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EFFECTS OF LATE-AUTUMN NITROGEN APPLICATION ON HILL COUNTRY PASTURES AND SHEEP PRODUCTION

M.G. LAMBERT and D.A. CLARK
Grasslands Division,
DSIK, Palmerston North

Abstract

Effects of late-May/early June application of fertiliser nitrogen (N) on pasture and animal performance from hill pastures, were measured during 1982-1984 on four 10 ha farmlets at Ballantrae Research Area near Woodville. Two farmlets had a history of high superphosphate (375 kg/ha/year) application and were stocked at 16.1 ewes/ha and two farmlets that received less superphosphate (125 kg/ha/year) were stocked at 12 ewes/ha. Urea was applied at rates equivalent to 3kg N/ewe, or 50 and 37kg N/ha/year respectively on one high fertiliser and one low fertiliser farmlet. Pasture production responses were large and reliable (range of 17 to 34, average of 28kg DM/kg N), and extended through winter into spring. Average legume content of pastures was depressed from 12 to 8% by N application. Ewes were heavier in winter and spring where N was applied, but not at mating in April/May. Lambing performance was similar across farmlets, but weaned lamb liveweight was 14% higher where N was applied. Nitrogen use resulted in 6% greater ewe wool production and 12% greater lamb wool production Profitability of N use would have been enhanced if utilisation of N-boosted pasture had been greater, more responsive stock classes used, or application of superphosphate reduced temporarily.

Keywords: Hill country, North Island, hill pastures, urea, fertiliser nitrogen, sheep production. wool production, lamb production, profitability.

INTRODUCTION

In southern North Island hill country, pasture growth falls short of breeding ewe requirements in winter and early spring, and is in excess of requirements in late spring and early summer (Lambert and Clark 1981). This can result in underfeeding of livestock in winter-early spring, and poor utilisation of herbage in spring-early summer.

Farmers overcome these inequalities by a variety of measures including feed budgeting, specific stock buying and selling policies, and fertiliser application. Hay or silage is sometimes fed, but conservation of surplus feed is generally not practicable.

Traditional application of fertilisers containing phosphorus and sulphur stimulates pasture legumes, and through increased nitrogen (N) fixation increases annual pasture production. However, effects on seasonal pattern of production are not certain (Grant et al. 1973, Lambert et al. 1983). Direct alleviation of N deficiency by fertiliser application has more influence on seasonal production (Field and Ball 1978), and responses in hill country are large and relatively reliable (Ball et al. 1982).

For three years we annually applied fertiliser N on hill country, and measured responses of the pastures and sheep grazing them. Our aim was to stimulate winter pasture productivity: to maintain ewes in good condition through winter and early spring; so as to increase ewe mating liveweights and lambing percentages; and, hence, to increase utilisation of surplus pasture in the late spring-early summer.

METHODS AND MATERIALS

Four 10 ha farmlets within a large-scale grazing trial at Ballantrae Hill Country Research Area near Woodville (Lambert et *al.* 1983) were used. Average annual rainfall is 1280mm, and soils are formed from recent sediments.

When the trial started in 1982, two of the farmlets (LF) had a history of low superphosphate application (1375 kg/ha total), the other two (HF) a history of high superphosphate (4375 kg/ha total) plus lime (3750 kg/ha total) application, since 1973. Urea was applied to one LF (LF(+N)) and to one HF (HF(+N)) farmlet, at rates equivalent to 3kg N per stock unit, on 25.5.82, 6.6.83 and 16.5.84. Treatments are outlined in Table 1.

TABLE 1: Fertiliser Application During 1982-1984, Stocking Rate, and Average Soil Olsen P and pH Status in 1981.

	Superphosphate application (kg/ha/yr)	Nitrogen application (kg/ha/yr)	Stocking rate (su/ha)	Olsen P status ($\mu g/g$)	pH
LF(-N)	125	0	12.0	7	5.1
LF(+N)	125	37	12.0	8	5.1
HF(-N)	375	0	16.1	14	5.6
HF(+N)	375	50	16.1	16	5.7

Pastures were rotationally grazed with Romney breeding ewes, apart from five weeks of set stocking over lambing. Rotation lengths varied from 15 days in spring to 60 days in winter.

Ewes were mated during April-early May. Lambs were weaned and removed from farmlets in mid-January, apart from on the +N farmlets in the second year, when they were weaned in mid-February.

Pasture production was measured using grazing exclosures and a trim technique. Legume contribution was determined by hand separation of herbage samples. Response, of pastures to applied N was calculated from differences in winter and spring pasture production between -N and +N farmlets.

Ewe and lamb liveweights and wool yields were measured. Results of animal measurements for the first two yearsonly are presented, as effects of N application on animal performance were confounded with additional treatments (+N ewes were treated with fecundin and the stocking rate on one farmlet was changed) in the third year.

Statistical significance of effects of N application on pasture production was determined by analysis of variance of results from the larger trial of which the trial described here was a part.

TABLE 2: Average Pasture Production During 1982-1984.

		LF (-N)	LF (+N)	HF (-N)	HF (+N)	SIG.[1]
Annual pasture production: (kg DM/ha)		9520	10900	11900	13390	**
Pasture productivity: (kg DM/ha/d)	[2]Summer	39.2	39.0	48.6	48.3	ns
	Autumn	18.5	22.1	23.3	25.8	*
	Winter	11.5	17.0	15.7	24.8	**
	Spring	35.6	41.6	43.2	48.1	*

[1] Significance of difference between +N and -N. * = $P<0.05$, ** = $P<0.01$, ns — not significant
[2] Three-month seasons. Summer = December, January, February.

TABLE 3: Efficiency of Nitrogen Use (kg Pasture DM/kg N Applied).

