Yield response and profitability of Coastcross 2 Bermudagrass at different rainfall and fertility levels

C.J.G. LE ROUX, J.S. SWART, E. OOSTHUYSEN, C. TRETHEWEY AND C. PITTAWAY
Döhne Agricultural Development Institute, Stutterheim, Republic of South Africa

Abstract
A model to estimate the yield of Coastcross 2, a cynodon hybrid, at Bathurst in the Eastern Cape Province, Republic of South Africa was developed to determine the most profitable fertilisation rates, corresponding yields and margins at a range of rainfall factors and opportunity costs. The model uses nitrogen application rate, soil phosphorus status and rainfall as predictor variables. At current price ratios, the most profitable fertilisation rates are far below those needed for maximum yields. The results indicated a surprisingly high phosphorus fixation rate in the soil.

Introduction
Coastcross 2 constitutes 8000 of the 36 000 ha of cultivated pastures in the Bathurst (Eastern Cape) area. One of the reasons for the popularity of this grass is its high digestibility (Chapman et al. 1992) resulting in the potential to produce higher weight gains in steers than Pennisetum clandestinum (Bransby 1981). It is drought-tolerant, and Aucamp and Nel (1982) found it yielded similar amounts of herbage to P. clandestinum. A further advantage is that it is very suitable for making hay due to its fine stems. This paper presents the results of a study of its yield response to nitrogenous and phosphatic fertilisation at the Bathurst Research Station. A model to predict yield in terms of rainfall and fertility is presented, and the fixation rate of phosphorus (P) in the soil is evaluated.

Materials and methods
The trial was conducted at the Bathurst Research Station (30°31’S, 26°49’E), which is 10 km from the coast in a frost-free area. The mean maximum temperature during February is 26.2°C and the mean minimum temperature during July is 10.2°C. The rainfall of 743 mm/yr is on average evenly spread throughout the year, but is erratic (Table 1), as periods of up to 4 months with little rain are not uncommon. As the study area lies near the border of predominantly summer and winter rainfall zones, these dry periods can occur in any season.

The experimental site was a 20-year-old, flat, fallow area. The soil was deep (0.9 m) and of the Hutton form, Stella family (Soil Classification Work Group 1991). Texturally, there was 60% sand, 14% silt and 26% clay, with 135 mm of moisture potentially available (between 10 kPa and 100 kPa negative pressure) per metre of depth. The analytical values were pH (KCl) 4.65; exchangeable acidity 0.08 meq/100g; 2 mg/kg available P (ISFEI) (Hunter 1974); 340 mg/kg exchangeable K; 124 mg/kg Na; 152 mg/kg Mg and 606 mg/kg Ca.

Initially (September 1983), the trial was laid out with 3 replications of the factorial combinations of 7 levels of nitrogen (N) (0–900 kg in 150 kg increments) and 5 levels of P (0, 54, 107, 163 and 215 kg/ha). The N was applied as limestone ammonium nitrate (LAN) (28% N) divided into 3 equal dressings each year. The P was applied prior to planting as single superphosphate (10.5% P). Plots were 10 m x 3.5 m and the central area of 7.6 m x 1.2 m was harvested. The material was harvested to a height of 80 mm (1983/84 to 1984/85), or 40 mm (1986/87 to 1992/93). Due to weed invasion, no yields were recorded during 1989/90. Dry matter (DM) yield,
crude protein and crude fibre were determined on harvested material. During September 1986, a further application of P was made; 0, 15, 31, 46 and 62 kg/ha P, respectively, were applied to the P treatments above.

During September 1990, the plots were split so that one half of each plot received the same P application as in September 1983. During September 1992, these subplots received 20, 30, 44, 67 and 100 kg/ha P, respectively. Double superphosphate (19.6% P) was used in 1990 and 1992 instead of single superphosphate.

The soil was sampled annually (20 cores per plot) to determine soil fertility status. Soil-P was determined by the ISFEI method (Hunter 1974) between 1983–1992 and the AMBIC-2 method in 1993 (Merwe et al. 1984), and the soil cations by ammonium acetate extraction. By applying muriate of potash (50% K), dolomitic lime (17% Mg and 13% Ca) and calcitic lime (26% Ca and 3% Mg), the initial soil cation status was maintained. Potash was applied during 1986, 1987, 1989 and 1992, and lime during 1986, 1987, 1988, 1989 and 1992. The ameliorants were applied to the soil surface. Two kg/ha was assumed to increase the cation values to a depth of 0.15 m by 1 mg/kg (with a soil bulk density of 1.4, there are approximately 2 million kg of soil in a 0.15 m layer per ha). N application rates played an important role in cation depletion.

