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A COMPARISON OF PHOSPHORUS RESPONSES IN PASTURE AND SHEEP, AND EFFECTS OF INCREASED GRAZING PRESSURE IN A DRY SEASON

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SUMMARY

A stock grazing trial to determine responses to rates of superphosphate application and which measures pasture and animal production is described. Wether hoggets are set-stocked and graze permanent pastures. Data from two seasons indicate:

- (1) Linear responses up to the high rate of superphosphate applied (1000 kg/ha).
- (2) Animal measurements may be statistically more sensitive assessments of fertilizer responses than the pasture measuring technique employed.
- (3) High fertilizer applications may minimize adverse effects of increased grazing pressure in seasonally dry conditions

A FERTILIZER STOCKING TRIAL (Otakanini stock grazing trial) is being conducted on 10 hectares adjacent to the Kaipara Harbour, in Northland. The trial area soil type is described as Red Hill/Tangitiki sandy clay complex. Red Hill and Tangitiki soil types are moderately leached semi-mature members of the Pinaki soil suite of which there are 124,000 hectares in Northland.

The major objective of the trial is to determine pasture and animal responses to rates of superphosphate. Further data, including assessments of techniques for stock grazing trials, production responses to rates of stocking, pasture composition changes, and herbage chemical status are being collected. The trial is also serving to indicate some problems of animal health and growth and will assist to estimate optimum fertilizer levels for soils of the district.

This paper presents results from the 1968-9 and 1969-70 seasons.

EXPERIMENTAL

TRIAL DESIGN AND LAYOUT

A 3×3 factorial design (two replications) is used. The factors are:

level of fertilizer — Low (LF), Medium (MF), High (HF)
 stocking rate — Low (LS), Medium (MS), High (HS)

The trial commenced in 1964 on land in permanent pasture which had not been topdressed for the three preceding years. Modifications to the original design have been made to suit management, and to make the best use of the area, as technique and site limitations became evident. Stocking rates and fertilizer applications have been stabilized in recent years and are shown in Table 1.

In the 12 months prior to the 1968-9 year LF plots received no fertilizer, and MF and HF plots received equal applications of about 200 kg superphosphate per hectare.

Stocking rates are altered seasonally on the trial, and the hogget numbers shown in Table 1 are in fact "full-time" sheep and remain on the trial for the whole year. Extra hoggets ("part-time" sheep) are used to control pastures at periods of excessive growth; they are introduced in the spring as extra mouths and simulate cattle, lambs or hay conservation in practice. "Part-time" sheep increased the stocking rates to 35, 40 and 45 per hectare in both 1968-9 and 1969-70. Sheep numbers were increased slightly for the 1969-70 year in anticipation of another good growing season, and to utilize pasture grown, particularly on lighter stocked paddocks.

TABLE 1: TREATMENTS APPLIED IN TWO YEARS OF TRIAL

<i>Treatment</i>	<i>1968-9</i>	<i>1969-70</i>
	<i>Hoggets/ha (ac)</i>	
LS	22 (9)	25 (10)
MS	27 (11)	30 (12)
HS	32 (13)	35 (14)
	<i>Superphosphate (kg/ha)</i>	
LF	125	0
MF	500	500
HF	1000	1000

ANIMALS

Romney wether hoggets chosen for uniformity of type, size and wool in April (beginning of the trial year) at eight months of age are used. These animals are set-stocked on the trial for one year and then replaced. Monthly anthelmintic drenching and regular dipping is adopted.

PRODUCTION PARAMETERS

Monthly weight gains and wool production of animals (shearing, September and April) are recorded.

Pasture growth is measured using the rate of growth technique (Lynch, 1960), which employs two large pasture cages in each paddock. A production cut from every paddock is taken fortnightly after trimming two weeks previously.

PASTURE COMPOSITION

Pasture composition is reasonably uniform and consisted (1968-70) of 35% ryegrass, 40% other grasses, 15% clover, 10% bare ground and weeds. Annual point analyses, taken on permanent transects in every paddock, have shown no significant changes in major pasture components up to July 1969 as a result of any treatments. More recent analyses indicate some increase of ryegrass with higher fertilizer applications.

CLIMATIC CONDITIONS

Temperature and rainfall data recorded at Woodhill Climatological Station some 15 km south-west of the trial area and a similar distance from the west coast are shown in Fig. 1.

The 1968-9 trial year was a good growing season and there were no severe or extended limitations to pasture growth. 1969-70 was considerably drier and somewhat warmer. Monthly rainfall was less in the autumn and winter and again in spring and late summer. It was not considered that the autumn and winter dry spells had a severe effect on pasture production. However, spring and summer dry spells caused a drop in dry matter production.

Temperatures in late spring and summer months of 1969-70 were higher than in 1968-9.

