Pastures

Powdery mildew resistant medics for the EP and Mallee

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Key messages

• We have short-listed a small group of strand medics with resistance to powdery mildew which exceed our benchmark strand medic cultivars, Herald and Angel, by up to 30% for dry matter production and seed yield.

• If the agronomic performance of non-segregating lines can be confirmed at new and regenerating sites, there are excellent prospects for a future cultivar release.

• The lines also have tolerance to SU herbicide residues, aphid resistance and a larger seed size.

• Regeneration and hardseed breakdown studies indicate they behave similarly to Angel.

• Unexpected responses to Rhizobium inoculation confirm some grower observations of poor medic nodulation in the Mallee, but the reasons for this remain unclear.

Why do the trial?

The main aim of this SAGIT funded project was to assess the potential of a group of early generation “multi-trait” breeders’ lines for future commercial development. More specifically the project has:

• Evaluated the agronomic performance of 27 early generation strand medic lines (and subsequent re-selections) possessing various combinations of important new traits;

• Made in-situ field re-selections from segregating medic lines under evaluation at the field sites and multiplied seed of these for further testing.

How was it done?

As part of this project, field selections and glasshouse screening for traits that are still segregating, have been regularly undertaken. Based on the excellent performance at multiple sites in 2010 and 2011 (EPFS Summary 2010, pp 61-62; EPFS Summary 2011, pp 68-70), a set of 17 non-segregating (stable) strand medic hybrids with various combinations of powdery mildew (PM) resistance, SU herbicide tolerance, aphid resistance and large seeds, was shortlisted for sowing in 2012. This included daughter lines for field testing to ensure they perform as well agronomically as the segregating PM parent lines from which they were selected. Also included were five benchmark cultivars and parents and, in response to farmer feedback at field days and measures of poor nodulation in 2010 and 2011 field trials, we also included some additional rhizobial treatments.
In addition to regenerating sites at Karoonda and Minnipa two experiments were established in the Murray Mallee at Lameroo and Netherton, enabling further evaluation of dry matter production, disease tolerance and seed yield.

**What happened?**

**2012 sown trials – agronomic evaluation (Lameroo and Netherton)**

Once again we were very encouraged with the agronomic performance of the PM lines with respect to dry matter (DM) production, seed yields are currently being processed and analysed. At Lameroo the top five PM lines (range: 84–95 of % maximum site yield (MSY); average 89% MSY) significantly out-yielded the benchmark strand medic cultivars, Herald, Angel and Jaguar (range: 55–71% MSY; avg. 66%). At Netherton the top five PM lines (88–95% MSY; avg. 91%) similarly out-yielded the strand medic cultivars (70-81% MSY; avg. 76%).

A feature of the new lines was increased early season vigour, possibly a benefit of the larger seed size inherited from the original PM resistant parent. Seed yields, which provide a critical measure of potential pasture persistence and future productivity, have been harvested and are currently being processed. The harsh spring finish should provide a good test of their ability to produce seed and persist under adverse conditions. In previous years they have been excellent; for example at Netherton 2011 the PM resistant lines averaged 1100 kg/ha, 30% greater than Herald and Angel (Figure 1).

![Figure 1 Leaf senescence (%) associated with the development of powdery mildew symptoms (bar), and kg/ha seed yield (line) of annual medic cultivars and PM-strand medic selections at Netherton, SA, 2011 (LSD P=0.05)](image)

**2012 regeneration of 2011 Karoonda site (powdery mildew resistance – field observations)**

Despite the poor establishment at this site last year due to areas of non-wetting soil, there was enough seed-set to enable an adequate regeneration after early season rains in March. Although experimentally quite variable, this site as a whole responded very well to winter rains with the best plots producing an estimated 4 tDM/ha.

At the time of the Karoonda MSF Field Day (GRDC GroundCover #102, p 14) the PM lines were still fresh and showing no signs of powdery mildew infection whereas Herald and Angel, although also growing well, were developing a heavy PM infection in the understory.
This is the second year we have been able to observe the impact of powdery mildew on the PM lines in the field (Netherton, 2011, Figure 1.) and we are very encouraged in that so far they support our results from greenhouse studies and field observations at the Waite Campus. However it is important to note that more fundamental research regarding the identification, pathogenicity and prevalence of different races of powdery mildew (if more than one) in SA is needed so that appropriate breeding strategies can be developed to ensure that the excellent levels of resistance in the current set of PM lines will be maintained.

