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

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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, Bromus 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 (µg/cm³) 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 m³ 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 \( a \exp(-Ex) + c \exp(-bx-b_1/r) \) 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 \( a \exp(-E) + c \exp(-b_1/r) \) were fitted to the slope of the curve. Constants \( a_1 \) and \( b_1 \) were chosen to make the spline segments match. 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 \( \mu g/cm^2 \) 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% 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 \( \mu g/cm^2 \) 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.

<table>
<thead>
<tr>
<th></th>
<th>P</th>
<th>K</th>
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<tbody>
<tr>
<td>Yatsyn</td>
<td>0.29-0.38</td>
<td>2.8-3.2</td>
</tr>
<tr>
<td>Matua</td>
<td>0.29-0.31</td>
<td>3.1-3.7</td>
</tr>
<tr>
<td>Wana</td>
<td>0.37-0.70</td>
<td>1.5-2.2</td>
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**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
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