The monthly and mean monthly growth rates were determined (Hunt 1982). Rainfall (measured at the Research Station) was used to create a rainfall factor (Rf) for use in the DM yield regressions. The Rf was the monthly rainfall for the months of September–April multiplied by factors of 1, 1.6, 1.6, 1, 1, 1 and 0.5, respectively. It was derived by dividing the proportional growth by the proportional rainfall (Roux et al. 1995). Rainfall received after the last harvest of the season was ignored. In an attempt to allow for deep percolation of rain, the rainfall used in the calculations was restricted to the evaporation for the month. As the experimental site was relatively flat, run-off was assumed to be minimal.

The decrease in soil-P values over time was studied using polynomial regression. This resulted in estimates of soil-P, which were used in the DM yield estimations.

As the site received 300 kg/ha N during the establishment period, yields of those plots which should have received less than 300 kg/ha were ignored during the first season. The yields of the plots which received N-fertilisation were not included in the 1991/92 data, as the fertiliser was applied after the spring flush of growth.

The relationships between DM yield and the Rf, applied N, soil-P, -K, -Mg and -Ca were determined by polynomial regression and logarithmic regression (SAS 1988) to determine transformations for use in the model and, subsequently, best subset regression (Galpin 1981) to create a predictive model. The relationship between the predictive variables was studied by observing the correlation matrix and principal component analysis (not presented).

### Table 1. Rainfall at Bathurst and mean monthly growth rate of Coastcross 2.

<table>
<thead>
<tr>
<th>Month</th>
<th>Rainfall (mm)</th>
<th>Growth (% of season)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jun</td>
<td>54 25 18 16 25 0 3 28 31 43 0.7</td>
<td></td>
</tr>
<tr>
<td>Aug</td>
<td>12 3 104 72 31 45 94 129 55 70 2.4</td>
<td></td>
</tr>
<tr>
<td>Sep</td>
<td>32 15 58 81 62 41 25 39 43 61 8.5</td>
<td></td>
</tr>
<tr>
<td>Oct</td>
<td>54 149 136 23 53 80 132 108 110 93 26.2</td>
<td></td>
</tr>
<tr>
<td>Nov</td>
<td>55 340 113 26 69 37 57 101 119 90 20.0</td>
<td></td>
</tr>
<tr>
<td>Dec</td>
<td>27 114 45 42 63 17 35 26 42 62 14.3</td>
<td></td>
</tr>
<tr>
<td>Jan</td>
<td>93 91 22 27 12 54 27 51 49 49 8.1</td>
<td></td>
</tr>
<tr>
<td>Feb</td>
<td>81 59 57 170 47 69 38 6 69 66 7.6</td>
<td></td>
</tr>
<tr>
<td>Mar</td>
<td>20 93 49 53 33 15 10 26 42 72 8.3</td>
<td></td>
</tr>
<tr>
<td>Apr</td>
<td>75 28 32 59 115 24 24 47 51 52 2.7</td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>16 7 31 64 18 7 3 9 19 39 0.9</td>
<td></td>
</tr>
<tr>
<td>Jun</td>
<td>43 33 79 12 13 35 36 90 43 46 0.5</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>562 956 746 644 541 422 484 659 663 743 100.0</td>
<td></td>
</tr>
</tbody>
</table>
Maximum margins (crop income–fertiliser cost) at various Rf and soil fertility levels were estimated. May 1993 prices for fertilisers (R770/t LAN, R834/t muriate of potash, R739/t single superphosphate, R255/t dolomitic lime and R40/t calcitic lime), and the May 1993 prices for bought hay (R200/t at source minus R50/t for mowing, baling etc.) were used. An opportunity value of R50/t was assumed to simulate the use of the pasture in comparison with natural range during summer. The equation to estimate the soil-P status from the amount of P applied vs the time since application suggested that 2.75 kg/ha P was needed in spring to raise the P level by 1 mg/kg in midsummer, and that one half of the applied P had been fixed by the next spring, so the cost of P amelioration was discounted over 2 years.

Results

The mean rainfall (Table 1) for the experimental period was slightly lower than the long-term mean. In particular, 1984/85, 1988/89, 1990/91 and 1991/92 were dry. Above-average rain fell in 1985/86, and this is largely due to one very wet month.

