Proceedings of the New Zealand Grassland Association 54: 167-170 (1992)

Phosphorus in herbage grasses - prospects of reducing fertiliserphosphate requirements

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Abstract

Previously published results show that herbage grasses vary in the severity with which they compete with white clover (*Trifolium repens*) for soil phosphorus. It is argued that grasses such as 'Grasslands Matua' prairie grass (*Bromus willdenowii*) with lower herbage phosphorus concentrations than ryegrass, will maintain better productivity and clover contents in the sward as phosphate fertiliser rates are reduced, than a comparable ryegrass sward. Apart from prairie grass, there seems to be little variation in herbage phosphorus levels in current 'Grasslands' forage grasses and screening for reduced levels is advocated.

Keywords *Bromus willdenowii*, competition, cultivars, grasses, herbage, *Lolium perenne* phosphate, phosphorus, superphosphate.

Introduction

Grasses vary in the severity of the competition for P that they impose on white clover (*Trifolium repens*) (Mouat & Walker 1959) with ryegrass (*Laliumperenne*) being a less severe competitor than browntop (*Agrostis capillaris*) (Mouat 1983). Ryegrass still competes very strongly with clover for P (Jackman & Mouat 1972) causing an important inefficiency in the grass-clover association - large amounts of phosphate have to be used, in part because the demands of the grass must be met before the needs of the clovers can be satisfied (Jackman & Mouat 1970).

Phosphate fertiliser recommendations for New Zealand pastures are usually based on a wide range of soil, animal and agronomic factors (Comforth & Sinclair 1984; Metherell & Morrison 1984). Different pasture species are acknowledged to contribute to the risk of trace element deficiency in stock and both cocksfoot (*Dactylis glomerata*) and timothy (*Phleum pratense*) pastures are thought to carry some risk of being low in phosphorus (Whitehead 1966; Comforth 1984). Although MAF fertiliser recommendations distinguish between pasture and luceme, variation in the cultivars sown in a mixed sward is not taken into account when fertiliser rates are calculated.

Most published New Zealand data on the mineral content of pasture herbage refer to ryegrass and white clover because these plants have traditionally dominated in pasture seeds mixtures. More recently a wider range of cultivars has been sown but there are little data available on the mineral composition of these alternative species. Exceptions are 'Grasslanda Puna' chicory (*Cichorium intybus*) (Crush & Evans 1990) and 'Grasslands Matua' prairie grass (*Bromus willdenowii*) (Crush et al. 1989).

This report discusses the prospects for improved fertiliser economy through use of herbage species other than ryegrass

Prairie grass pasture in the Manawatu

The pastures which were sampled monthly, were 1.62 ha, 8 paddock self-contained farmlets stocked at 7.4 Friesian bulls/ha. Details of the soils, management, pasture yields and botanical composition, herbage chemical composition and meat yields are given by Rijkse & Daly (1972), Brougham *et al.* (1975), Crush *et al.* (1989) and Cosgrove & Brougham (1988).

The prairie grass pastures grew a little more DM than the ryegrass pastures but had very similar clover content and total herbage phosphorus (P) content (Table 1). However clover in the prairie pasture contained a substantially greater proportion of the total herbage P than did the clover in the ryegrass pasture.

Table 1 Dry matter and herbage phosphorus yields and clover herbage phosphorus for ryegrass and prairie grass pastures in the Manawatu. Data from Crush et al. (1989).

	Ryegrass pasture	Prairie grass pasture
kg DM/ha/yr	12840	13660
% clover in DM	13.7	15.5
kg herbage P/ha/yr	37.8	35.1
Clover herbage P (as % of herbage P)	13.7	22.9

In these pastures, prsirie grass had an average herbage P concentration of 0.24% compared with 0.28% for the ryegrass (difference significant $p<0.01$). Because less P was required to satisfy the requirements for prairie grass shoot growth, clovers were presumably able to compete more effectively for the pool of available P. The experiment was on a fertile Kairanga soil with a long history of high (250 kg/ha/yr) super-phosphate applications. The data and theoretical considerations (Mouat & Walker 1959; Jackman & Mouat 1972), suggest that at lower superphosphate application rates a prairie grass pasture should maintain its clover content and productivity better than a ryegrass pasture would. This should be tested experimentally.

