Effects of phosphate fertiliser and perennial pastures on sheep production in northern Victoria

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ABSTRACT

A grazing experiment was established to investigate effects of phosphate fertiliser with annual or perennial based pastures on sheep production in a 460 mm rainfall area at Wedderburn in north central Victoria. The experiment compared low (75 kg/ha of superphosphate every second year) and high (150 kg/ha of superphosphate annually) fertiliser treatments with both annual and perennial (phalaris / cocksfoot based) pastures. The sheep enterprise was late winter lambing merino ewes. Sheep numbers were changed to match pasture growth and availability. Average pasture growth in 1998 and 1999 was 6050 kg DM/ha and 7090 kg DM/ha on low and high phosphate plots respectively. Annual pastures averaged 6160 kg DM/ha while perennial pastures averaged 6980 kg DM/ha. Both high fertiliser rates and perennial pastures carried more sheep. Fertiliser and pasture type had no significant effects on ewe weight or lamb growth rates. The phalaris had no effect on the percentage of sub clover but led to significant reductions in silver grass and capeweed.

KEY WORDS

Sheep, stocking rate, pasture, phalaris, superphosphate.

INTRODUCTION

Experiments at Hamilton in South West Victoria have indicated the value of improved pastures with adequate phosphate fertilisers (2). They have indicated that even with present wool prices gross margins per hectare can be increased by 50% to 150%. An integrated grazing study (South-West Sheep Pasture Productivity Project) was conducted on 5 farms in western Victoria. A package of management practices was applied including resowing new pasture cultivars, applying appropriate fertilisers, increasing stocking rates and changing lambing times to fully utilise feed grown. Results show that sustainable stocking rates can be increased by 50-125% (5-8 ewes/ha) and gross margins by $40-75/ha (6). Improved grazing management and productive sheep genotypes offer further scope to lift productivity.

In contrast, several past experiments in northern Victoria (Ruffy, Mia Mia) have indicated that higher levels of phosphorus increased the wool production of wethers by a relatively small amount (1,7). Thus, there is some doubt in northern Victoria about the value of higher inputs of fertiliser compared to normal farmer practice. Consequently a field site was established in north central Victoria, where little superphosphate was being applied to pastures.

The aim of the project was to determine, for merino ewe flocks in northern Victoria, the effects of increased fertiliser application (over and above current district practices) on the profitability on typical pastures based on annual grasses and subterranean clover or pastures based on subterranean clover and perennial grasses.

METHOD

The experiment was established on a farm 15 km south-west of Wedderburn (36?40'S, 143?15'E; mean annual rainfall 460 mm). The soil was a fine sandy clay loam and yellowish greyish brown in colour with a pH (H_2O) of 5.7 to 6.1. The site was cropped in 1993 to oats and sown to pasture in 1994. The site was resown in 1995 by direct drilling with narrow points because establishment of pasture was poor in 1994 due to drought.

The experiment comprised of 8 paddocks, each of 6 ha. Two fertiliser treatments were compared in factorial combination with 2 pasture treatments in a completely randomised design with 2 replications. Data was analysed using Analyses of Variance. Treatment means were compared using Fisher's unrestricted LSD. The fertiliser treatments were 75 kg/ha of superphosphate every second year (low) and 150 kg/ha of superphosphate annually (high). Two types of pasture were sown: a mixture of 5 kg/ha of Seaton Park and 5 kg/ha of Trikkala subterranean clover (annual), and the same clover mixture together with 2 kg/ha Sirosa phalaris and 1 kg/ha Porto cocksfoot (perennial).

Sheep were first introduced to the plots on 5 August 1996. The herbage mass as dry matter (DM) per hectare was monitored regularly, especially in late autumn and winter. This information was used to make periodic adjustments to the stocking rate of individual plots, the objective being to have a similar herbage mass on each plot in autumn and winter. A review of stocking rate each February also sought a similar percentage pasture utilisation after an allowance of 1.5 t DM/ha for dead carryover feed over the summer. Further adjustments were made until mid July, just prior to lambing. Sheep were removed from the plots when herbage mass fell to 500 kg DM/ha. In 1996 we used merino ewes joined to merino rams. In subsequent years merino ewes were joined to Dorset rams in order to produce prime lambs.

Fertiliser was applied in March each year using a modified seed drill to ensure its even application. Shearing was in the last week of June or early July. Wool weights were adjusted to reflect 365 days of growth. Joining started about 20 February each year and lasted for 5 weeks.

Measurements taken included pasture growth rates (cage method), herbage mass (both Hamiltion weighted disk pasture meter and visual ranking methods), pasture composition, sheep and lamb live weights, lambing percentage, greasy fleece weight and the yield, fibre diameter, staple length and strength of the wool. Soil samples (30 cores per plot) were taken to a depth of 10cm in October and February in order to monitor the phosphorus (P) status of the plots. For the statistical analysis of data for year 1 and subsequently, the Olsen P in year 0 (before treatments started) was used as a covariate.