The mean monthly growth rate as a percentage of the year’s total (Table 1) showed that about 90% of the year’s total growth takes place between September and the end of April. This prompted the decision to use only these months’ rainfall in the yield model. Sixty per cent of the year’s growth takes place during October, November and December. The Rf was derived by dividing the % monthly growth rate by the % monthly rainfall (Roux et al. 1995).

The coefficients of variation (CV) (Table 2) of the pH, K, Mg and Ca levels in the soil for a given year’s soil samples are generally lower (usually below 20%) than those for soil-P (usually above 30%). This suggested that the soil-P values were of lower repeatability. The analyses of variance of the ISFEI soil-P values failed to indicate a significant effect of N on soil-P. In the case of the AMBIC-2 values, a significant effect of N on soil-P was observed.

The analytical results of soil-P were also inconsistent from year to year (Table 3). The mean P values for a given treatment level showed an unaccountable increase during 1986. This tendency, in conjunction with the high CVs, indicated that the analytical results were unreliable and could not be used in the regression. The regression model analysis of soil-P versus applied P and time after application (ignoring the 1986 results) is as follows:

\[
P \text{(predicted)} (\text{mg/kg}) = 1.537 + 0.176 \sum \frac{\text{Applied P} \times \sqrt{t}}{4} \quad (r = 0.94, n = 54, \text{root mean square for error (RMSE) = 5.05})
\]

where:

\[\Sigma = \text{summed over the four P applications of the experiment;}
\]

Applied P = applied P (kg/ha); and

\[t = \text{time in years since P was applied.}
\]

The above equation for predicting soil-P values was not satisfactory for those plots which received no P fertilisation. In these cases, predicted P levels were well below observed levels and initial yield regression equations suggested that these differences were important. Consequently, a second equation was used to estimate the soil-P values of plots which received no P. This equation used the observed P levels of 1984, 1987, 1989 and 1990 and an assumed value of 3.80 mg/kg after 12 years, as a graphic presentation of the data suggested that this was probably the lowest level to which the soil-P would decline:

\[
P \text{(predicted)} = 6.370 - 0.6796t + 0.03892t^2 \quad (r = 0.99, N = 5, \text{RMSE} = 0.15)
\]

where \(t = \text{time in years since 1984.}\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean</th>
<th>Coefficient of variation</th>
<th>Minimum value</th>
<th>Maximum value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield (t/ha)</td>
<td>4.77</td>
<td>*1</td>
<td>0.10</td>
<td>16.74</td>
</tr>
<tr>
<td>Soil-P (mg/kg)</td>
<td>22.0</td>
<td>60.05</td>
<td>3.4</td>
<td>96.3</td>
</tr>
<tr>
<td>Soil-K (mg/kg)</td>
<td>266.0</td>
<td>14.45</td>
<td>165.2</td>
<td>344.1</td>
</tr>
<tr>
<td>Soil-Mg (mg/kg)</td>
<td>166.6</td>
<td>17.38</td>
<td>111.1</td>
<td>246.1</td>
</tr>
<tr>
<td>Soil-Ca (mg/kg)</td>
<td>579.9</td>
<td>15.76</td>
<td>427.0</td>
<td>812.5</td>
</tr>
<tr>
<td>N applied kg/ha/yr</td>
<td>434.7</td>
<td>*</td>
<td>0</td>
<td>900.0</td>
</tr>
</tbody>
</table>

*1Not relevant.
The linear correlations matrix of the predictor and dependent parameters is presented in Table 4. Rainfall had the highest linear correlation with yield (0.70), followed by Mg (−0.52) and N (0.46). Although the relationship between N and the soil cations was not well correlated, there was a high (negative) correlation between Rf and soil-Mg (−0.63). This correlation was the result of the first lime being applied after the high rainfall 1985/86 season, and indicated that soil cations should be excluded from the yield regression equation.

The September–April rainfall, Rf and some selected yields are presented in Table 5. The correlation between yield and rainfall is apparent. Averaged over the N and rainfall levels, Coastcross 2 demonstrated a large response to soil-P in the lower P ranges, which decreased rapidly above 34 mg/kg. Meaned over all P and rainfall levels, there are only moderate increases in the yield of Coastcross 2 to N beyond 450 kg/ha (Table 6).

Table 6 is distorted slightly by the coincidence of very high soil-P levels and predominantly dry years, and the exclusion of high N application levels of 1991/92 from the regression.

