Sirolan phalaris and Kasbah cocksfoot prove more persistent than lucerne under drought in a medium rainfall cropping environment

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Abstract
Cultivars of phalaris (Phalaris aquatica L.) and cocksfoot (Dactylis glomerata L.) suited to lower rainfall cropping environments have existed in Australia for over 40 years, but remain rarely used in commercial crop rotations. A field experiment was established in 2010 at Ariah Park, NSW, to test the persistence of phalaris cv. Sirolan and cocksfoot cv. Kasbah compared to winter active and semi-winter dormant lucerne (Medicago sativa L.) cultivars on a red soil where the average annual rainfall is 460 mm. All treatments established successfully in 2010 and persisted well through the summers of 2010/11 and 2011/12 which were both substantially wetter than average. A rapid reduction in perennial plant density was observed in all treatments following the dry spring/summer period of 2012/13. However, the basal frequency of Sirolan phalaris (19%) and Kasbah cocksfoot (25%) was greater than either winter active or semi-winter dormant lucerne genotypes (4-5%). Sirolan was the most productive of all perennial treatments, producing significantly more dry matter than lucerne in years 1, 4 and 5. Kasbah cocksfoot was more productive than lucerne in year 5 only, but was significantly less productive in year 2. This study showed that the perennial grasses were productive and persistent in this environment and their greater use could benefit modern crop rotations.

Key words
Pasture mixture; production; winter activity

Introduction
Lucerne (Medicago sativa L.) is the most widely used perennial pasture species in winter-cropping systems of south-eastern Australia. It is broadly adapted and is highly valued in mixed farming systems for its ability to produce high quality forage for livestock and fix nitrogen (N) for subsequent crops. However, there is a need for viable alternatives to lucerne in these farming systems to improve the balance of seasonal pasture production and to mitigate the low levels of groundcover in lucerne swards. Cool-season perennial grasses are arguably one of the few viable options that exist in these environments (Hayes et al. 2012). They have been shown to be able to survive in phased rotations in lower-rainfall mixed farming environments (Dear et al. 2004), although adoption remains relatively low, due in part to perceived lower production and poor persistence of these species relative to lucerne (Hayes et al. 2010). The current study tested the production, persistence and relative ground cover of two cool-season grasses, Sirolan phalaris (Phalaris aquatica L.) and Kasbah cocksfoot (Dactylis glomerata L.), compared to winter active and semi-winter dormant lucerne types over 5 years at a site in the medium rainfall cropping zone of southern NSW.

Method
A field experiment was sown near Ariah Park, NSW (34.35S, 147.22E), on 7 May 2010 using a cone seeder. Treatments reported here include Kasbah cocksfoot (sown at 3 kg/ha of germinable seed), Sirolan phalaris (2.5 kg/ha), winter active lucerne (dormancy rating 9-10, where 1 is most dormant and 10 is most active) comprising an equal mixture of cultivars Cropper 9.5, Sardi 10 and Silverado sown at a total of 2.5 kg/ha and an equal parts mixture of semi-winter dormant lucerne (dormancy rating 4-5) cultivars (Venus, Stamina 5 and 54Q53) sown at 2.5 kg/ha. All treatments were mixed with 4 kg/ha subterranean clover (Trifolium subterraneum L.) cv. Urana. All legume seed was inoculated with appropriate rhizobia groups and lime pelleted prior to sowing. The results of the annual legume component of the sward will be reported elsewhere. Plot size was 6 × 4 m. Starter fertiliser (6.7% N, 13.9% P, 8.6% S) was applied at 120 kg/ha at sowing and single superphosphate (8.8% P, 11% S) was top-dressed annually at approximately 100 kg/ha. In the year of establishment annual grass weeds were removed by hand.

