Abstract

Grazing experiments investigating some factors determining the dry matter production and oestrogenicity of Pawera red clover are described. The legume content of the summer dry matter yield was double that of Ruunu and Huia pasture following overdrilling of lightly paraquated pasture with 4 or 8 kg/ha of Pawera. Persistence of Pawera was demonstrated by its ability to survive in sufficient density under grazing to contribute 35% of total summer dry matter production in its fourth year after direct drilling into lightly paraquated pasture. A Pawera sward when overdrilled with Tana ryegrass or Rahu rye-corn produced the same annual yield as Ariki/Huia pasture, but the seasonal distribution was markedly different, with production from the overdrilled Pawera being greater in winter and summer. Pure Pawera swards produced some 70% more dry matter during December-February than Ariki/Huia pasture. The significance of this is related to conservation practices in Southland. Oestrogenicity of pure swards of Pawera was determined by measuring the cervical mucus response in ovariectomized ewes. Responses to grazing were equivalent to a single injection of 9 to 31 μg of oestradiol-17β.

INTRODUCTION

Tetraploid red clovers have shown greater productivity and persistence (Julén, 1956) and disease resistance (Vestad, 1960) than diploid red clovers. Consequently Grasslands Division embarked on a breeding programme leading to the release of 'Grasslands Pawera' tetraploid red clover (Trifolium pratense L.). Development was by selection and breeding after colchicine treatment of 'Grasslands Turoa' and some lines introduced from Sweden (Anderson, 1973a). In a mowing trial at Palmerston North, Pawera gave higher yields, particularly in the summer and autumn, than 5 diploid red clovers and white clover, and was the most persistent red clover (Anderson, 1973b). Harris et al. (1973) found in Southland that 'G 4706' (later released as Pawera) outyielded 3

1 Grasslands Division, DSIR, Private Bag, Gore.
2 Invermay Agricultural Research Centre, Private Bag, Mosgiel.
diploid varieties at two cutting regimes, 23 cm to 5 cm and 10 cm to 2 cm, while at Lincoln E. W. Vartha (pers. comm.) recorded yields in excess of 20 000 kg/ha dry matter (DM) from ‘G 4706’ under a lax cutting system during the 1960-1 season. Also in a mowing trial on a dryland site in the Waitaki Valley, Sheath et al. (1976) showed production from Pawera to be superior to Turoa in spring and summer but not in autumn. Because these trials and many others in progress were under cutting, and there has been no work on possible oestrogenic effects of Pawera to sheep, production and oestrogenicity of Pawera under grazing were investigated.

EXPERIMENTAL METHODS

The first experiment commenced in spring 1973 by direct drilling Pawera at two sowing rates (4 and 8 kg/ha), and Ruana (Lolium perenne L.) and Nui (L. perenne L.) ryegrasses at 15 kg/ha, with a triple-disc “730 Multiliner” drill into “runout” pasture which had been sprayed at the light rate of 360 g active ingredient parquat/ha. This spraying treatment was designed to remove all grass apart from ryegrass which demonstrates a resistance to this rate of parquat. Treatments were grazed with wethers to 2 cm when the regrowth height averaged 15 cm. In the second experiment, which commenced in spring 1974, the seasonal production of pure Pawera swards and Pawera overdrilled with the winter annuals ‘Grasslands Tama’ Westerwolds (Lolium multiflorum Lam.) and Rahu rye (Secale cereale L.) were compared with a pasture comprising ‘Grasslands Ariki’ ryegrass/Grasslands Huia’ white clover (Trifolium repens L.). A frequent (15 cm to 4 cm) and infrequent (23 cm to 4 cm) grazing regime was applied to each treatment over the spring-summer months. In both trials four 0.25 m² quadrats per plot were harvested using hand shears immediately before grazing. Stocking rate was adjusted to achieve defoliation to the required height in less than 48 hours. If necessary paddocks were topped after grazing. Both experiments had four replications. Each autumn 375 kg/ha of 25% potassic superphosphate (O-7-12) was applied to both experiments.

