RESEARCH FINDINGS IN PASTURE ESTABLISHMENT ON TE ANAU SOILS

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Summary

The results of nearly 30 trials which investigated pasture establishment problems on Te Anau yellow-brown loam soils are summarized. High initial application rates of phosphatic fertilizer and clover inoculation were shown to be of vital importance for good pasture establishment. Excellent grass and clover establishment was obtained by oversowing.

INTRODUCTION

AFTER the acquisition of Lynwood Estate in 1953, land development was initiated by the Lands and Survey Department in the Te Anau district. By 1960, major development was under way on the 60,000 ha block and 8,900 ha had been regrassed (Watt, 1960) .

The main area of development was in the vicinity of Te Anau township on yellow-brown loam soils derived from glacial moraine. In its unimproved state, the land had a vegetative cover of bracken, fescue tussock, manuka and native shrubs, herbs and grasses. Although most of the land is of relatively low altitude (180 to 460 m) and is rolling in contour, the presence of boulders, swamps and gullies made cultivation difficult and costly.

The climate at Te Anau is generally favourable for pasture growth with a rainfall of about 800 mm annually.

Initial development of the morainic soils, involving traditional cultivation techniques, gave disappointing results and as a consequence investigations were commenced by the Department of Agriculture in 1960. During 1960-67 nearly 30 trials were laid down to investigate various aspects of pasture establishment. Results are summarized in this paper.

RESULTS

CLOVER INOCULATION

Because of the virtual absence of clovers in newly sown pastures, clover nodulation failures were suspected. This was con-

firmed in one of the first experiments laid down in 1960 where seed inoculation gave a large increase in the number of healthy clover plants surviving and in dry matter production (Table 1).

TABLE 1: EFFECT OF INOCULATION ON CLOVER PLANT NUMBERS AND DRY MATTER PRODUCTION

	Clover Plants per m^2	*DM Production (kg/ha)*
Not inoculated ...	21	250
Inoculated ,,,, ,,,, ,,,,	118	1510

Further trials confirmed the importance of effective clover inoculation with sowings on cultivated soil and by oversowing. Although early trials failed to show any advantage from clover pelleting compared with inoculation only (During et al., 1963), recent work by Lowther and McDonald (1972) has shown marked advantages from seed pelleting.

LIME

In the initial land development at Te Anau, rates of lime up to 7,500 kg/ha were used although there was no evidence to suggest such high rates were needed and soil pH was relatively high (5.4 to 5.6). Because of high costs of application in this area, investigation of lime requirement was of high priority.

Results of a liming trial on cultivated ground which included four rates up to 3,640 kg/ha applied in various ways indicated that lime responses were likely to be small on Te Anau yellow-brown loam. In this trial on newly sown pasture, lime increased the ground cover and vigour of grasses in the 18 months after sowing but had little effect on the clovers. Small increases in herbage production were recorded in the limed treatments in the second and third year after application (Table 2). Discing

TABLE 2: EFFECT OF LIME ON PASTURE YIELDS

Lime Rate (kg/ha)	*Total DM Production (kg/ha) (Cuts 22/3/63 and 15/4/64)*
0	5,170
502	5,420
879	5,480
1,883	5,890
3,641	6,050

the lime into the soil three months before sowing or immediately before sowing did not prove superior to surface applications at sowing (Cullen and Grigg, 1971a).

In a further trial on cultivated ground (Cullen and Arnold, 197 1), 9,400 kg lime showed no significant superiority in dry matter production or vigour over 1,880 kg lime.

In two trials with oversown grasses and clovers, lime enhanced grass establishment but had no effect on, or depressed, clover establishment.

Studies by J. L. Grigg (pers. comm.) have shown Te Anau yellow-brown loam has a very wide C/N ratio of the order of 20/1 and it is considered that the small lime response in the seedling grasses could have been the result of increased nitrogen mineralization in the soil.

FERTILIZERS AND TRACE ELEMENTS

Phosphorus

The first trial sown in 1960 indicated that Te Anau yellow-brown loam had a very high requirement for phosphate (During et al., 1962) and that initial applications of not less than 700 kg/ha were needed at sowing for successful pasture establishment on cultivated ground.

