow brown earths. Trial results indicate nutrient deficiencies in decreasing order of importance are: P > L/Mo > S > K. Molybdenum deficiency can be corrected cheaply but lime, although initially expensive, can be a worthwhile long-term investment (O'Connor et *al.* 1981). Sulphur deficiency in the short term may be less important than previously thought.
4. Yellow brown pumice soils. Nutrient deficiencies in decreasing order of importance are: P > K > S > L. Potash deficiency is widespread while the extent and degree of S deficiency requires further investigation.

		Kiwinui (2)	5.4	96	102
	YBP	Kawa	5.8	97	96
		Makiri	5.7	109	113**
		Mangatarata	5.5	+104	107
		Mahunga	5.4	+104	106
(d) **Molybdenum** (Autumn cuts) + Spring Cut				No Mo = 100	
	YBE	Kiwinui (1)		98	106
		Pakarae		115*	111*
		Pauariki		+107	124*
		Kiwinui (2)		100	109*
	YBP	Kawa		97	96
		Makiri		99	99
		Mangatarata		+ 97	100
		Mahunga		+101	99
(e) **Potassium**			K[1]	No K = 100	
	YBE	Kiwinui (1)	6	137**	113
		Pakarae	10	97	95
		Pauariki	12	101	102
		Kiwinui (2)	12	96	99
	YBP	Kawa	9	102	101
		Makiri	5	116***	113***
		Mangatarata	4	104	114***
		Mahunga	4	118***	110***

* = $P < 0.05$; ** = $P < 0.01$; *** = $P < 0.001$, otherwise not significant.

[1] MAF Quicktests (Cornforth, 1979; Saunders *et al.* 1981).

[2] sampled June, 1983.

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REFERENCES

Blackmore, L.W.; Ludecke, T.E.; Hogg, D.E. *1969. Proc. N.Z. Grassld Ass., 31: 87-95.*

Campkin, R. 1982. *In* Fertiliser and Lime Recommendations for Pastures and Crops in N.Z. Ed. Cornforth, IS.; Sinclair A.G.

Cornforth, I.S. 1979. Soil and Plant Analyses Bulletin, MAF, Ruakura.

Crouchley, G.; Sinclair, A.G. 1982. *N.Z. J. exp. Agric. 10: 185-191.*

During, C. 1972. *In* Fertilisers and Soils in N.Z. Farming. Govt. Printer, Wellington, 312 pp.

Edmeades, D.C. *1982.* N.Z. *agric. Sci., 15: 192-199.*

____________; Feyter, C.; O'Connor, M.B. *1984: Proc. N.Z. Grass/d. Ass., 45:* (in Press).

Fitzharris, M.J. *1982. Proc.* N.Z. *Soc. Farm Management Conf., Masterton: 51-57.*

Gregg, P. E. H *. 1982. Proc. Fertiliser Seminar E. C. F. F.*

Grigg, J.L. *1972.* N.Z. *J. agric. Res. 15: 643-652.*

Lambert, M.G.; Grant, D.A. 1980. *N.Z. J. exp. Agric. 8: 223-229.*

Mauger, J.H. *1977. Proc. Teach. Conf.* N.Z. *Fert. Manufacturers: 145-l 56.*

O'Connor, M.B.; Foskett, H.R.; Smith, A. 1981. *Proc.* N.Z. *Soc. Anim. Prod. 41: 82-87.*

____________; Sheath, G.W.; Jagusch, K.T. 1981. Internal Report, MAF.

Saunders, W.M.H.; Cooper, D.M.; Sinclair, A.G. 1981. Aglink FPP649. MAF, Wellington.

Toxopeus, M.R.J.; Gordon, R.B. *197 1. Proc.* N.Z. *Grassld. Ass. 33: 35-4 1.*