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OBSERVATIONS ON THE PERSISTENCE AND POTENTIAL FOR BEEF PRODUCTION OF PASTURES BASED ON TRIFOLIUM SEMIPILOSUM AND LEUCAENA LEUCEOCEPHALA IN SUBTROPICAL COASTAL QUEENSLAND

R. J. JONES AND R. M. JONES

CSIRO Division of Tropical Crops and Pastures, 306 Carmody Road, St Lucia, Queensland, 4067. Present address of senior author: CSIRO Division of Tropical Crops and Pastures, Davies Laboratory, Townsville, Qld 4814.

ABSTRACT

Legume-grass pastures based on Trifolium semipilosum (KENYA white clover) cv. Safari and Leucaena leucocepha (leucaena) cv. Peru persisted under grazing in a subtropical environment of south-east Queensland over an 11 year period of study. Stocking rates were increased from 1.2 to 3.0 yearling steers ha\(^{-1}\) on the Safari pasture and from 1.9 to 2.5 yearlings ha\(^{-1}\) on the leucaena pasture.

Mean annual liveweight gain ha\(^{-1}\) was 469 kg on Kenya white clover and 311 kg on the leucaena pasture. Animals on the leucaena pasture showed clinical signs of leucaena toxicity in two of the eleven years, with serum thyroxine levels below 16 n mol litre\(^{-1}\) and reduced weight gains in autumn.

Although both Kenya white clover and leucaena are usually slower to establish than alternative legumes in wider commercial use, such as white clover and Siratro, they appear to have additional potential for improving animal production in the humid
Australian subtropics. As pastures based on leucaena and Kenya white clover can be stocked more heavily over summer they could also be used to complement Siratro-based pastures, which can benefit from lower stocking rates in summer and early autumn.

INTRODUCTION

Kenya white clover (*Trifolium semipiloseum*) cv. Safari was released to the Australian grazing industry in 1973 (Mackay 1973) as a pasture legume for the humid subtropics and elevated tropics. However, there are no long term data about persistence or beef production potential of Kenya white clover based pastures under grazing.

Likewise, although the potential productivity of leucaena (*Leucaena leucocephala*) and problems associated with mimosine are well documented, there are no long term data dealing with beef production from leucaena-grass pastures (Jones 1979).

This report summarises 11 years' data on animal production and pasture composition from unreplicated pastures based on Kenya white clover and leucaena in coastal south-east Queensland.

PASTURES UNDER STUDY

Both pastures were established on the CSIRO Samford Research Station (27°S, 152°E), with altitude 50 m and 1100 mm annual average rainfall, two-thirds of which falls in the six warmer months (October–April). Both areas received 500 kg superphosphate, with trace elements (Cu, Zn, Mo) and 125 kg KC1 ha⁻¹ at establishment. Since then both pastures have received approximately 250 kg superphosphate and 50 kg KC1 ha⁻¹ year⁻¹. Pasture and animal measurements were made from 1969 to 1980. Annual rainfall (Table 1) was above average in 5 of the first 6 years (1969–1974) but below average in 5 out of the next 6 years (1975–1979).

Kenya white clover pasture

The Kenya white clover pasture of 1.7 ha was mainly on gleyed podzolic soils on a site where the grass, but not the clover, was invariably partly or wholly frosted in

