Proceedings of the New Zealand Grassland Association 51: 167-I 70 (1990)

Response of Yatsyn ryegrass, Matua prairie grass and Wana cocksfoot to phosphorus and potassium

T.J. Clough

Ruaknra Agricultural Centre, Private Bag, MAFTech, Hamilton

ABSTRACT At present most pasture fertiliser recommendations are based on the nutrient requirements of perennial ryegrass. The requirements of alternative pasture species are not fully understood and fertiliser is generally applied as for perennial ryegrass. Yatsyn 1 perennial ryegrass, 'Grasslands Matua' prairie grass and 'Grasslands Wana' cocksfoot were grown in sand culture to determine their phosphorus (P) and potassium (K) requirements. Yatsyn and Matua had similar requirements for P and K while Wana required a lower level of K and more P to attain 90% of maximum yield. Magnesium levels in the herbage differed between species and decreased as K applied increased. It is concluded that further studies should be done to more accurately determine the nutrient requirements of alternative pasture species in the field so that accurate and balanced fertiliser applications can be made for alternative pasture species.

Keywords phosphorus, potassium, *Bromis willdenowii*, *Lolium perenne*, *Dactylis glomerata*, nutrient requirements

INTRODUCTION

In New Zealand one of the most dominant pasture grass species is perennial ryegrass (*Lolium perenne* L.). In recent years a range of other grass species has been bred and commercially released for improved seasonal pasture production.

For example, 'Grasslands Matua', a commercial cultivar of prairie grass (*Bromus willdenowii* Kunth), is now available. It has created much interest as an alternative pasture species because it can provide feed at a time when traditional pasture mixtures based on ryegrass-white clover yield little dry matter (De Lacy 1987). Matua prefers a soil of high fertility, as does ryegrass (Clark 1985; Rumball 1984').

Many papers have discussed the question of how to manage prairie grass, but have mentioned its nutrient requirement only briefly, if at all (Charlton & Thorn 1984; Goold 1985; Lancashire 1978; Ridler 1985).

In contrast to perennial ryegrass and Matua, both of which are assigned a high fertility status, are the grasses used for low fertility areas. One of these, 'Grasslands Wana' cocksfoot (*Dactylis glomerata* L.), has the role of providing summer forage, particularly where soil fertility and moisture are low (Rumball 1982).

At present most fertiliser recommendations are based on the requirements of perennial ryegrass pasture. The objective of this experiment was to determine if the alternative pasture species mentioned have different requirements for phosphorus (P) or potassium (K).

MATERIALS AND METHODS

Species and plant culture

Three perennial grass species were grown in sand culture: Yatsyn 1 perennial ryegrass, Matua prairie grass and Wana cocksfoot.

The grasses were grown in plastic pots containing 1 kg of silica sand. Sand was steam heated in hydrochloric acid (18 % v/v) and oxalic acid (1% v/v) in a 'Keebush' sand purification unit and then washed in deionised water. This sand was then dried, weighed into pots and sown with 150 seeds per pot. The trials were carried out in a glasshouse (15°C minimum to 27°C maximum), with artificial lighting being used to extend the day length to 16 hours.

Nutrient solutions

The Ruakura nutrient solution (Smith *et al.* 1983) was applied at a level shown to produce maximum dry matter of perennial ryegrass (Smith *et al.* 1985). Micro-elements included were Fe, B, Mn, Zn, Cu and Mo. Actual concentrations and the salts used to make the solution are described in Smith *et al.* (1985).

Layout and treatments

Two experiments, one involving rates of P, the other rates of K, were conducted in the glasshouse at Ruakura.

The P trial had 15 levels of P, 3 grass species and 4 replicates (180 pots). The potassium trial had 11 levels of K, 3 grass species and 4 replicates (132 pots). Concentrations ($\mu g/cm^3$) of the nutrient treatments applied were as follows:

Phosphorus: 5 10 15 20 30 40 50 60 80 100 120 140 160 180 200

Potassium: 30 90 180 240 300 360 480 600 720 840 1200

After germination, nutrient solutions were applied 3 times per week, 50 m^3 per application.