Later trial results (Cullen, 1971a) confirmed the need for high phosphate applications when applied to the surface at sowing, responses being recorded to increasing rates of P up to 202 kg/ha (Table 3).

TABLE 3: RESPONSE TO PHOSPHORUS

P (kg/ha)	*DM 21/12/67 (kg/ha)*
0	—
67	100 cB
134	920bA
202	1,130abA
269	1,460aA
336	1,230abA
CV %	14.4

Because of the very high phosphate requirement, it was decided to investigate various forms of phosphatic fertilizer and methods of application in an endeavour to reduce the high initial superphosphate application. Forms tested included lime and serpentine reverted superphosphate, basic slag, and “thermophos”, a fused

calcium-magnesium-silica phosphate. Of these, lime-reverted and serpentine-superphosphate failed to show any superiority over superphosphate, basic slag was slightly superior on an equivalent P basis, while thermophos was markedly superior in all three trials (Cullen and Grigg, 197 lb) (Table 4) .

TABLE 4: COMPARISON OF SUPERPHOSPHATE AND THERMOPHOS DRY MATTER YIELDS (kg/ha)

P (kg/ha)	No Lime		Lime 5,020 (kg J ha)	
	Super	Thermophos	Super	Thermopkos
33	1,190	3,490	1,790	2,690
78	2,920	4,550	3,260	4,380
123	3,630	5,620	3,960	4,690
168	4,040	5,450	4,240	5,030

Mean yields: Superphosphate — 3,120
Thermophos — 4,470

As placement of fertilizer is important on highly phosphate-deficient soils, a study was undertaken of the relative merits of drilling and broadcasting seed and fertilizer. The results (Cullen, 1971b) indicated that drilling was vastly superior to broadcasting. Reverted superphosphate at 376 kg/ha drilled with the seed gave results comparable with 941 kg/ha broadcast, while 941 kg drilled was vastly superior to the same rate broadcast.

Because of the superior results, drilling is recommended on cultivated soils as a means of reducing fertilizer application rates.

Phosphate Maintenance Rates

In one trial where approximately 1,255 (113 P) kg/ha of superphosphate was applied initially, there was little response two years later from applications of more than 54 kg P/ha. This suggests that maintenance dressings of less than 45 kg P/ha would be adequate despite the high P fixing properties of this soil type. Phosphate trials which have not received any fertilizer for 7 years still show marked sward composition differences, indicating a good residual P response.

Sulphur

Sulphur treatments were included in three trials, two on cultivated ground and one on an oversown sward. Responses to sulphur were generally small and were noted mainly in the presence of high phosphate.

P (kg/ha)	Yield Dry Matter (kg/ha) So	S 100 (kg/ha)
67	170	70
201	940	1190

On most occasions sulphur improved grass and clover vigour and also showed frequent interactions with other elements (Cullen and Arnold, 1971) .

Nitrogen

As stated earlier, the Te Anau soil in its unimproved state has a very wide C/N ratio and low available nitrogen status. Consequently newly sown pasture normally exhibits symptoms of extreme nitrogen deficiency and, as expected, marked responses were obtained to nitrogen fertilizers in several trials.

One of these investigated the effect of two rates of nitrogen, 11 kg and 45 kg/ha, applied as nitrolime, at three times-at sowing; two weeks after emergence; and nine weeks after emergence.

At 11 kg/ha, nitrogen enhanced early clover growth but the higher 45 kg rate caused some clover depression when applied at sowing or 2 weeks after emergence. The 45 kg rate applied at sowing or 2 weeks after emergence markedly increased the grass vigour and percentage of the sward but 11 kg showed little effect. There was little response to nitrolime applied 9 weeks after grass emergence.. Despite the marked short-term responses to nitrogenous fertilizers in this trial and the higher grass percentage of the sward in the high N treatment, there was little difference in the appearance of the pasture in any treatment two years after sowing, and good permanent pasture was established without the use of nitrogen (Cullen, 197 lc) .

Nitrogen (51 kg/ha) aided vigour and early establishment of seedling grasses in an oversowing trial, particularly in the absence of vegetation cover (Cullen, 1966), but as with the cultivated pasture nitrogen fertilizers made little difference to ultimate establishment and it was concluded nitrogen was not essential for successful pasture establishment.