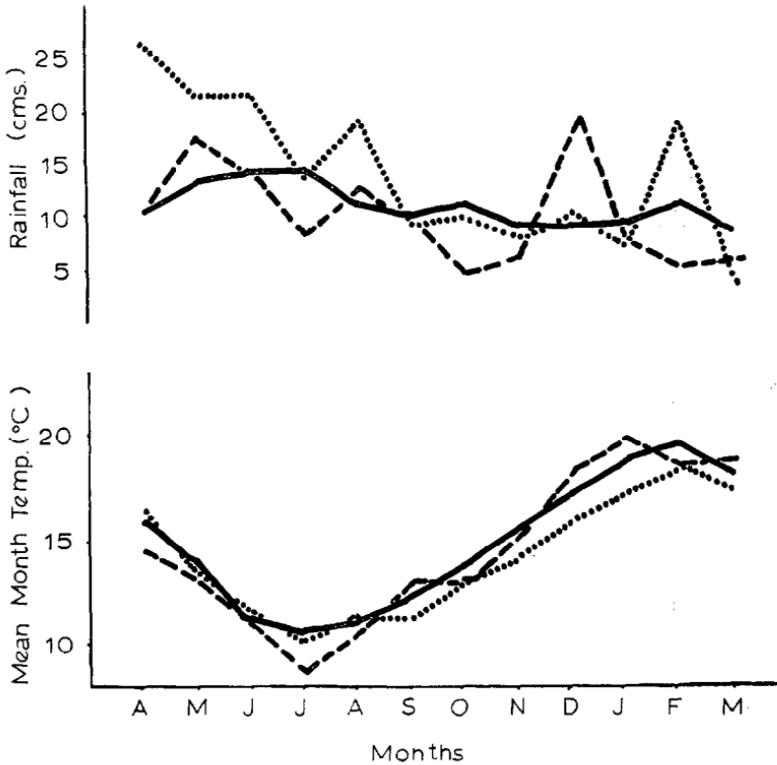


Fig. 1: Monthly mean temperatures and rainfall recorded at Woodhill Climatological Station.

Data for 1968-9 (. . . .), 1969-70 (- - - -) and average of both years (—).

BIOMETRICAL CONSIDERATIONS

The trial has lacked two desirable attributes — insufficient replication (only two replicates of the nine treatments), and lack of homogeneity between paddocks. Results from two paddocks (Nos. 8 and 12) are consistently atypical.

An atypical paddock will distort production figures both for individual treatment and main effect; and the fewer the replicates the greater the relative weight of that paddock on the result. Excluding the data from the two atypical paddocks the remaining seven treatments conform with the thesis that there is practically no fertilizer by stocking rate interaction. There is sufficient evidence

TABLE 2: PASTURE DRY MATTER PRODUCTION (kg/ha)

Fertilizer Rates	1968-9			1968-9		1969-70	
	LS	Stocking Rates MS	HS	All Data	Main Effects (MS deleted)	All Data	Main Effects (MS deleted)
LF	17200	13500	15500	15400 bB	16400 bA	7300 cB	8300 bB
MF	17800	21600	17000	18800 aA	17400 abA	10700 bA	9500 bAB
HF	19800	17200	19000	18700 aA	19400 aA	13200 aA	13900 aA
Main effects	18300 a	17400 a	17100 a	17620	17720	10410	10560
Coeff. of Var. %				6.5	6.7	17.2	17.8

Note: The results of multiple range tests (Duncan, 1955) at the 5% and 1% levels are indicated by small and capital letters after the means, respectively. For each level of significance, means with the same letter do not differ significantly.

TABLE 3: ANIMAL PRODUCTION (kg/animal)

Fertilizer Rates	Liveweight gain				Wool Production			
	1968-9†		1969-70‡		1968-9		1969-70	
	All Data	MS deleted	All Data	MS deleted	All Data	MS deleted	All Data	MS deleted
LF	17 bB	20 bB	5 bB	7 cC	5.4 bB	5.7 bB	4.9 cB	5.2 cC
MF	25 aA	23 bAB	16 aA	14 bB	6.2 aAB	6.0 bAB	6.2 bA	6.0 bB
HF	29 aA	29 aA	20 aA	20 aA	6.7 aA	6.7 aA	6.7 aA	6.7 aA
Coeff. of Var. %	14	11	28	27	8	4.5	5.4	3.4

†Initial weight 24 kg.

‡Initial weight 30 kg.

to reject the data from paddock 8 (MF MS) and paddock 12 (LF MS).

There is a high degree of consistency in all the production figures for both years' data. An example is provided by the analysis of pasture dry matter production (kg/hectare) for the 1968-9 year which is shown in Table 2. The main effects show the expected trends (sizable response to fertilizer, little effect from stocking rates). However, the full 3×3 array appears distorted with LF MS and MF MS out of line.

To justify deletion of the results from the two atypical paddocks the data were also analysed excluding all MS treatments to obtain modified fertilizer main effects (No. of paddocks = 12, error degrees of freedom = 6). The modified main effects (excluding MS treatments) show as extensive but more linear responses to fertilizers. In the following tables of results main effects and modified main effects are presented; truly significant results lie somewhere between these.

