Establishment year productivity, botanical composition and nutritive value of grass/lucerne/plantain dairy pasture mixtures

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Abstract
In the context of dairy grazing systems, pasture mixtures including tall fescue, lucerne and plantain have been identified by animal modelling as having potential to both improve milk production and reduce urinary nitrogen excretion. A grazed paddock-scale trial was established in the Waikato in September 2015 to test this in two short-term grazing trials including these species. This paper presents the pasture production, botanical composition and nutritive value data generated from four pasture mixtures sown in spring 2015 and sampled until autumn 2017 (18 months). The pasture mixtures represented a comparison between perennial ryegrass and tall fescue, with and without the herb narrow-leaved plantain. The inclusion of plantain in grass-lucerne mixtures had a positive effect on first-year herbage dry matter (DM) production, by –2.6 t DM/ha/year in ryegrass-based pastures and –1.6 t DM/ha/year in tall fescue-based pastures. Where plantain was included, the proportion of grass was reduced by more than half from autumn 2016 through to summer 2016-2017, while the proportion of lucerne was reduced to a lesser degree. The proportion of plantain was 35-70% through most of the first year, declining to <20% in the second autumn. Plantain pastures showed poor forage supply and persistence because of summer drought and pest damage (Daly et al. 1996; Woodward et al. 2013). These mixtures can achieve greater total annual nitrogen (N) uptake due to their complementary root systems and seasonal growth patterns (Vibart et al. 2016). In New Zealand, the early interest in using diverse pasture mixtures arose from a need to maintain animal production in environments where conventional perennial ryegrass/white clover pastures showed poor forage supply and persistence because of summer drought and pest damage (Daly et al. 1996; Woodward et al. 2013). Herbs such as chicory (Cichorium intybus) and narrow-leaved plantain (Plantago lanceolata) were used as they had already shown promise in monoculture; good quality seed was available and their management was well understood.

It is important to know whether the benefits of diverse pastures can be attributed to the greater diversity of species in the pasture mixture or to the presence of individual species. Pemberton et al. (2015) attributed such benefits to the functional attributes of the additional species and Vibart et al. (2016) also suggested that the presence of specific well-adapted species is more important than the number of species, in driving herbage production and N-dynamics. There is now good evidence from New Zealand studies of dairy systems that pasture mixtures containing forage herbs, in particular narrow-leaved plantain, lead to reductions in urinary N concentration (Table 1). In some cases, this has also resulted in improvements in milk solids (MS) production.

Given that much of the work on this subject to date has been conducted in Canterbury, a grazed paddock-scale trial was established in the Waikato in September 2015 to examine the effect of specific pasture mixtures on milk production and urinary N in two short-term grazing trials. The results of these grazing trials in...
February 2016 and November 2016 will be presented elsewhere (see Dodd et al. 2017). The objective of this paper is to document the early development of the pasture mixtures in terms of seasonal herbage production, botanical composition, and nutritive value.

Methods
Selection of swards
The pasture species selected for this field experiment were based on simulations with the MOLLY animal model, using data on chemical composition and metabolisable energy for a range of pasture species (Gregorini et al. 2016). The modelling compared perennial ryegrass (Lolium perenne), tall fescue (Festuca arundinacea), cocksfoot (Dactylis glomerata), kikuyu (Pennisetum clandestinum), perennial ryegrass (Lolium perenne), tall fescue (Festuca arundinacea), cocksfoot (Dactylis glomerata), kikuyu (Pennisetum clandestinum), chicory and plantain (Plantago major), autum. Perennial ryegrass (Lolium perenne), tall fescue (Festuca arundinacea), cocksfoot (Dactylis glomerata), kikuyu (Pennisetum clandestinum), chicory and plantain (Plantago major), and prairie grass (Bromus wildenowii), white clover (Trifolium repens), lucerne (Medicago sativa) (2017). The objective of comparison using high sugar ryegrass.