Persistence of sown species was assessed as basal frequency by counting the presence of a perennial base (crown) in two fixed 1 × 1 m quadrats containing 100 squares, expressed as a percentage of the total number
of squares. Basal frequency was measured 12 weeks after sowing in year 1, and shortly after the first rains in autumn in years 2-5. Above ground biomass was assessed at the end of spring in the establishment year and at the end of every season thereafter using a calibrated visual assessment. The botanical composition of each sward was assessed at the same time as available biomass by using the dry-weight rank method (t’ Mannetje and Haydock 1963) on 10 quadrats across a transect of each plot. Following each assessment of biomass the site was grazed with a high stocking rate of sheep leaving a residual biomass of approximately 1 t/ha across the site. Exposed bare ground was assessed in November 2011 and subsequently in early autumn in each year thereafter by counting the number of squares containing no plant material, including litter, in the above-mentioned fixed quadrats. Data is expressed as a percentage of quadrat squares containing no plant material. All data were analysed using an analysis of variance at the 95% confidence level.

Results
The site experienced wetter than average conditions in the first 3 years of experimentation, with years 4 and 5 being drier than average (Table 1). The period from September 2012 to February 2013 was extremely dry with very few substantial rainfall events, and proved to be a significant turning point for the persistence of perennial pasture species in this experiment.

Table 1. Monthly rainfall (mm) recorded near the experimental site 2010-14 compared to the long term (120 year) median and average for that location (Source: Bureau of meteorology; station 73000).

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Total</th>
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<tr>
<td>2010</td>
<td>10.2</td>
<td>67.8</td>
<td>73.6</td>
<td>34.2</td>
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<td>19.6</td>
<td>65.8</td>
<td>53.2*</td>
<td>64.4</td>
<td>114.3</td>
<td>66.0</td>
<td>84.6</td>
<td>728.1</td>
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<tr>
<td>2011</td>
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<td>203.8</td>
<td>72.8</td>
<td>21.2</td>
<td>23.8</td>
<td>20.0</td>
<td>18.0</td>
<td>49.4</td>
<td>28.4</td>
<td>29.0</td>
<td>92.0</td>
<td>82.0</td>
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<td>111.4</td>
<td>125.2</td>
<td>7.4</td>
<td>43.6</td>
<td>30.8</td>
<td>42.2</td>
<td>41.2</td>
<td>9.0</td>
<td>12.8</td>
<td>34.0*</td>
<td>13.2</td>
<td>551.8</td>
</tr>
<tr>
<td>2013</td>
<td>1.0</td>
<td>42.0</td>
<td>23.4</td>
<td>2.8</td>
<td>53.8</td>
<td>87.2</td>
<td>39.4</td>
<td>26.8</td>
<td>40.4</td>
<td>15.8</td>
<td>14.8</td>
<td>12.8</td>
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<td>2014</td>
<td>20.0</td>
<td>25.6</td>
<td>40.0</td>
<td>53.0</td>
<td>32.2</td>
<td>69.4</td>
<td>27.4</td>
<td>16.0</td>
<td>34.8</td>
<td>16.4</td>
<td>31.8</td>
<td>16.6</td>
<td>383.2</td>
</tr>
</tbody>
</table>

Mean 28.0 22.0 24.0 23.1 30.9 36.2 38.9 36.7 30.9 36.3 34.2 31.0 463.9
Median 42.5 38.1 38.8 35.9 37.8 42.3 41.8 37.5 37.4 44.3 39.6 40.6 481.5

* Values unavailable from Ariah Park recording station so taken instead from Barmedman

All treatments established successfully with higher initial seedling density for cocksfoot and phalaris and lower seedling density for both winter active and semi-winter dormant lucerne (data not shown). Establishment differences were reflected in the initial measurement of basal frequency in July 2010 (Fig. 1A). Following the first summer differences in basal frequency between treatments were not significant at P=0.05, until the final sampling in 2014 where the basal frequency of the two grasses was significantly greater than both lucerne types (Fig. 1A). Differences in levels of groundcover between treatments were only significant at P=0.05 in 2013 where the level of exposed bare ground was higher in the semi-winter dormant lucerne than either grass treatment (Fig 1B).