	1982	1983	1984	Average
LF	20	33	34	29
HF	17	31	30	26

RESULTS

Nitrogen application increased annual pasture production, mainly as a consequence of increased winter and spring growth rates (Table 2). A small response also occurred in autumn, but summer growth rates of +N and -N areas were similar. Efficiency of use of fertiliser N ranged from 17 to 34kg DM/kg N applied over the three years and averaged 28 (Table 3). Legume contribution was less in pastures where N had been applied (Table 4), both as a consequence of dilution by increased grass growth, and of reduced legume growth.

Ewes were heavier during winter, and after lambing, as a result of N application (Table 5), but average liveweights at mating were similar. Average lambing percentages were also similar across treatments (99 to 104%), so the advantage in lamb production from the +N farmlets was mainly a result of higher weaning liveweight.

Ewe wool production was greater from +N farmlets at first shearing in November, and less at second shearing in March (Table 5). However, total ewe wool production was greatest on +N farmlets. More lamb wool was produced on +N than -N farmlets (Table 5).

TABLE 4: Legume Response (Averaged Over 1982-1984) to Nitrogen Application.

	LF		HF	
	(-N)	(+N)	(-N)	(+N)
Legume Contribution: %	11.0	8.1	13.6	8.7
Legume Production: (kg DM/ha/a)	970	790	1518	1087
Change in Legume Production:		-19%		-28%

TABLE 5: Ewe Liveweights, Lamb Production, and Wool Production. Average for 1982/83 and 1983/84.

	LF		HF		S.E.M
	(-N)	(+N)	(-N)	(+N)	
Ewe Liveweight (kg)					
Prelamb (July/August)	51.8	54.3	48.8	53.1	1.0
Postlamb (October/November)	48.9	53.8	48.0	53.9	1.1
Mating (April/May)	51.2	51.6	50.2	50.9	1.2
Weaned Lamb Liveweight (kg/ha)	277	323	383	428	
Difference		+46		+45	
Ewe Wool Production (kg/ha)					
1st Shear	27.6	34.1	38.0	48.4	
2nd Shear	28.2	24.9	37 8	32.6	
Total	55.8	59.0	75.8	81.0	
Difference		+3.2		+5.2	
Lamb Wool Production (kg/ha)	11.0	13.8	16.9	17.5	
Difference		+2.8		+0.6	

DISCUSSION

Pastures

Urea application changed the pattern of seasonal pasture production by increasing winter and spring growth rates. The small response in autumn occurred in each of the three years, but was statistically significant ($P< 0.1$) only in the first year ($P<0.01$) prior to the first annual appliation of urea. During summer, growth rates of +N and -N pastures were similar.

Responses to fertiliser N were relatively large, as is to be expected for soils with intense N deficiency (Ball and Field 1982, Ball et al. 1982). The responses occurred over a relatively long period, probably because of moderate initial responses (16kg DM/kg N) over winter, and strong retention of N by hill soils with wide C:N ratios (average 14:1), enabling a residual spring response (12kg DM/kg N) to occur (Ball et al. 1982).

Nitrogen application reduced the proportion of legumes in the pastures, as has been noted by others (O'Connor 1982). Herbage mass was 16% higher in +N than in -N pastures (Clark unpubl.) which may have decreased the competitiveness of legumes because of shading by grasses However, Luscombe and Fletcher (1982) found that even in short-grazed pastures, legume performance was less where fertiliser N was applied.

Animals

Liveweight of ewes grazing +N pastures was considerably greater than that of ewes on -N pastures during June to December, because of higher pasture growth rates and hence greater animal intake. First-shear wool production was 25% greater, lamb wool production 12% greater, and weaning liveweight of lambs 14% greater.

During the remainder of the year (mid-summer to autumn) ewe liveweights were similar in +N and -N farmlets. Because liveweights were not different at mating, and as nutritional stress at lambing was not severe enough in any treatment to greatly increase lamb mortality, lambing performances did not differ across treatments.

Reasons for the failure of the +N ewes to maintain their previous weight advantage during mid-summer to autumn, and for lowered (by 13%) second-shear wool production, are not certain. Herbage mass to ground level, although higher in +N farmlets, was generally above 2000kg DM/ha in all farmlets so was probably not limiting intake at this time of the year. The -N ewes may have made compensatory growth, or they may have been able to select a more nutritious diet because of higher legume (Table 4) or lower dead matter content in pastures, or because herbage was younger.

Economics

We calculated profitability of N application using the following costs and net returns: urea purchase -- $485/t; urea cartage $30/t; urea application -- $12/ha; ewe wool return -- $3.50/kg; lamb wool return — $4.20/kg; lamb liveweight return -- $0.75/kg.

Using these values, net returns exceeded costs by $4/ha for LF (+N), but were less by $13/ha for HF (+N). Profitability could be increased on commercial farms, which do not have experimental constraints, by a number of strategies:

(1) Nitrogen-boosted pasture could be fed to more responsive (and profitable) classes of stock, e.g. hoggets or young cattle. A plentiful supply of winter feed enables bought-in stock to be purchased earlier, at a lower price, hence increasing profit margins.

(2) Winter stocking rates on treated areas could be increased. Utilisation of N-boosted pasture was relatively poor, so a greater stocking rate would ensure that pasture was grazed while quality was high, and that subsequent pasture growth was not reduced because of under-grazing.

(3) Application of phosphatic fertiliser could be temporarily reduced and consequent savings offset against cost of N application.

CONCLUSIONS

Late-autumn/early-winter application of urea to moist hill country gave large, reliable and protracted responses in pasture growth rate. These responses greatly modified seasonal pattern of pasture production, thereby overcoming one of the greatest limitations to efficiency of pastoral hill farming. Increased pasture production resulted in greater wool and lamb production.

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