A best subset model (Galpin 1981) to predict the yield of Coastcross 2 on soils similar to those of the experiment in the Bathurst region is:

\[ Y = -1.062 + 0.2199R_s + 0.06683N_s + 0.1043P_s + 0.04899R_sN_sP_s \]

\[ (r = 0.93, n = 303, \text{RMSE} = 1.31) \]

where: \[ Y = \text{yield (t/ha DM)}; \]
\[ R_s = -3.569 + 0.0166R_f \] \[ (r = 0.70, \text{RMSE} = 2.60); \]
\[ R_f = (\text{Sep + 1.6 Oct + 1.6 Nov + 1.6 Dec + Jan + Feb + Mar + 0.5 Apr}) \text{ rainfall}; \]
\[ N_s = 7.486 - 6.560\text{Exp}(\text{−0.003347N}) \] \[ (r = 0.60, \text{RMSE} = 3.64); \]
\[ N = \text{applied N (kg/ha)}; \]
\[ P_s = 6.406 - 3.893\text{Exp}(\text{−0.01466P}) \] \[ (r = 0.40, \text{RMSE} = 1.76); \]
and \[ P = \text{estimated soil P in summer (ISFEI extract)}. \]

Table 3. Mean observed soil-P values (mg/kg) by season.

<table>
<thead>
<tr>
<th>Month</th>
<th>P&lt;sub&gt;1&lt;/sub&gt;</th>
<th>P&lt;sub&gt;2&lt;/sub&gt;</th>
<th>P&lt;sub&gt;3&lt;/sub&gt;</th>
<th>P&lt;sub&gt;4&lt;/sub&gt;</th>
<th>P&lt;sub&gt;5&lt;/sub&gt;</th>
<th>D&lt;sub&gt;1&lt;/sub&gt;</th>
<th>D&lt;sub&gt;2&lt;/sub&gt;</th>
<th>D&lt;sub&gt;3&lt;/sub&gt;</th>
<th>D&lt;sub&gt;4&lt;/sub&gt;</th>
<th>D&lt;sub&gt;5&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>June&lt;sup&gt;a&lt;/sup&gt; 84</td>
<td>6.43</td>
<td>11.57</td>
<td>37.67</td>
<td>48.43</td>
<td>20.29</td>
<td>5.48</td>
<td>7.42</td>
<td>8.57</td>
<td>12.81</td>
<td>17.33</td>
</tr>
<tr>
<td>June 85</td>
<td>8.40</td>
<td>11.60</td>
<td>20.74</td>
<td>30.76</td>
<td>16.92</td>
<td>9.52</td>
<td>16.52</td>
<td>30.94</td>
<td>45.23</td>
<td>61.62</td>
</tr>
<tr>
<td>June 86</td>
<td>11.29</td>
<td>17.10</td>
<td>37.57</td>
<td>53.33</td>
<td>22.10</td>
<td>15.42</td>
<td>26.00</td>
<td>26.00</td>
<td>38.71</td>
<td>50.62</td>
</tr>
<tr>
<td>June 87</td>
<td>4.52</td>
<td>8.67</td>
<td>40.05</td>
<td>54.52</td>
<td>13.57</td>
<td>15.42</td>
<td>41.08</td>
<td>44.44</td>
<td>66.77</td>
<td>72.38</td>
</tr>
<tr>
<td>June 88</td>
<td>5.14</td>
<td>6.86</td>
<td>19.19</td>
<td>25.33</td>
<td>9.81</td>
<td>15.42</td>
<td>38.71</td>
<td>38.71</td>
<td>56.04</td>
<td>72.38</td>
</tr>
<tr>
<td>June 89</td>
<td>3.95</td>
<td>4.86</td>
<td>16.05</td>
<td>20.76</td>
<td>18.19</td>
<td>27.37</td>
<td>26.00</td>
<td>38.71</td>
<td>56.04</td>
<td>72.38</td>
</tr>
<tr>
<td>June 90</td>
<td>3.81</td>
<td>5.05</td>
<td>10.62</td>
<td>16.57</td>
<td>7.81</td>
<td>27.37</td>
<td>26.00</td>
<td>38.71</td>
<td>56.04</td>
<td>72.38</td>
</tr>
<tr>
<td>June&lt;sup&gt;b&lt;/sup&gt; 91</td>
<td>4.86</td>
<td>5.52</td>
<td>11.00</td>
<td>12.90</td>
<td>6.71</td>
<td>34.8</td>
<td>26.00</td>
<td>38.71</td>
<td>56.04</td>
<td>72.38</td>
</tr>
<tr>
<td>June 92</td>
<td>3.33</td>
<td>3.48</td>
<td>9.86</td>
<td>11.76</td>
<td>6.19</td>
<td>34.8</td>
<td>26.00</td>
<td>38.71</td>
<td>56.04</td>
<td>72.38</td>
</tr>
<tr>
<td>June 93</td>
<td>7.35</td>
<td>9.11</td>
<td>15.19</td>
<td>20.87</td>
<td>11.16</td>
<td>27.37</td>
<td>41.08</td>
<td>56.04</td>
<td>72.38</td>
<td>72.38</td>
</tr>
</tbody>
</table>