However, the extreme nitrogen deficiency was highlighted in two trials in which the response to four rates of N (0, 77, 154 and 309 kg/ha) and 4 rates of P (35, 70, 104 and 207 kg/ha) was investigated on ryegrass and cocksfoot (Table 5).

TABLE 5: RESPONSE OF RYEGRASS AND COCKSFOOT TO RATES OF P AND N

(7 months' growth)

	Ryegrass DM (kg/ha)	*Cocksfoot DM (kg/ha)*
Phosphorus (kg/ha):		
35	690	1,570
70	950	3,580
104	940	2,980
207	1,050	2,890
Nitrogen:		
0	*Negl.*	Negl.
77	940	1,280
154	1,050	2,730
309	1,470	4,260

The production from cocksfoot at the higher nitrogen rates was more than double that of ryegrass.

Dramatic nitrogen responses were noted also on turnips (Table 6) and indicated the importance of sowing nitrogenous fertilizer as well as phosphate with turnip crops on newly developed soils.

TABLE 6: RESPONSE OF TURNIPS TO RATES OF P AND N

(5 months' growth)

	Height (cm)	*Vigour (O-10)*	*DM (kg/ha)*
Phosphorus (kg/ha):			
35	23	5.7	40,390
70	27	5.6	55,700
104	27	5.4	69,500
207	29	5.6	63,470
Nitrogen:			
0	*6*	1.9	5,770
77	21	4.7	59,970
154	39	6.6	79,520
309	44	9.0	83,800

Other Major and Minor Elements

Several trials were conducted on Te Anau soils with various major and minor elements (Cullen and Arnold, 1971). Elements included in one or more trials were calcium, potassium, phosphorus, magnesium, sulphur, manganese, copper, zinc, boron, iron and molybdenum.

Responses to lime, phosphorus and sulphur have already been mentioned. Although responses were noted with potassium, for

lime and molybdenum most were small. Magnesium gave no response, while the trace elements, manganese, iron, boron, zinc and copper, showed occasional responses. Copper significantly depressed growth in several cases and reduced the uptake of iron, phosphorus and other elements, but gave a significant response in white clover in the presence of high sulphur. Boron tended to inhibit responses to other elements.

METHOD OF SOWING PASTURE — SOWING ON CULTIVATED GROUND AND OVERSOWING

The initial development of the Te Anau soils was done by cultivation and sowing on a prepared seedbed. Later, after successful oversowing trials, large areas, particularly of the rougher and steeper areas, were developed by oversowing. This method of development proved highly successful and confirmed earlier trial results (During et al., 1963; Cullen, 1966; Cullen et *al., 1966).* These indicated that an initial application of 750 kg/ha or more of lime-reverted superphosphate was necessary for optimum establishment of oversown clovers and that the best time of sowing was during late winter and early spring. The presence of some fern cover aided establishment, particularly during later spring when it is likely that high clover rhizobia mortality occurred on seeds sown in the absence of cover.

Despite the very slow growth of seedling grasses in the first two years, grass establishment from oversowing was good and the inclusion of grass is recommended in oversowing mixtures. A mixture recommended for oversowing is Huia white clover 4.5 kg, Turoa red clover 2.25 kg, Ruanui ryegrass **11** kg, Apanui cocksfoot 4.5 kg, and Kahu timothy **1** kg/ha.

Although the grasses and particularly ryegrass are not evident to any marked degree for the first year or two, eventually grasses constitute a high percentage of the sward which is difficult to distinguish from one sown on cultivated ground. As mentioned earlier, lime is not necessary but molybdenum is recommended and inoculation of the clovers is essential.

This method is much cheaper than traditional cultivation techniques and offers a practical means of development of the rugged glacial moraines which are too difficult or costly to develop with cultivation equipment.

CONCLUSION

Despite the difficult problems presented by the Te Anau soils, experimental results and large-scale operations by the Lands and

Survey Department have shown that highly productive pastures can be established on Te Anau soils by conventional cultivation and oversowing techniques.

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