RESULTS AND DISCUSSION

Soil Olsen P

Changes in Olsen P with time are shown in Figure 1. Each point on the graph is the mean of the 2 samplings made each year. There is no easy explanation for the apparent decline in Olsen P after the early samplings and the later annual applications of fertiliser. At the conclusion of the experiment samples held in archive will be analysed to further investigate the apparent decline in soil Olsen P.

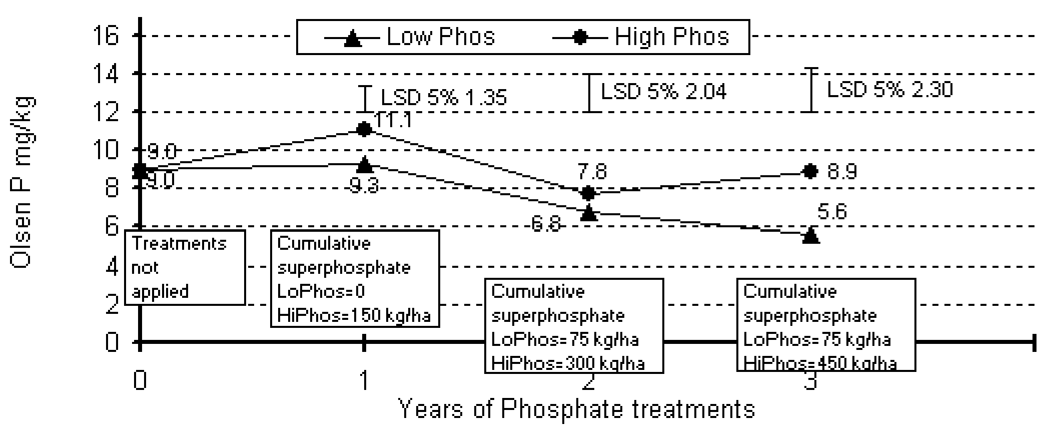


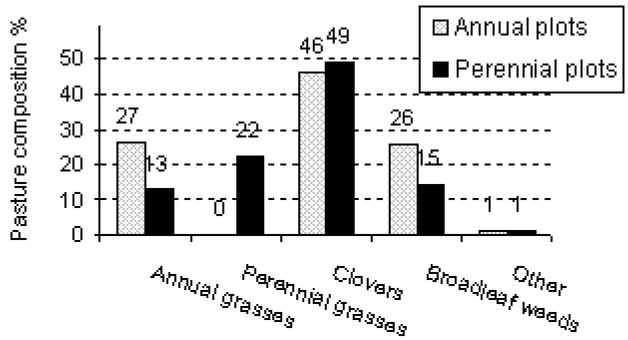
Figure 1. Olsen P soil test (0-10cm) over time.

Pasture production and composition

The pasture production in the later years of the experiment was greater for both the high fertiliser and the perennial pasture treatments (Table 1). Insignificant or small differences in pasture production in the early years of P fertiliser experiments have been observed elsewhere. The perennial component had little effect on total year productivity early in the experiment but the difference between annual and perennial treatments approached statistical significance in 1999. The analysis of variance indicated no interactions between fertiliser and pasture type in pasture production or composition, pasture results are thus assumed to be additive and presented as main effects. Average pasture growth in 1998 and 1999 was 6050 kg DM/ha and 7090 kg DM/ha on low and high phosphate plots respectively. Annual pastures averaged 6160 kg DM/ha while perennial pastures averaged 6980 kg DM/ha. Further seasonal analyses revealed significant autumn - winter productivity differences in 1999 (annuals 3090 kg, perennials 3670 P=0.04). Measurements of the ground cover of perennial grasses in a series of 10?10 cm grids during the course of the experiment showed an increase from 21% to 44% in the frequency of rooted tillers. The perennials comprised 95% phalaris and 5% cocksfoot. This increase in perennial vigour, even under set stocking had substantial benefits on pasture composition (Figure 2). Perennials had no effect on the percentage of subterranean clover in the pasture but significantly reduced the proportion of annual grasses (mainly silver grass and barley grass) and broadleaf weeds (*Erodium* species and capeweed). High stocking rates can lower pasture production (2), but the lack of differences between low stocking and medium stocking rates at Hamilton (2) indicate that this effect may be small if pastures are managed to ensure a similar green herbage mass in autumn and winter.

Table 1. Main effects of fertiliser and pasture type on annual pasture production (kg DM/ha).

	Fertiliser (Fe)			Pasture (Pa)			Fe and Pa	sig. of
			sig. of F			sig. of F	L.S.D.	Fe?Pa
Year	Low	High	(*P*)	Annual	Perennial	(*P*)	*P*=0.05	(*P*)
1996	3780	4260	0.33	3760	4280	0.30	1150	0.49
1997	3910	4390	0.24	4280	4020	0.50	927	0.34
1998	5890	6990	0.03	6110	6770	0.14	958	0.14
1999	6210	7186	0.08	6200	7190	0.08	1140	0.99



LSD Sig.of F
(P=0.05) ratio (P)

Annual grasses 5.5% <.001
Perennial grasses
Clovers 9.4% 0.59
Broadleaf weeds 6.4% 0.002
Other 1.2% 0.88