<sup>b</sup>Applied 0, 53.7, 107.4, 162.9 and 214.7 kg/ha P during September 83 to P<sub>1</sub>–P<sub>5</sub>, respectively.
<sup>c</sup>Applied 0, 15.5, 30.9, 46.4 and 61.8 kg/ha P during September 86 to P<sub>1</sub>–P<sub>5</sub>, respectively.
<sup>d</sup>Applied 0, 53.7, 107.4, 162.9 and 214.7 kg/ha P during September 90 to D<sub>1</sub>–D<sub>5</sub>, respectively (split of P<sub>1</sub>–P<sub>5</sub>).
<sup>e</sup>Applied 19.7, 29.6, 44.4, 66.7 and 100.0 kg/ha P during September 92 to D<sub>1</sub>–D<sub>5</sub>, respectively.

Table 4. Correlation matrix of parameters.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Y</th>
<th>P</th>
<th>K</th>
<th>Mg</th>
<th>Ca</th>
<th>N</th>
<th>Rf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield</td>
<td>1</td>
<td>0.08</td>
<td>1</td>
<td>-0.17</td>
<td>0.22</td>
<td>1</td>
<td>0.70</td>
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<tr>
<td>Soil-P</td>
<td></td>
<td></td>
<td></td>
<td>-0.52</td>
<td>0.15</td>
<td>-0.05</td>
<td>-0.15</td>
</tr>
<tr>
<td>Soil-K</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.05</td>
<td>0.17</td>
<td>-0.35</td>
</tr>
<tr>
<td>Soil-Mg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.42</td>
<td>-0.01</td>
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<tr>
<td>Soil-Ca</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.45</td>
</tr>
<tr>
<td>Applied N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rf</td>
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<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Table 5. Correlation matrix of parameters.
Table 5. Rainfall (September–April, mm), Rf and selected yields per season.

<table>
<thead>
<tr>
<th>Season</th>
<th>Rainfall (Sept–Apr)</th>
<th>Rf</th>
<th>Lowest yield</th>
<th>Mean yield</th>
<th>Highest yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>84/85</td>
<td>435.8</td>
<td>479.3</td>
<td>2.35**</td>
<td>6.17**</td>
<td>7.45</td>
</tr>
<tr>
<td>85/86</td>
<td>888.0</td>
<td>903.2</td>
<td>2.46</td>
<td>11.92</td>
<td>16.75</td>
</tr>
<tr>
<td>86/87</td>
<td>513.5</td>
<td>664.4</td>
<td>0.78</td>
<td>3.17</td>
<td>7.79</td>
</tr>
<tr>
<td>87/88</td>
<td>480.5</td>
<td>467.1</td>
<td>0.41</td>
<td>4.40</td>
<td>4.93</td>
</tr>
<tr>
<td>88/89</td>
<td>454.2</td>
<td>452.1</td>
<td>0.40</td>
<td>2.76</td>
<td>6.00</td>
</tr>
<tr>
<td>90/91</td>
<td>336.0</td>
<td>404.5</td>
<td>0.39</td>
<td>3.17</td>
<td>7.79</td>
</tr>
<tr>
<td>91/92</td>
<td>348.6</td>
<td>402.4</td>
<td>0.19</td>
<td>4.14</td>
<td>6.62</td>
</tr>
<tr>
<td>92/93</td>
<td>403.6</td>
<td>465.4</td>
<td>0.10</td>
<td>6.12</td>
<td>6.62</td>
</tr>
</tbody>
</table>

*Only N1 yields valid (Other N levels excluded from the regression).
**Not included in regression model.
N1 = 0 kg/ha N; N7 = 900 kg/ha N.
P1, P2, P3, P4, P5 = 0, 54, 107, 163 and 215 kg/ha P applied during September 1983, and 0, 15, 31, 46 and 62 kg/ha P applied during September 1986.
D1, D2, D3, D4, D5 = 0, 54, 107, 163 and 215 kg/ha P applied during September 1990 to P1–P5; and 20, 30, 44, 67 and 100 kg/ha P applied during September 1992.