Oestrogenic activity of Pawera to sheep was investigated in 1977, using the oestrogen bioassay production of cervical mucus in ovariectomized Romney ewes (Lindsay and Francis, 1968). The response after 3 days’ grazing was calculated, in equivalents of oestradiol-17β, using a dose response curve from control ewes.
TABLE 1: MEAN HERBAGE YIELD (kg DM/ha) FROM OVERDRILLED PASTURE, 1974-5 AND 1975-6

<table>
<thead>
<tr>
<th>Species and Sowing Rate (kg/ha)</th>
<th>Pawera White</th>
<th>Clover White</th>
<th>Clover All spp.</th>
<th>Summer* Production</th>
<th>Remainder of Annual Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pawera 8</td>
<td>1380</td>
<td>820</td>
<td>4500</td>
<td>610</td>
<td>1140</td>
</tr>
<tr>
<td>Ruannui 15</td>
<td>1440</td>
<td>810</td>
<td>4550</td>
<td>1070</td>
<td>1030</td>
</tr>
<tr>
<td>Nui 15</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LSD 5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*December 1-March 1.

TABLE 2: DM PRODUCTION (kg/ha) FOR SUMMER PERIOD 1976-7 (NOVEMBER NO-MARCH 10) FOUR YEARS AFTER DRILLING

<table>
<thead>
<tr>
<th>Overdrilled Species and Sowing Rate</th>
<th>Pawera White</th>
<th>Clover White</th>
<th>Ryegrass</th>
<th>Other Species</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pawera 8 kg/ha</td>
<td>1920</td>
<td>660</td>
<td>1540</td>
<td>1440</td>
<td>5560</td>
</tr>
<tr>
<td>% of total</td>
<td>35</td>
<td>12</td>
<td>28</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 3: MEAN SEASONAL DISTRIBUTION OF PRODUCTION (kg DM/ha) FROM 1974-5 AND 1975-6 WITH FREQUENT OR INFREQUENT DEFOLIATION

<table>
<thead>
<tr>
<th>Swards</th>
<th>Spring*</th>
<th>Summer</th>
<th>Autumn</th>
<th>Winter</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pawera</td>
<td>4500</td>
<td>7100</td>
<td>1200</td>
<td>750</td>
<td>13550</td>
</tr>
<tr>
<td>Pawera + winter annual</td>
<td>6000</td>
<td>5000</td>
<td>1500</td>
<td>2000</td>
<td>14500</td>
</tr>
<tr>
<td>Ariki/Huia pasture</td>
<td>6600</td>
<td>4100</td>
<td>2500</td>
<td>1200</td>
<td>14400</td>
</tr>
<tr>
<td>LSD 5%</td>
<td>640</td>
<td>760</td>
<td>390</td>
<td>390</td>
<td>890</td>
</tr>
</tbody>
</table>

*Spring period taken as September-November inclusive.

TABLE 4: OESTROGENIC ACTIVITY OF PAWERA TO OVARIECTOMIZED EWES AND LEAF FORMONONETIN CONCENTRATION

<table>
<thead>
<tr>
<th>Time of Grazing</th>
<th>Mean Mucus Production (g)</th>
<th>Response in OD-17 β (µg)</th>
<th>(% DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late January</td>
<td>0.24</td>
<td>0.91</td>
<td>15</td>
</tr>
<tr>
<td>Early March</td>
<td>0.17</td>
<td>1.52</td>
<td>31</td>
</tr>
<tr>
<td>Early May</td>
<td>0.32</td>
<td>1.08</td>
<td>9</td>
</tr>
</tbody>
</table>
grazing ryegrass/white clover pasture. In addition, the amount of formononetin in the leaves of the Pawera at the time of grazing was determined by the technique of Francis and Millington (1965).

RESULTS

YIELD

Table 1 presents DM production obtained in the first experiment from two drilling rates of Pawera and compares it with Ruanui and Nui.