Deionised water was used to supplement the nutrient solution so that the moisture content of the pots remained at 75% of the saturation capacity.

Measurements

After an initial trim (2 1 days after germination) plants were harvested at 14, 28 and 42 days after the initial trim. Plants were cut 2.5 cm above the sand surface. Harvested leaf tissue was oven dried at 90°C overnight, weighed and analysed for macro-elements (N, P, K, S, Mg, Ca, Na) by the procedures summarised in Smith *et al.* (1985).

Statistical analysis

For the P response curves exponential smoothing splines of the form $a_1 \exp(-Ex)\exp(-|x-b_1|/r)$ were fitted to the slope of the curve. Constants a_1 and b_1 were chosen to make the spline segments match. Constants E and r were fitted by solving the REML equations (Harville 1977). These splines produce a curve with a horizontal asymptote whose position was recorded as the maximum yield.

For the K yield curve smoothing splines of the form al and bl are chosen to make the spline segments match. The constant r was fitted by solving the REML equations. Upsdell (1985) gives more details of the fitting procedure. The values of P and K required for 90 % maximum yield were found by interpolating the spline curves.

RESULTS

Yatsyn, Matua and Wana produced a maximum yield of 13.7, 13.3 and 9.2 g DM over the 3 cuts respectively in response to P. The 90% of maximum yield for Yatsyn, Matua and Wana occurred at 38, 35 and 85 $\mu g/cm^3$ of P respectively (Figure 1).

The percentage of P in the herbage ranged from 0.13-0.90, 0.16-0.59 and 0.24-0.72 for Yatsyn, Matua and Wana respectively.

Critical concentrations of P and K required to produce 90 % of maximum yield are shown in Table 1.

Yatsyn, Matua and Wana produced a maximum yield of 9.1, 9.6 and 7.1 g DM over the 3 cuts respectively in response to K. Yatsyn, Matua and Wana produced 90% of maximum yield at 212, 222 and 181 $\mu g/cm^3$ of K respectively (Figure 2).

Percentage of K in herbage ranged from 2.7-7.4, 2.8-6.8 and 2.7-7.6 for Yatsyn, Matua and Wana respectively.

TABLE 1 Critical concentrations of P and K for 90% maximum yield. Range of values for cuts 2, 3 and 4.

	P	K
Yatsyn	0.29-0.38	2.8-3.2
Matua	0.29-0.31	3.1-3.7
Wana	0.37-0.70	1.5-2.2

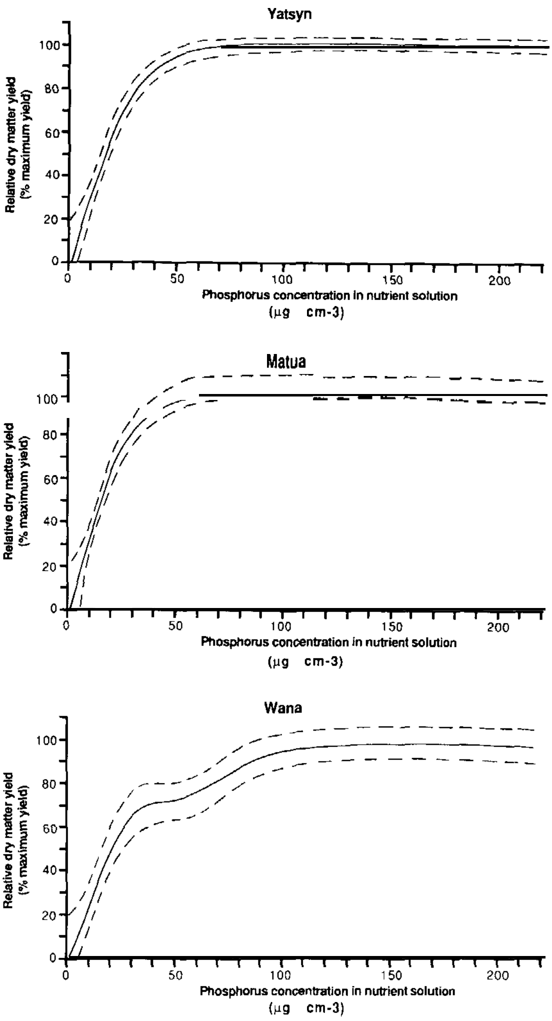

Figure 1 Effect of applied P on relative dry matter yields.