Fig. 1. A) Basal frequency (%) of sown perennial species and B) area of each sward where the soil surface was exposed, at one sampling time in each year for swards sown to Kasbah cocksfoot, Sirolan phalaris, semi-winter dormant (4-5) or winter active (9-10) lucerne. Error bars show differences between treatments at P=0.05, otherwise marked ‘ns’.

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Sirolan phalaris was the most productive sown species in this experiment with significantly more biomass compared to cocksfoot or either of the lucerne treatments, especially in years 1 and 4 (Figure 2). In both of those years the level of available Sirolan phalaris biomass was more than double that of any other treatment. By contrast, Kasbah cocksfoot was the most productive sown perennial species in year 5 although this was the only occasion where there was significantly ($P=0.05$) greater cocksfoot biomass than phalaris.

The experiment demonstrated that Sirolan phalaris and Kasbah cocksfoot can be more productive and persistent than lucerne over a 5-year pasture phase in the medium rainfall environment of southwest NSW. Sirolan phalaris in particular was able to take advantage of favourable seasonal conditions during the establishment year to produce almost 10 t/ha of aboveground biomass, more than double that of either lucerne or Kasbah cocksfoot. It was the most productive perennial species in year 4 which also happened to be the driest year of experimentation (Table 1), made possible by its high winter activity. The performance of Sirolan over a range of seasonal conditions highlights its broad adaptation to this environment. Sirolan phalaris was bred for lower rainfall cropping environments in south-eastern Australia and was released in 1978 (Oram 1990). There remain few phalaris genotypes which can out-yield Sirolan in medium-low rainfall cropping environments (Culvenor et al. 2012).

Kasbah cocksfoot is a highly summer-dormant public cultivar collected from a semi-arid environment in southern Morocco receiving approximately 270 mm rainfall a year, and was released commercially in Australia in 1970 (Oram 1990). It is perhaps not surprising that it persisted through the drought period in years 3 and 4 and recovered to be the most productive perennial species in year 5 of this experiment. The significantly lower levels of production of Kasbah cocksfoot in year 2 was of particular interest given that this was generally a favourable year for pasture production, with November, December, February and March, being substantially wetter than normal (Table 1). A substantial amount of rainfall in this year fell during the summer period when Kasbah cocksfoot would normally be dormant. The authors noted that Kasbah was less summer dormant than expected in the summer of 2010/11 and less productive than expected during the following cooler months of 2011. The reason for this is not clear as previous studies have shown this cultivar to have a very strong summer dormancy mechanism (Norton et al. 2006). We postulate that abnormally low summer temperatures in addition to higher summer rainfall reduced the ability of Kasbah cocksfoot to enter summer dormancy which had a negative impact on the overall performance of this cultivar during the earlier years of experimentation.
years of experimentation. Nevertheless, Kasbah recovered during the drier years to produce the highest dry matter in year 5.

We found very little difference in the overall performance of lucerne regardless of whether it was winter active or semi-winter dormant. In no year did either group produce more total biomass than the other, nor did one persist better than the other. Levels of groundcover in the year following the period of drought did not differ between lucerne genotypes, however, differences in levels of bare ground between the summer active lucerne compared with Sirolan phalaris were significant at P=0.05. The superior persistence of both Kasbah cocksfoot and Sirolan phalaris compared to both lucerne treatments after the extended dry period is another important result and provides field validation to earlier glasshouse studies showing that Kasbah has better dehydration tolerance than lucerne (Volaire 2008). These results suggest that in such drought prone environments these perennial grasses could add value to mixed farming enterprises. More thorough analysis of the data is necessary to evaluate aspects such as seasonal production, but this initial data set provides little evidence that winter activity group affects lucerne persistence in this environment. This is contrary to a previous study which showed highly winter active varieties to be less persistent under a more continuous grazing regime (Humphries et al. 2006). However, given the high stocking rates (12-80 dry sheep equivalent/ha) used to realise these differences, it remains questionable whether differences in persistence between winter activity groups would be significant in a paddock situation under the extensive grazing regime commonly imposed on lucerne pastures in the medium-rainfall cropping zone of NSW.

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References