These figures show marked differences in the legume component of the yields. Clover production in the Pawera treatments was superior to that from the Nui and Ruanui plots at all times, and contributed up to half the total summer production. This superiority in summer was due principally to production from Pawera. The contribution was evenly shared by Pawera and white clover during the remainder of the year in the 8 kg/ha Pawera treatment. There was no evidence of suppression of white clover in the plots overdilled with Pawera.

The persistence of Pawera was demonstrated by the number of plants present in random quadrats within the plot. Over the 3½-year period, the numbers declined rapidly in the first 18 months, but thereafter showed little change (Fig. 1).

Pawera overdilled with Tama or Rahu ryecom gave similar total yields to Ariki/Huia pasture but out-produced it in summer and winter (Table 3). Pure Pawera swards produced 3000 kg/ha more than pasture over the summer period but less in other seasons.

OESTROGENIC EFFECTS

Stands of pure Pawera grazed three times in the summer-autumn period resulted in the secretion of large amounts of cervical mucus by ovariectomized ewes more than that produced by ewes grazing non-oestrogenic pastures (Table 4). The responses were equivalent to that produced following single injection of between 9 and 31 µg of oestradiol-17β. Concentration of formononetin in Pawera was high at all times.
DISCUSSION

The Ruanui and Nui plots confirm work of Harris et al. (1973) and Radcliffe (1974) which has shown that the percentage legume in Southland pastures is low compared with other regions in New Zealand (Brougham, 1960; Radcliffe, 1975a, b; Radcliffe and Sinclair, 1975; Baars et al., 1975). This low legume content and poor pasture growth in the late summer-autumn period causes problems on many Southland farms, in getting lambs to killing weight before there is competition for feed for flushing ewes prior to tupping. Pawera could be used in combination with grasses to provide special pastures for finishing lambs in late summer. This would utilize the higher nutritive value of legume-dominant pasture (Ulyatt et al., 1976) and the greater production of Pawera in late summer. The writers consider a red clover population of about 12 plants/m² in a mixed sward was sufficient to give high quality production without penalizing autumn grass growth. Figure 1 shows that a stable population of this value could be achieved by overdrilling at 4 kg/ha. It was sufficient to contribute 35% of the DM production during the summer of the fourth year (Table 2).
An important feature of Pawera is its compatibility with a winter annual, introduced by overdrilling following hard grazing. This gives better spread of production throughout the year than either a conventional white clover-based pasture or pure Pawera. The overdrilling technique will give more feed in late winter-early spring.

The phyto-oestrogen formononetin, present in high concentrations in Pawera, has been found to cause infertility problems in sheep (Lindsay and Kelly, 1970). In Western Australia exposure of breeding ewes to pastures dominated by subterranean clover, later found to have high levels of formononetin, has resulted in lambing percentages (lambs tailed/ewes mated) falling from 80% to below 30% and with as many as 70% of the ewes exhibiting signs of permanent infertility (Bennetts et al., 1946). However, when the oestrogenic legume was mixed with a grass in pastures, the subsequent dilution of total ingested formononetin resulted in a lessening of deleterious effects (Davies and Maller, 1970).

It is concluded that it would be unwise to graze ewes for extended periods on pure Pawera, particularly at mating time, but the high late-summer production and excellent herbage quality of pure Pawera stands (23% crude protein) would be valuable for lamb finishing. Also, with Pawera's high yield potential during December to February, the hay-making period in Southland, hay requirements could be met with two or three cuts from a limited area. This hay may be fed to breeding stock, since drying to a moisture level suitable for conservation causes the formononetin level to decline markedly. For example, the writers have recorded formononetin levels falling from 1.0% at mowing to 0.2% at baling, a level considered by Marshall (1973) in his review to be unlikely to cause infertility in sheep.

Pawera appears therefore to have high potential in Southland, although indiscriminate use that disregards the important phyto-toxic effects could lead to a decline in animal production.

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REFERENCES