Concentrations of magnesium (Mg) in herbage differed significantly between species at all levels of K applied ($P<0.001$). As the level of K applied increased, Mg level in the herbage decreased.

Magnesium values in the herbage ranged from 0.39-0.20, 0.33-0. 18 and 0.29-0. 17 for Yatsyn, Matua and Wana respectively.

DISCUSSION

Matua and Yatsyn had a similar requirement for K and P, but Wana required a greater level of P than either Matua or Yatsyn, and a lower level of K than Yatsyn or Matua.

Wana is intended for areas of low fertility, but it responded to P and K, and could be of use in areas of higher fertility.

Smith *et* al. (1985) found the critical level of P and K for 90% maximum yield in perennial ryegrass to

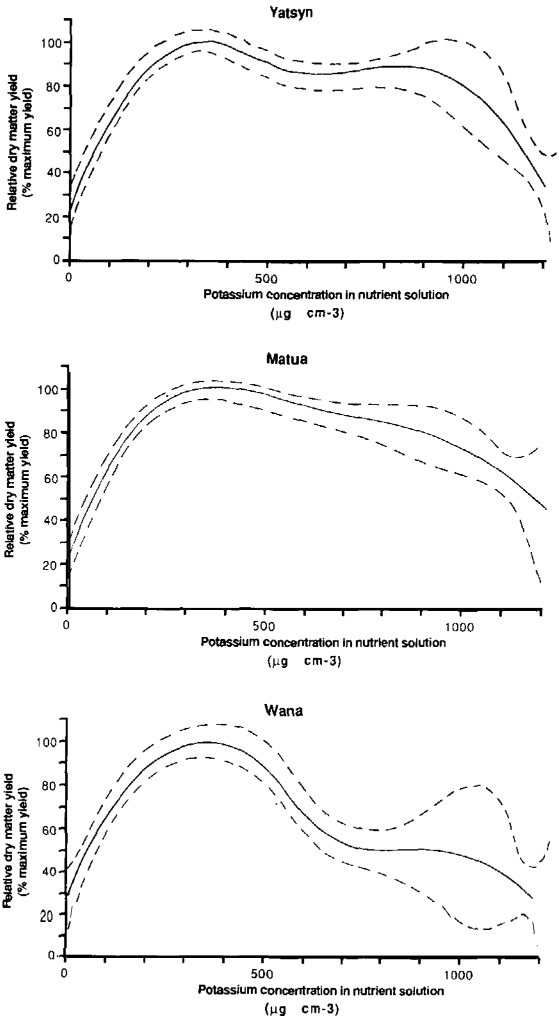

Figure 2 Effect of applied K on relative dry matter yields.

be 0.21% and 2.8% respectively, while McNaught (1970) gives critical concentrations of 0.28-0.36% for P and 1 .O-2.5% for K in perennial ryegrass. Published information on the critical values of P and K for Matua prairie grass appears to be non existent. McNaught (1958) found K deficiency symptoms in cocksfoot on K-responsive soils; the levels of K in the herbage were 0.77- 1.44 % . These values are below those attained in this experiment, even though K deficiency symptoms occurred. This may be due to the higher level of background nutrients creating a greater demand for K in the grasses. For example, Kresge & Younts (1963) found that the critical K level in cocksfoot was higher when rates of N were higher.