Table 1

<table>
<thead>
<tr>
<th>pasture type</th>
<th>ryegrass + white clover + chicory + plantain</th>
<th>ryegrass + white clover + chicory + lucerne</th>
<th>ryegrass + white clover + prairie grass + chicory + plantain + red clover</th>
<th>ryegrass + white clover + prairie grass + chicory + plantain + red clover</th>
<th>Plantain</th>
<th>ryegrass + white clover + plantain</th>
<th>ryegrass + white clover + plantain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Season</td>
<td>Autumn</td>
<td>Spring</td>
<td>Summer</td>
<td>Summer</td>
<td>Autumn</td>
<td>Autumn</td>
<td>Autumn</td>
</tr>
<tr>
<td>Change in MS yield (kg MS/cow/d)</td>
<td>Nil</td>
<td>-17% (1.47 versus 1.72)</td>
<td>+11% (1.50 versus 1.67)</td>
<td>+7% (1.50 versus 1.60)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in UN concentration (g N/L)</td>
<td>-40% (5.7 versus 3.4)</td>
<td>-30% (4.2 versus 2.9)</td>
<td>-28% (4.4 versus 3.3)</td>
<td>-28% (4.4 versus 3.1)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Autumn +22% (4.8 versus 3.9), Summer +17% (1.47 versus 1.72), Spring +11% (1.50 versus 1.67), Summer +5% (0.4 versus 0.4), Spring +5% (0.4 versus 0.4). These seasonal differences are consistent with the well-recognised establishment rates and relative seasonal growth patterns of PR and TF (Clark et al. 2010). Over a full year of pasture harvests (Feb 2016 to Jan 2017), there was no significant difference in the total herbage production of the ryegrass and fescue-based pastures. However, over that full year, the paddocks with plantain grew on average 2.6 t DM/ha (for ryegrass-based pastures) or 1.6 t DM/ha (for fescue-based pastures) more forage in total than those without plantain (P<0.01). The seasonal breakdown showed that this difference was most apparent during early (P<0.01) and late spring (P<0.05). No significant interactions were found between bare grass species and plantain presence in terms of herbage DM production at any stage. While there are a number of previous studies showing increased DM production with the inclusion of plantain in mixed pastures, in such cases it has typically been a minor component with a number of other species (e.g. Daly et al. 1996; Nobilly et al. 2013). These results indicate the potential contribution of plantain as a major sward component.
Botanical composition
The contribution of ryegrass in the PR+L swards was consistently greater than that of tall fescue in the TF+L swards (Figure 1), although this was only significant in late spring (P<0.05). The proportion of plantain in PR+L swards, this was not significant in any season. While the contribution of lucerne was consistently less in tall-fescue swards, this was not significant in any season. The contribution of lucerne was consistently greater in PR+L swards, this was not significant in any season. While the contribution of lucerne was consistently less in tall-fescue swards, this was not significant in any season.

<table>
<thead>
<tr>
<th>Season</th>
<th>Measure</th>
<th>PR+L</th>
<th>PR+L+P</th>
<th>TF+L</th>
<th>TF+L+P</th>
<th>SED</th>
<th>Grass effect</th>
<th>Plantain effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autumn 2016</td>
<td>C</td>
<td>21.2</td>
<td>18.5</td>
<td>21.4</td>
<td>18.6</td>
<td>1.7</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>DOMD</td>
<td>56.5</td>
<td>59.8</td>
<td>57.8</td>
<td>59.1</td>
<td>1.6</td>
<td>NS</td>
<td>NS</td>
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<tr>
<td></td>
<td>ME</td>
<td>9.1</td>
<td>9.6</td>
<td>9.2</td>
<td>9.5</td>
<td>0.3</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Winter 2016</td>
<td>C</td>
<td>25.5</td>
<td>23.4</td>
<td>30.0</td>
<td>23.7</td>
<td>1.8</td>
<td>P&lt;0.05</td>
<td>P&lt;0.01</td>
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<tr>
<td></td>
<td>DOMD</td>
<td>71.7</td>
<td>72.7</td>
<td>73.9</td>
<td>73.1</td>
<td>1.2</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>ME</td>
<td>11.5</td>
<td>11.6</td>
<td>11.8</td>
<td>11.7</td>
<td>0.2</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Late Spring 2016</td>
<td>C</td>
<td>22.7</td>
<td>24.8</td>
<td>24.3</td>
<td>26.5</td>
<td>1.8</td>
<td>NS</td>
<td>NS</td>
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<tr>
<td></td>
<td>DOMD</td>
<td>76.5</td>
<td>75.9</td>
<td>72.1</td>
<td>74.8</td>
<td>0.9</td>
<td>P&lt;0.01</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>ME</td>
<td>12.3</td>
<td>12.2</td>
<td>11.5</td>
<td>12.0</td>
<td>0.2</td>
<td>P&lt;0.01</td>
<td>NS</td>
</tr>
<tr>
<td>Summer 2016</td>
<td>C</td>
<td>17.4</td>
<td>17.2</td>
<td>18.8</td>
<td>20.3</td>
<td>1.5</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>DOMD</td>
<td>69.3</td>
<td>69.2</td>
<td>66.9</td>
<td>67.2</td>
<td>0.8</td>
<td>P&lt;0.01</td>
<td>NS</td>
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<tr>
<td></td>
<td>ME</td>
<td>11.1</td>
<td>11.1</td>
<td>10.7</td>
<td>10.7</td>
<td>0.1</td>
<td>P&lt;0.01</td>
<td>NS</td>
</tr>
</tbody>
</table>

Table 3 Seasonal and annual herbage DM accumulation (t DM/ha) of four pasture mixtures as measured by harvesting to a 4.5 cm stubble. Seasons are as defined in the DairyNZ Forage Value index for the upper North Island. PR = perennial ryegrass; TF = tall fescue; L = lucerne; P = plantain; SED = standard error of difference; NS = not significant, P>0.05.
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REFERENCES


