The effects of combinations of surface-applied lime and superphosphate on perennial pasture

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ABSTRACT

Factorial combinations of lime and superphosphate were broadcast onto small plots at two farms in south-western Victoria. At Nareen, where soil aluminium was high (82 mg/kg), there were increases in DM production and perennial ryegrass content as lime rates increased. High acidity has not been previously identified as a major constraint to perennial ryegrass production in this region. At Branxholme, where aluminium was less (26 mg/kg), DM production was affected by an interaction between lime and superphosphate only in one year and subterranean clover was reduced during the experiment.

KEY WORDS

Phosphorus, soil pH, botanical composition, pasture growth.

INTRODUCTION

Lime x phosphorus (P) interactions have been investigated in many glasshouse and laboratory studies (4), but little field research has been conducted (5) and results should not be extrapolated between regions in Australia. Woolgrowers in south-western Victoria need more information on which to base decisions on appropriate combinations of lime and phosphorus to apply, especially as soil acidity is increasing (1). To better understand these issues, field research to examine changes in soil chemistry, pasture growth and composition, and animal production is warranted in this region.

MATERIALS AND METHODS

Factorial combinations of lime (0, 2.5, 5 and 10 t/ha) and phosphorus (0, 5, 10, 20, 40 and 80 kg/ha) were applied to 10 m^2 plots at Nareen and Branxholme in 1997. These complemented a larger, adjacent grazing experiment at each farm and were located within one of the control plots in the grazing experiment. There were two replicates of each treatment. Lime was applied only once but the superphosphate was applied at the same rates each autumn.

Pasture DM production was measured using a rotary mower at 5 to 7-week intervals. The experimental area was not grazed but dung return was simulated by returning 50% of the clippings from either side of the sampled strip. Cumulative herbage yields for each growing season were analysed using ANOVA in Genstat 5.41.

The botanical composition of the pasture was measured in mid-October each year using the botanal technique with 10 random quadrats (each $0.1m^2$) per plot. Data for perennial ryegrass, subterranean clover, fog grass and broadleaf weeds were statistically analysed by ANOVA.

RESULTS AND DISCUSSION

Before treatments were applied, the soil pH ($CaCl_2$, 0-10 cm) at both sites was 4.4 and the exchangeable aluminium (Al) at Nareen and Branxholme was 82 and 26 mg/kg, respectively. Some changes in soil chemistry and sheep production at the two sites have been reported (2, 6, 7).

At Nareen, lime applied at 2.5 t/ha increased pasture production each year when compared with the control (Table 1), but there was little extra pasture growth at lime rates above this. There was an increase in dry matter production, due to superphosphate, only in 1999 at Nareen (Table 2).

Table 1. Annual herbage production (t DM/ha) for lime treatments at Nareen over 3 years.

Year	Lime application rate (t/ha)				l.s.d. (*P*=0.05)
	0	2.5	5.0	10	
1997	3.90	4.64	4.95	5.00	0.49
1998	7.67	8.44	9.11	9.06	0.56
1999	4.83	5.33	5.00	4.87	0.36

Table 2. Annual herbage production (t DM/ha) for superphosphate treatments at Nareen in 1999.

Phosphorus (kg/ha)						
0	5	10	20	40	80	l.s.d. (*P*=0.05)
4.72	4.71	4.95	5.28	5.30	5.10	0.44

In 1997 and 1999 there was no increase in annual herbage production at Branxholme in response to any treatment. In 1998, where no lime was applied, there was an increasing amount of DM produced as superphosphate rate increased (Table 3). However, responses to superphosphate tended to diminish as lime rates increased. Hydroxy-Al-polymers could have resulted from high rates of lime and these have potential to adsorb applied phosphate (3). When superphosphate rate was below 10 kg/ha of P, there were significant increases in pasture production in response to lime application.

Table 3. Annual herbage production (t DM/ha) for each treatment at Branxholme in 1998.

Lime (t/ha)	Phosphorus (kg/ha)					
	0	5	10	20	40	80
0	7.14	8.22	9.31	9.88	10.03	10.04
2.5	8.11	8.85	8.81	8.94	9.60	8.90
5.0	8.33	8.59	9.13	8.96	8.52	8.98
10.0	8.60	9.02	8.93	8.88	8.39	8.50

There were significant differences in clover content of pasture at Nareen in 1998 but there were no clear trends as application rates of lime or superphosphate increased. There was less clover at 80 kg/ha P compared with all other P levels, but no other difference between levels. In 1999, there was a weak trend for clover content to decline as lime application rate increased (Table 4), but contents were generally low that year. In 1998 and 1999 there were substantial increases in perennial ryegrass content as lime rates increased (Table 4). Liming reduced fog grass content in 1998. In 1997 there was less subterranean clover at Branxholme after 10 t/ha lime (14%), than with no lime (22%). In 1998, plots with rates of P higher than 10 kg/ha had less clover (37 to 18%) than plots with no P (47%).

Table 4. Changes in botanical composition in response to lime application at Nareen. Arcsine-transformed means are given in parentheses.

Species and year	Lime (t/ha)				Arcsine l.s.d.
	0	2.5	5.0	10	(*P*=0.05)
Sub. clover 1998	24 (29)	38 (38)	27 (31)	16 (23)	5.1
Sub. clover 1999	9 (16)	10 (17)	5 (12)	3 (8)	6.1
Perennial ryegrass 1998	15 (28)	26 (34)	38 (41)	54 (51)	6.4
Perennial ryegrass 1999	25 (21)	32 (30)	43 (37)	60 (47)	8.2
Fog grass 1998	32 (31)	19 (26)	21 (26)	18 (24)	7.0

CONCLUSION

The responses to lime and phosphorus varied depending on site, most likely due to the difference in soil Al concentration. The critical Al concentrations for ryegrass-based pasture should be examined in more detail within this region. At Nareen, where there was the highest Al, the perennial ryegrass content in the pasture increased continually up to a lime rate of 10 t/ha, indicating that soil acidity has potential to considerably constrain production by this desirable species.

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