The effect of K applications in reducing Mg herbage concentrations has also been noted by Metson (1974). In our study the levels of Mg in herbage differed between species. Prairie grass has been shown to have a low Mg level in its herbage (Rumball *et al.* 1972), and lack of Mg in pasture can cause hypomagnesaemia (Young *et al.* 1979). Herbage with a Mg content of less than 0.2 % is considered inadequate to meet the demands of a lactating animal (Ulyatt et al. 1980). The level of Mg applied in these trials was twice that required for optimum yield in perennial ryegrass (Smith *et al.* 1985), and lower levels of Mg would probably be available to these pasture species under field conditions. A grass with a low Mg content because of its breeding or because of low available Mg in the soil might be more susceptible to K fertiliser lowering Mg levels, or might be more responsive to Mg fertilisers lifting its Mg content.

Many fertiliser recommendations and herbage analysis interpretations are based on information and data collected under ryegrass cutting and grazing trials, for example, the MAF Soil Fertility Service. This study shows that species differ in their P and K requirements. Nutrient requirements of alternative pasture species probably will not always be the same as those of perennial ryegrass.

Further field trials should be pursued to enable more accurate fertiliser recommendations to be made for pasture species other than perennial ryegrass.

REFERENCES

Charlton, J.F.L.; Thorn, E.R. 1984. Establishment and persistence of new herbage species and cultivars. NZ *Agricultural Science 18:* 130-135.

Clark, P. 1985. Matua prairie grass establishment. *Proceedings of the NZ Grassland Association 46: 147-149.*

De Lacy, H. 1987. Ryegrass not good enough for Canterbury farms. *NZ Journal of Agriculture:* March p.12-13.

Goold, G.J. 1985. New pasture species for high dairy production. *Proceedings of Ruakura Farmers Conference* 37: 129-132.

Harville, D.A. 1977. Maximum likelihood approaches to variance component estimation and to related problems. *Journal of American Statistical Association 72:* 320-340.

Kresge, C.G.; Younts, S.E. 1963: Response of orchard grass to K and N fertilisation. *Agronomy journal 55:* 161-164.

Lancashire, J. A. 1978. Improved species and seasonal pasture production. *Proceedinns of the Agronomy Society of NZ 8:* 123-127.

McNaught, K.J. 1970. Diagnosis of mineral deficiencies in grass-legume pasture; by plant analysis. *Proceedings of the International Grassland Congress: 334-338.*

McNaught, K.J. 1958. Potassium deficiency in pastures. I. Potassium content of legumes and grasses. NZ *Journal of Agriculture Research* I: 148-181.

Metson, A.J. 1974. Magnesium in NZ soils. I. Some factors governing the availability of soil magnesium: A review. *NZ Journal of Experimental Agriculture 2:* 277-319.

Ridler, B. 1985. Matua with establishment costs. *NZ Farmer 106(8):* 12-14.

Rumball, W.; Butler, G.W.; Jackman, R.H. 1972. Variation in nitrogen and mineral composition in populations of prairie grass *(Bromus unioloides* H.B.K.). *NZ Journal of Agricultural Research 15: 33-42.*

Rumball, W. 1974. 'Grasslands Matua' prairie grass *(Bromus catharticus* Vahl). *NZ Journal of Experimental Agriculture* 2: 1-5.

Rumball, W. 1982. 'Grasslands Wana' cocksfoot (*Dactylis glomerata* L.). *NZ Journal of Experimental Agriculture 10:* 51-52.

Smith, G.S.; Johnston, C.M.; and Cornforth, I.S. 1983. Comparison of nutrient solutions for growth of plants in sand culture. ***New Phytologist 94:*** 537-548.

Smith, G.S.; Comforth, IS.; Henderson, H.V. 1985: Critical leaf concentrations for deficiencies of nitrogen, potassium, phosphorus, sulphur and magnesium in perennial ryegrass. *New Phytologist 101:* 393-409.

Ulyatt, M.J.; Fennessy, P.F.; Rattray, P.V. and Jagusch, K.T. 1980: The nutritive value of supplements. In Supplementary feeding. NZ Society of Animal Production, p. 176.

Upsdell, M.P. 1985: Bayesian inference for functions. PhD Thesis. Nottingham University.

Young, P.W.; O'Connor, M.B.; Feyter, C. 1979: Importance of magnesium in dairy production. ***Proceedings of the Ruakura Farmers' Conference:*** 110-120.