### TABLE 1

*Seasonal and annual rainfall* (mm) *at Samford from 1969–1980*

<table>
<thead>
<tr>
<th>Year</th>
<th>Summer* (Dec,Jan,Feb)</th>
<th>Autumn (Mar,Apr,May)</th>
<th>Winter (Jun,Jul,Aug)</th>
<th>Spring (Sep,Oct,Nov)</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969</td>
<td>209</td>
<td>330</td>
<td>229</td>
<td>394</td>
<td>1212</td>
</tr>
<tr>
<td>1970</td>
<td>316</td>
<td>210</td>
<td>47</td>
<td>371</td>
<td>944</td>
</tr>
<tr>
<td>1971</td>
<td>1102</td>
<td>176</td>
<td>89</td>
<td>192</td>
<td>1559</td>
</tr>
<tr>
<td>1972</td>
<td>718</td>
<td>524</td>
<td>61</td>
<td>695</td>
<td>1998</td>
</tr>
<tr>
<td>1973</td>
<td>557</td>
<td>109</td>
<td>427</td>
<td>237</td>
<td>1330</td>
</tr>
<tr>
<td>1974</td>
<td>1526</td>
<td>505</td>
<td>151</td>
<td>263</td>
<td>2445</td>
</tr>
<tr>
<td>1975</td>
<td>255</td>
<td>138</td>
<td>115</td>
<td>308</td>
<td>816</td>
</tr>
<tr>
<td>1976</td>
<td>741</td>
<td>308</td>
<td>68</td>
<td>397</td>
<td>1514</td>
</tr>
<tr>
<td>1977</td>
<td>369</td>
<td>158</td>
<td>32</td>
<td>164</td>
<td>723</td>
</tr>
<tr>
<td>1978</td>
<td>284</td>
<td>343</td>
<td>114</td>
<td>195</td>
<td>936</td>
</tr>
<tr>
<td>1979</td>
<td>449</td>
<td>150</td>
<td>139</td>
<td>219</td>
<td>957</td>
</tr>
<tr>
<td>1980</td>
<td>314</td>
<td>380†</td>
<td>48</td>
<td>18 ††</td>
<td>893</td>
</tr>
</tbody>
</table>

Long term average

|                     | 445 | 286 | 150 | 227 | 1108 |

*Summer rainfall includes December rainfall from the previous calendar year.
† Negligible rainfall in March and April, 347 mm in May.
†† This total is limited to rainfall in September and October and excludes rain falling just before the final weighing of animals on leucaena (Nov 4, 1980).
winter. Kenya white clover cv. Safari, inoculated with a mixture of *Rhizobium* strains CB526 and CB782, together with *Setaria sphacelata* (CPI 32930), was oversown into a predominantly carpet grass (*Axonopus affinis*) pasture in 1966. The stocking rate was gradually increased from 1.2 (1969) to 3.0 beasts ha\(^{-1}\) in 1974 and was maintained at this level to 1980 (Table 2). Animals were weighed monthly until 1974, and 4 times a year thereafter. Pasture yield and composition were also measured at monthly intervals from 1969 to 1974 and after that only in autumn (April).

Soil seed reserves of Kenya white clover were measured in 1974 and 1978, using the technique of Jones and Bunch (1977), with occasional measurements of seedling regeneration following good seedling strikes.

Animal liveweight gain averaged 469 kg ha\(^{-1}\) since 1974 (Table 2). Clover yields were highest in the early years but then declined, and were negligible in 1977–78 following low rainfall (Table 1) but recovered in 1978–79. Animal production was also poorest in 1977–78 but, like clover productivity, recovered in the following year. However, clover and animal production were again depressed in the dry 1979–80 season (Tables 1 and 2).

**TABLE 2**

Animal production and autumn presentation yield of legume from *T. semipilosum* based pasture at Samford.

<table>
<thead>
<tr>
<th>Year</th>
<th>Stocking rate (beasts ha(^{-1}))</th>
<th>Liveweight gain (kg head(^{-1}))</th>
<th>Clover presentation yield (kg ha(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969–70*</td>
<td>1.24</td>
<td>265</td>
<td>255</td>
</tr>
<tr>
<td>1970–71</td>
<td>1.85</td>
<td>183</td>
<td>386</td>
</tr>
<tr>
<td>1971–72</td>
<td>2.47</td>
<td>194</td>
<td>1071</td>
</tr>
<tr>
<td>1972–73</td>
<td>2.47</td>
<td>163</td>
<td>210</td>
</tr>
<tr>
<td>1973–74</td>
<td>2.47</td>
<td>233</td>
<td>143</td>
</tr>
<tr>
<td>1974–75</td>
<td>3.08</td>
<td>166</td>
<td>63</td>
</tr>
<tr>
<td>1975–76</td>
<td>3.08</td>
<td>188</td>
<td>204</td>
</tr>
<tr>
<td>1976–77</td>
<td>3.08</td>
<td>154</td>
<td>87</td>
</tr>
<tr>
<td>1977–78</td>
<td>3.08</td>
<td>122</td>
<td>1</td>
</tr>
<tr>
<td>1978–79</td>
<td>3.08</td>
<td>159</td>
<td>655</td>
</tr>
<tr>
<td>1979–80</td>
<td>3.08</td>
<td>123</td>
<td>1</td>
</tr>
<tr>
<td>Mean</td>
<td>3.08</td>
<td>152</td>
<td>169</td>
</tr>
</tbody>
</table>