Figure 2. Effect of pasture type on pasture composition, average of 1997, 1998 and 1999

Stocking rate and sheep performance

Sheep numbers were progressively increased on all treatments during the course of the experiment, Figure 3. In 1996 and 1997 pastures were in a build up phase after several years of cropping. Pasture seed reserves were depleted and the ground cover of the newly sown perennial pasture was increasing. The increases in pasture productivity and stocking rates resulted in the increased wool and lamb production per hectare shown in Table 2. Sheep bodyweights in 1998 and 1999 were in the range of 48 to 59 kg (fleece free) and lamb growth rates were between 280 and 320 g/day. Ewe fat scores were generally in the range of 3 to 4. There were no significant effects of fertiliser or pasture type on ewe bodyweight per head in any year; either during the growing season (April to November) or when pastures were dry (November to March). Neither fertiliser nor pasture type affected lamb weight gain per head or per head characters of wool weight, fibre diameter, tensile strength or staple length. This was due to the adjustments of stocking rate, which resulted in a similar green herbage mass in the plots. It is possible that increases in pasture quality associated with P fertiliser (6) may have lead to increased live weight gains as experienced elsewhere (5), but this did not occur within the range of conditions in this experiment.

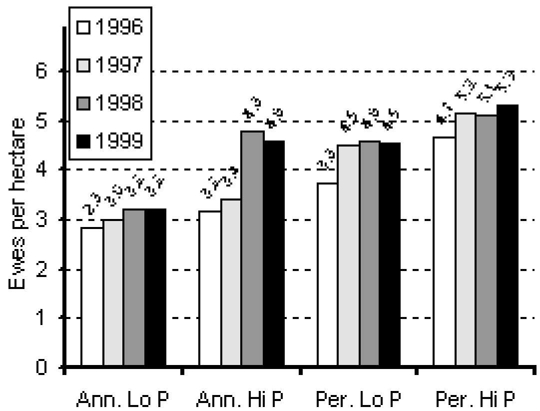
Associated test strips

Only 2 fertiliser treatments were compared in this experiment. The resources available for this grazing experiment influenced its design with the result that some coefficients of variation were large. This is insufficient to describe responses to fertiliser in terms that can be used for modelling. Four sets of associated fertiliser test strips were therefore established within the experiment. The difference between pasture yields with no fertiliser and asymptotic yields with fertiliser rates of 40kg and 80 kg of P indicated potential increases in pasture yield of the high fertiliser treatments of between 20 and 40%. These aspects of the experiment will be further investigated with the GrassGro decision support tool (4).

Table 2. Effect of pasture type and fertiliser on wool (kg/ha greasy) and weight of lamb weaned (kg/ha fleece free) in 1998 and 1999.

					sig. of	sig. of	sig. of	Fe and Pa	Fe x Pa
	Annual		Perennial		Fertiliser (Fe)	Pasture (Pa)	Fe?Pa	L.S.D.	L.S.D.
Year	Low	High	Low	High	(*P*)	(*P*)	(*P*)	P=0.05	P=0.05

Wool 1998	17.5	22.1	27.8	30.0	0.35	0.045	0.72	8.8	12.5
Wool 1999	21.6	32.2	31.4	37.4	0.021	0.030	0.33	6.1	8.6
Lamb 1998	104	153	141	185	0.22	0.33	0.93	86	122
Lamb 1999	123	160	173	207	0.013	0.004	0.87	23	32



	sig. of Fe (*P*)	sig. of Pa (*P*)	sig. of Fe?Pa (*P*)	$LSD_{0.05}$ Fe?Pa Ewes/ha
Aug96-Mar97	0.38	0.11	0.64	1.54
Apr97-Mar98	0.40	0.046	0.85	2.33
Apr98-Mar99	0.065	0.11	0.28	1.63
Apr99-Mar00	0.010	0.012	0.27	0.91

Figure 3. Effect of pasture type and fertiliser on ewe numbers.

Implications for the sheep industry

The results obtained here comparing moderately fertile systems found on many well managed farms with highly fertile systems, and are similar to findings in south western Victoria (2,5), where highly fertile grazing systems are capable of carrying high stock numbers. Results in this experiment from the sale of the wool and prime lambs with standard industry costs suggest a gross margin of \$170 per hectare for the high fertility perennial pasture systems and a gross margin of \$125 per hectare for the low P annual pasture system. Gross margins of flocks with district average stocking rates and medium wool production are estimated to be \$50 per hectare. Our results have shown that on this site, with a history of moderate fertiliser use, it was possible to substantially increase productivity using a combination of phalaris-based pastures, more fertiliser and appropriate stocking rates. The herbage mass of dead pasture generally declined from 3.2 t DM /ha in mid November to 600 kg DM /ha by early April. Pasture utilisation estimates using the grazed decision support (3) indicated that approximately 20% of this feed might be eaten by stock. It is also likely that this system of pasture production and utilisation with winter-lambing ewes will be capable of supporting higher stocking rates than autumn lambing flocks or self replacing flocks where the demand for feed by sheep is higher in autumn and early winter.

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