Phosphorus concentrations in grass cultivars

There is a paucity of data allowing strict comparison of the P concentration in ryegrass and alternative herbage grasses. The best available data comes from experiments established in the Waikato and Manawatu to determine pasture species preferences of horses and deer (Hunt *et* al. 1989; Hunt & Hay 1990). Four replicates of each of 16 grasses, herbs and legumes were sown at three locations during September 1987 in 7 m x 7 m plots. Herbage samples were collected on nine occasions over 19 months and analysed. The P content of herbage for each grass was compared with that in high enclophyte Nui at the same site (Table 2). Of the ryegrasses. only 'Grasslands Moats' (*L. multiflorum*) on the Te Arakura soil contained significantly less P than high endophyte Nui at the same site. Roa tall fescue (*Festuca arundinacea*) and Wana cocksfoot were similar to Nui but Kara cocksfoot had a significantly lower P concentration on the Te Arakura soil. Clough (1990) found that Wana had a higher P requirement than Yatsynryegrass. At two sites Matua prairie grass was lower in P than Nui ryegrass, but contrary to expectations (Whitehead 1966; Cornforth 1984) Kahu timothy was relatively high in P.

The results confirm that Matua prairie grass has lower tissue P concentrations than ryegrass and suggest that Kara cocksfoot may be worth further investigation. None of the other cultivars offer any immediate prospect for reducing P stress on clovers in mixed swards.

Lack of variationbetween these cultivars in herbage P concentration may result from the use of relatively fertile soils during the selection of parent plants. However, as pointed out by Campbell (1990), New Zealand pasture cultivsrs display a narrow, closely related set of ecological traits. Perhaps the surprising result is that Matua prairie grass diifers so much, in terms of P content, from the other cultivars.

Discussion

The data and other results in the literature indicate a high probability that prairie grass-white clover pastures should maintain production with lower P inputs than equivalent ryegrass-clover pasture. This has not yet been proven experimentally but farmers seeking to reduce fertiliser costs could consider a progressive reduction in super-

Table 2 Average percent phosphorus in DM far 9 grasses in three grazed experiments. Value asterisked differ significantly from the P concentration of the high endophyte Nui grown at the same site.

Cultivar	Matamata Tlrau soil Horses	Walton Tlrau soil Deer	Palmerston North Te Arakura soil Horses
Nul perennial ryegrass (high endophyte)	0.30 ± 0.01	0.36 ± 0.03	0.32 ± 0.02
Nul perennial ryegrass (low endophyte)	0.20 ± 0.01	0.36 ± 0.03	0.31 ± 0.02
Greenstone hybrid ryegrass	0.32 ± 0.01	0.36 ± 0.03	0.31 ± 0.02
Moata Italian ryegrass	0.32 ± 0.02	0.36 ± 0.02	0.27 ± 0.01"'
Kahu timothy	0.37 ± 0.02**	0.36 ± 0.03	0.34 ± 0.02
Roa tall fescue	0.28 ± 0.01	0.39 ± 0.03	0.31 ± 0.02
Wana cocksfoot	Not sown	0.34 ± 0.02	Not sown
Kara cocksfoot	0.29 ± 0.01	Not sown	0.28 ± 0.02***
Matua prairie grass	0.27 ± 0.02"'	0.34 ± 0.02	0.27 ± 0.02"'

phosphate application rates for Matua prairie grass paddocks. There was a narrow range of P contents demonstrated by the cultivars *other than* Matua. However the experimental sites were all on well fertilised. fertile soils and herbage P contents may have varied more at lower levels of available P. Kahu timothy had relatively high herbage P levels which contrasted with overseas results for this species that usually show it containing leas P than ryegrass (Whitehead 1966). Timothy may accumulate P when it is available, despite its apparent ability to *grow* with a low tissue P level. It could therefore be quite a severe competitor for P with white clover in *mixed* swards.

Heritable genotypic variation in shoot P concentration occurs in hybrid ryegrass (Butler et al. 1962; Ball 1966) but only recently have attempts been made to screen ryegrass for variation in P content as part of a plant improvement programme (H.S. Easton pers. comm.). Screening wheat for maximum yield under limited phosphate supply has resulted in high-yielding Australian varieties with lower P contents (Lipsett 1964). Similar results should be achievable with forage grasses and a useful first step would be to screen for DM yield on moderate to low P soils.

Phosphorus requirements of grazing animals vary between classes of stock and with their reproductive phase. Responses to P supplements in sheep and cattle are almost unknown in New Zealand (Grace 1983) but for lactating cows there is a possibility that some pastures containing less than 0.3% P in DM may not be providing optimum amounts of P for maximum milk yields. There seems to be considerable scope for lowering the P content of grass herbage in the sheep industry without compromising animal Performance. In the dairy industry there may be less potential to reduce fertiliser requirements through new herbage grasses with lower P contents. However dairying is uniquely suited to diet supplementation techniques which may be used to compensate for sub-optimal P in pasture.

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