*Animals changed every July

Soil seed levels were 8,400 seed m\(^{-2}\) in 1974 and 8,000 in 1978, 88% of seed being hard after the recovery process. Seedling regeneration was sparse, particularly on lightly grazed areas. This is shown by one of the denser seedling strikes (November 14, 1977), including counts made on small enclosures burnt one month previously.

Yield of Pasture (kg ha\(^{-1}\))

<table>
<thead>
<tr>
<th>Seedlings m(^{-2})</th>
<th>&lt;2000</th>
<th>2000–5000</th>
<th>&gt;5000</th>
<th>burnt</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>4</td>
<td>0</td>
<td></td>
<td>57</td>
</tr>
</tbody>
</table>

Clover frequency was also depressed in dense, lightly grazed areas.

The main associated grasses were *Digitaria didactyla* (30% of all green material), *Setaria sphacelata* CPI 32930 (23%), *Chloris gayana* cv. Pioneer (19%) and *Axonopus affinis* (12%). Total dry matter yields were usually in the range of 3000 to 5000 kg ha\(^{-1}\).

The *Leucaena* pasture

Leucaena cv. Peru, inoculated with *Rhizobium* strain CB81, was sown at 7 kg ha\(^{-1}\) in rows 1.8 m apart over 70% of a 1.6 ha paddock in 1959. The pasture was used for farm grazing until yearlong grazing commenced in 1969. The main associated grasses have been Rhodes grass (*Chloris gayana*) cv. Pioneer and naturalised Queensland blue couch (*Digitaria didactyla*). The leucaena pasture is sited mainly on a red-yellow
podzolic soil of pH 5.6, a more elevated and more freely drained site subject to fewer and lighter frosts than the Kenya white clover pasture.

The paddock was continuously grazed from 1969 to 1972, but was divided into 2 and rotationally grazed on a 4 week on 4 week off system thereafter. The reason for this change is discussed later. Animals were weighed monthly until 1976 and 4 times a year thereafter. The stocking rate has been 2.5 heifers ha\(^{-1}\) since November 1974 (Table 3).

Bushes were slashed from near 2 m in height down to 30 cm in November 1976, without removing animals from the pasture. The height of bushes was measured every May at the end of the growing season, and plant density in 1969 and 1980.

Fourteen-month old heifers of approximately 220 kg were introduced into the pasture every November. Animals were weighed monthly until November 1976 and every 3 months thereafter. As part of a study into the effect of leucaena on thyroid gland activity, 2 of the 4 heifers received injections of 7 ml of Lipiodol (40\% iodine) every 2 months from November 1975. Blood samples were collected for measurements of serum thyroxine levels towards the end of the growing season in March 1970, 1975, 1978, 1979 and 1980 and in May 1977.

Average animal production was over 300 kg LWG ha\(^{-1}\) (Table 3) but was depressed in 2 drier years (1977 and 1980, Table 1). There were two occurrences of poor weight gains in autumn when there was an abundance of green leucaena. These poor gains in autumn (0.3 kg ha\(^{-1}\) day\(^{-1}\)) occurred when serum thyroxine levels were low, e.g. 15.5 n mol l\(^{-1}\) (1970) and <13 n mol l\(^{-1}\) (1975). Animals gained better in autumn (0.7 kg ha\(^{-1}\) day\(^{-1}\)) when thyroxine levels were within the normal range e.g. 114 (1977), 64 (1978), 85 (1979) and 117 n mol l\(^{-1}\) (1980). However, animal production over the full twelve month period in 1969–70 and 1974–75 was still satisfactory despite the poor gains in autumn (Table 3).