Mean yields of main effects followed by the same letter do not differ significantly (P = 0.05; n = 325; Root mean square for error = 2.98).
N applications rounded to the nearest 5 kg.

Table 6. Mean yields (t/ha DM) with various N applications and levels of P in the soil.

<table>
<thead>
<tr>
<th>Soil-P levels</th>
<th>N applications (kg/ha)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>130</td>
</tr>
<tr>
<td>0–7.0</td>
<td>0.7</td>
<td>3.4</td>
</tr>
<tr>
<td>7.01–13.5</td>
<td>0.9</td>
<td>3.7</td>
</tr>
<tr>
<td>13.51–20.0</td>
<td>1.1</td>
<td>4.9</td>
</tr>
<tr>
<td>20.01–34.0</td>
<td>1.2</td>
<td>5.0</td>
</tr>
<tr>
<td>&gt;34.0</td>
<td>1.2</td>
<td>4.1</td>
</tr>
</tbody>
</table>

Table 7. Highest margin above fertiliser costs, optimum fertiliser regimen yield and gross margin at various rainfall factors for Coastcross 2.

<table>
<thead>
<tr>
<th>Rainfall factor</th>
<th>Opportunity cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R50/t DM</td>
</tr>
<tr>
<td></td>
<td>Optimum N application rate</td>
</tr>
<tr>
<td></td>
<td>(kg/ha)</td>
</tr>
<tr>
<td>400</td>
<td>0</td>
</tr>
<tr>
<td>500</td>
<td>0</td>
</tr>
<tr>
<td>600</td>
<td>0</td>
</tr>
<tr>
<td>663*</td>
<td>0</td>
</tr>
<tr>
<td>700</td>
<td>0</td>
</tr>
<tr>
<td>800</td>
<td>0</td>
</tr>
<tr>
<td>900</td>
<td>0</td>
</tr>
</tbody>
</table>

*N applications rounded to the nearest 5 kg.
*Average rainfall for Bathurst.
Optimum soil-P status in summer, assuming an initial soil-P value of 5 mg/kg (ISFEI), and 260 mg/kg K, 150 mg/kg Mg and 610 mg/kg Ca. Purchase prices of R770/t LAN and R739/t single superphosphate.
The fertilisation rate which gave the highest margin (opportunity income–fertiliser costs) and the corresponding yields and margins for a range of rainfall factors are given in Table 7. The soil-P values are those that occur during mid-summer and not during winter, as is usually quoted. The “highest margin” fertilisation rates increased with the opportunity value and the rainfall factor. In terms of yield, the model suggests that it is not economical to fertilise a Coastcross 2 pasture if it is valued at the opportunity cost of summer range. (Without fertilisation there would be very little difference between the yield and quality of the two pastures). If it was valued at the opportunity cost of purchased grass hay, it becomes economical to apply small amounts of fertiliser if the rainfall factor approached the average for Bathurst (663 mm).

Discussion

The response of Coastcross 2 to soil-P differed markedly from that of Chloris gayana (Roux et al. 1995). Chloris gayana had a very slight but almost linear response to soil-P in the range 5–140 mg/kg (ISFEI summer values). Both grasses responded well to N up to about 300 kg/ha, although in Coastcross 2 there was a larger response above 300 kg/ha than in C. gayana. Although a K-Mg antagonism was evident in C. gayana, it was not found in Coastcross 2.

Overman et al. (1988; 1990) modelled the yield of Bermuda grass, showing the effect of N level, water availability and harvest interval. The present approach differs slightly, in that the model includes the interactive effects of N, P and moisture availability.

The economic evaluation of the model emphasises the inappropriate attitude towards pastures in South Africa over the past decades. Despite the steady rise in fertiliser costs relative to product prices, grass pastures with high N application levels have been the norm in the summer rainfall areas. The yields of Coastcross 2 at the “highest margin” fertilisation rates (even at the high opportunity value) are lower than the yields of Medicago sativa and other legumes (Roux et al. 1992). Clearly, the matter of N-fertilised pastures needs addressing.

Conclusions

Rainfall and N applications had the highest linear correlations with yield of Coastcross 2. Rainfall and the opportunity value of the product were the most important determinants of economic levels of fertiliser application. At present price ratios, the highest margins are obtained at fertiliser input levels that are considerably lower than the levels at which yield responses can be expected.

References


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