The lack of paddock replication poses problems with the analyses of animal production data. There is the opportunity to analyse these data using each animal as a "plot". The disadvantage of this method is that the standard error obtained is a measure of the variation between animals. If all six treatment groups were running together (impossible with this kind of trial), then observed treatment differences could be said to emanate from treatment effects. But when the groups of animals are confined to treated areas, observed treatment differences result both from treatment effects and paddock differences. The latter cannot be estimated.

Analyses of animal production data were made using both the animal as a plot and the paddock as a plot. With the former, all main effects were significantly different ($P < 0.01$) except for the 1968-9 LF and MF wool production ($P < 0.05$). Using paddocks as plots significant differences were obtained at a less stringent level of probability. The means for each analyses are virtually identical. In the following tables the less sensitive analyses, using paddocks as plots are given.

RESULTS

PASTURE PRODUCTION

Table 2 shows data for dry matter production.

The dry conditions prevailing in 1969-70 year reduced pasture production. In both years pasture dry matter was greater on MF than on LF plots. In the 1969-70 year, pas-

ture dry matter production was greater ($P < 0.05$) on HF than on MF plots. In 1968-9 HF treatments produced 3000 kg/ha more pasture dry matter than LF treatments. In the drier 1969/70 year HF treatments produced almost 6000 kg/ha pasture dry matter more than (nearly double) LF treatments.

ANIMAL PRODUCTION

Table 3 shows animal production for the two years.

Liveweight gains and wool weight figures show responses ($P < 0.01$) to the high fertilizer level. In 1968-9 weight gains were 50% better for HF treatments compared with LF treatments, whereas 1969-70 HF treatments produced three to four times as much weight gain and relatively better wool yields.

THE EFFECTS OF INCREASED GRAZING PRESSURE IN A DRY YEAR

In 1969-70, grazing pressure was greater than that prevailing in 1968-9 owing to a reduction in available pasture. This was a result of dry climatic conditions and a slight increase in stocking rates. Table 2 shows that the reduction in pasture production between the two years was less on HF plots than on LF plots. The drought reduced dry matter production by 50% (8000 kg/ha) on LF plots and 30% (5500 kg/ha) on HF plots.

Likewise the reduction in liveweight gains between the two years (Table 3) was less on HF plots (9 kg, 30% reduction) than on LF plots (13 kg, 70% reduction).

The drier 1969-70 season had a less adverse effect on wool than on pasture dry matter production or animal growth rate. LF treatments show a reduction in wool grown in 1969-70 when compared with 1968-9. Wool production for MF and HF treatments was similar for both years and the increased stocking rate in 1969-70 did, in fact, give a slightly better wool production per hectare compared with 1968-9. Coefficients of variation for wool production were very low in both years.

DISCUSSION

This trial conducted on a productive though variable site has shown that at high stocking rates there is a pattern of response to superphosphate applications which suggests that 1000 kg/ha is below the level at which responses cease. Indeed, if it is correct not to consider MS treatments, the response to fertilizer appears linear up to

the highest level applied. It does appear that the high stocking rates adopted demand rates of superphosphate in excess of 1000 kg/ha to optimise animal production.

The rate of growth technique for measuring pasture production appears to be a less sensitive assessment of fertilizer responses than is animal growth and wool production data. This is well shown in the data (MS treatments excluded) for 1969-70. Dry matter production for HF was greater than that for MF ($P < 0.05$) whereas that for MF was not significantly superior to LF. However, both liveweight gain and wool weight data show that the effects of fertilizer are $HF > MF > LF$ ($P < 0.01$). A similar, but less pronounced, indication of the sensitivity of animal measurements is shown in the results for the 1968-9 year. The average wool growth has been practically the same for all fertilizer main effects in both years. This suggests that wool weight alone might be a satisfactory animal measure of fertilizer responses. Pasture measurements assess the total dry matter produced. However, liveweight gain assesses only that component of pasture dry matter consumed which was not used for maintenance. It is concluded that animal measurements — liveweight gain and wool production — are more reliable measures of fertilizer responses than the rate of growth technique measuring pasture dry matter production.

A comparison of fertilizer responses between the good growing year (1968-9) and the following dry year when grazing pressure was increased, shows benefits of high levels of superphosphate applications. The production on HF treatments suffered a smaller reduction in both pasture and animal production compared with LF treatments. The trial results suggest that high fertilizer rates may buffer the effect of seasonal dry conditions.

ACKNOWLEDGEMENTS

Many members of the staff of the Department of Agriculture and the Otakanini Topu Farm Trust have assisted in the conduct, servicing and analyses of the trial. Special thanks are extended to C. A. Farrell, R. H. Lillywhite, E. Berkett, P. B. Lynch and H. Mowbray.

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