### TABLE 3

**Heights of leucaena in autumn, animal liveweight gain and grazing management on a leucaena-grass pasture**

<table>
<thead>
<tr>
<th>Year</th>
<th>Grazing Method</th>
<th>Stocking rate (beasts ha(^{-1}))</th>
<th>Height in autumn (cm)</th>
<th>Liveweight gain (kg head(^{-1}))</th>
<th>Liveweight gain (kg ha(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969–70*</td>
<td>Continuous</td>
<td>1.9</td>
<td>150</td>
<td>178</td>
<td>334</td>
</tr>
<tr>
<td>1970–71</td>
<td>Continuous</td>
<td>1.9</td>
<td>38</td>
<td>145</td>
<td>272</td>
</tr>
<tr>
<td>1971–72</td>
<td>Continuous</td>
<td>1.9</td>
<td>20</td>
<td>193</td>
<td>362</td>
</tr>
<tr>
<td>1972–73</td>
<td>Rotational</td>
<td>1.9</td>
<td>77</td>
<td>144</td>
<td>274</td>
</tr>
<tr>
<td>1973–74</td>
<td>Rotational</td>
<td>1.9</td>
<td>138</td>
<td>195</td>
<td>366</td>
</tr>
<tr>
<td>1974–75</td>
<td>Rotational</td>
<td>2.5</td>
<td>127</td>
<td>138</td>
<td>345</td>
</tr>
<tr>
<td>1975–76</td>
<td>Rotational</td>
<td>2.5</td>
<td>131</td>
<td>125</td>
<td>310</td>
</tr>
<tr>
<td>1976–77</td>
<td>Rotational</td>
<td>2.5</td>
<td>81</td>
<td>90</td>
<td>225</td>
</tr>
<tr>
<td>1977–78</td>
<td>Rotational</td>
<td>2.5</td>
<td>66</td>
<td>138</td>
<td>342</td>
</tr>
<tr>
<td>1978–79</td>
<td>Rotational</td>
<td>2.5</td>
<td>85</td>
<td>145</td>
<td>361</td>
</tr>
<tr>
<td>1979–80</td>
<td>Rotational</td>
<td>2.5</td>
<td>117</td>
<td>112</td>
<td>281</td>
</tr>
</tbody>
</table>

Mean 1974–80 2.5 101 125 311

*Animals changed every November.
†Leucaena slashed to 30 cm in November 1976.

There was no effect of iodine injection on liveweight gain. Averaging over 5 years, animals receiving iodine gained 117 kg while controls gained 127 kg. Mean thyroxine levels (1977–80) tended to be higher in animals receiving iodine (98 n mol l\(^{-1}\)) than in the controls (76 n mol l\(^{-1}\)).

Although the height of leucaena declined over three years of continuous grazing, it recovered under rotational grazing (Table 3). Despite an increased stocking rate many bushes were too high for grazing in November 1976 and the stand was therefore slashed. The pasture recovered from this despite the subsequent below average rainfall (Table 1). There was a 19\% decrease in plant density between 1969 (8640 bushes ha\(^{-1}\)) and 1980 (6990 bushes ha\(^{-1}\)).
DISCUSSION

Liveweight gain

Liveweight gain from the Kenya white clover pasture (469 kg ha\(^{-1}\) yr\(^{-1}\)) and the leucaena pasture (311 kg ha\(^{-1}\) yr\(^{-1}\)) exceeded that from Siratro pastures at Samford. The best Siratro pasture has given approximately 200 kg LWG ha\(^{-1}\) yr\(^{-1}\) (Jones and Jones 1980), on an area adjacent to the leucaena paddock. The production from the Kenya white clover pasture is well above that recorded from set-stocked white clover based pastures in south-east Queensland (370 kg ha\(^{-1}\) at Samford, Jones and Jones 1975; 348 kg ha\(^{-1}\) at Beerwah, Evans and Bryan 1973).

Dry years have been the main limiting factor for animal production on both pastures. There have also been some periods when we presume liveweight gain in autumn on the leucaena pasture has been reduced through depressed serum thyroxine levels arising from DHP (3-hydroxy-4(1H)-pyridone) which is the degradation product of mimosine and is known to be goitrogenic (Hegarty et al. 1979). The yearlong grazing imposed in this experiment was conducive to high intakes of leucaena, especially during summer and autumn when leucaena grows rapidly, and hence to depressed thyroxine levels. Other experiments (Blunt and Jones 1977, Jones 1979) suggest that either restricting the access of animals to leucaena or restricting the leucaena percentage in the diet would further minimise harmful effects of leucaena. Cataracts of the eyes reported by Holmes et al. (1981) for heifers grazing pure stands of leucaena in New Guinea, did not occur in our animals.

Pasture persistence and management

There was no autumn decline in the yield of Kenya white clover, unlike that observed with white clover in this environment (Jones and Jones 1975). This was due to the relatively good stolon persistence of Kenya white clover. Seedling regeneration of Kenya white clover is usually less than that of white clover, even though soil seed reserves may be higher (Jones and Jones 1975). Consequently management should ensure that thick grass growth does not force stolons away from the soil surface so preventing stolon rooting and survival (R. Sproule, unpublished data). Close grazing to achieve this encourages both stolon rooting and seedling regeneration.

The leucaena pasture, although 22 years old, has persisted well, confirming the good persistence noted on other leucaena stands (Jones and Harrison 1980). Although plants recovered from slashing in November 1976, this slashing may have been inadvisable as rainfall has subsequently been below average. The resultant increased grazing pressure slowed recovery of leucaena and may have contributed to the death of some plants. Seedlings were rarely seen in the pasture and none have persisted to form established shrubs.

The fixed stocking rates imposed resulted in undergrazing through the summer period, with some undesirable effects on both pastures. On the Kenya white clover pasture excessive grass growth in this period suppressed the legume, whereas on the leucaena pasture rapid legume growth can result in excessive shading of the grass and an increased possibility for high leucaena intake leading to toxicity problems. Furthermore, if the bushes appreciably exceed 2 m in height, top growth may be inaccessible in winter and spring.

Thus both pastures would benefit from a higher stocking rate in summer, although for different reasons. In this respect they could complement Siratro based pastures which, on theoretical grounds, would benefit from a reduced stocking rate in the summer-autumn period (Jones and Jones 1978).

Establishment can be more of a problem with leucaena (Cooksey 1974) and Kenya white clover (Shaw and Quinlan 1978) than it is with Siratro (Cook and Lowe 1977), but we believe the extra effort in establishing these species may be worthwhile, particularly in some intensively grazed areas of the humid Australian subtropics.
ACKNOWLEDGEMENTS

The assistance of Mr R. B. Waite, Mr G. C. McDowall, Mr G. A. Bunch and the Samford staff is gratefully acknowledged.

REFERENCES


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THE NUTRITIVE VALUE AND UTILIZATION OF THREE TROPICAL GRASS HAYS BY SHEEP

I. F. ADU and A. M. ADAMU

National Animal Production Research Institute, P.M.B. 1096, Shika, Nigeria.

ABSTRACT

Trials were carried out on signal, buffel and guinea grass hays using groups of four, 2 to 3 year-old, local Yankasa rams to determine their nutritive value.

The crude protein content of the hays ranged between 3 and 5%. Although dry matter intakes of 46 to 58g per kg W.75 were considered adequate to meet maintenance requirements, nutrient digestion coefficients were generally low. The low crude fibre digestion coefficient in particular, might partially be due to the low crude protein content of the hays and to a high rate of saliva flow commonly associated with poor quality feeds.

All hays gave a negative nitrogen balance. Hay as the only source of energy and protein provided about half of the animal’s requirement for maintenance.

The practical significance of the results was discussed in relation to hay quality intake and utilization. It is concluded that further pasture evaluation and improvement studies are needed to ensure increased animal production in Nigeria.

INTRODUCTION

About 80% of Nigeria’s total land area is covered by savanna grassland. It has a monsoonal climate with distinct rainy and dry seasons. Thus feed supply, especially pasture, is subject to seasonal variation in quantity and quality. Low levels of livestock production reflect the poor yield and low quality of pasture from these grasslands. Therefore, livestock improvement programmes in the country place strong emphasis on the production of better yielding pasture species with high nutritive value when