2012 regeneration of 2010 Minnipa Agricultural Centre site

After growing very well in 2010, this site was sown to canola in 2011 and regenerated successfully in 2012, enabling two dry matter assessments to be made in August and September. As this was our first site regenerating after crop, it was pleasing to note the good performance (relative to the strand medic cultivars) of the parental PM lines which had subsequently been progressed (via their selected non-segregating progeny) into later trials.

Hardseed breakdown studies

Pods of short-listed PM lines and both parents (Angel and PM parent) were harvested from the Netherton 2011 site and taken back to the Waite Campus for hardseed breakdown studies conducted over 12 weeks from February to May 2012. At the end of the study Angel’s hardseed content had declined from 99 to 88% and PM parent from 97 to 91%. The PM hybrid lines declined in hardseededness from 96-100% to 87-91% (i.e. very similar to both parents). This coupled with the Minnipa 2012 regeneration data, provides us with confidence that this material possesses an appropriate level of hardseededness for persistence in a ley farming system.

Nodulation responses in the field

Assessments of nodulation were made at Netherton, Lameroo and Karoonda where several additional rhizobia inoculation treatments were incorporated into the trial and demonstration plot designs in response to previous measures of inoculation response.

Large responses to inoculation in terms of nodule number were measured at Lameroo and Karoonda and improvements in legume vigour observed at the sites. The work again confirms that frequent grower reports of poor nodulation in the Mallee should be taken seriously and some work will continue to determine why this is occurring. Contrary to general practice, the findings show that medic should be inoculated to ensure good establishment and early vigour when sown on Mallee soils, even where there has been a recent history of medic in the paddock. Particular attention will be paid to ensuring PM medic lines are well inoculated in future trials to ensure their potential benefits are not limited by symbiotic constraints.

What does this mean?

The third year of field evaluation has so far confirmed our initial findings.

- We have identified a small group of material which exceed our benchmark strand medic cultivars, Herald and Angel, by up to 30% for dry matter and seed yield.
- The hybrid lines have powdery mildew resistance, SU herbicide tolerance, aphid resistance and larger seeds (cf Herald and Angel).
- Further selections have been made and there are excellent prospects for a future commercial release.
- Unexpected responses to inoculation confirm some grower observations of poor medic nodulation in the Mallee, but the reasons for this remain unclear.

Pending final harvest results from 2012 we will analyse all available data and further shortlist the PM daughter lines for final cultivar selection work in 2013-15, pending availability of future funding. These will be further seed increased at the Waite in 2013 to enable future cultivar developmental work.

Reference


Acknowledgements

We gratefully acknowledge the funding by South Australian Grains Industry Trust; technical assistance from Jeff Hill, SARDI; MAC (Roy Latta & Ian Richter) and collaborators: Peter & Hannah Loller, Karoonda; Lester & Kay Cattle, Netherton and Trevor Pocock, Lameroo, Andy & Helen Barr, Pinery.
Key messages
27 months after establishment the study has continued to show:

- Lucerne to be well adapted to good Eyre Peninsula cropping soils.
- Cullen and Tedera to be more persistent and productive than lucerne on shallow calcareous and highly acidic soils respectively.
- Sulla to be highly productive on good EP cropping soils in the growing season following establishment.

Why do the trial?
The use of perennial legumes on Eyre Peninsula has been largely restricted to lucerne, however it is not considered to be well adapted to shallow constrained soils common across much of the region. The benefits of a perennial legume phase within an intensive cropping system for soil rehabilitation and economic weed management is well documented.

As part of a national program to identify alternative perennial legumes to lucerne suitable for incorporation within cropping systems, there are at least 3 options potentially adapted to specific areas and systems within Eyre Peninsula.

Research in South Australia has shown Sulla (*Hedysarum coronarium*) to be a highly productive, perennial/biennial legume. The plants can survive for 2-3 years, but it will regenerate readily from seed. Sulla is used for grazing or hay production and contains condensed tannins that make it bloat-safe, increase protein digestion in livestock and make it less attractive to insects. These tannins also provide a reputed anthelmintic effect which may reduce worm and nematode burdens. Sheep grazing Sulla have been recorded to scour less, which is considered a result of the tannin content.

Western Australian research is suggesting that *Bituminaria bituminosa var albomarginata*, or Tedera, as it is more commonly known in its native Canary Islands, has the potential to offer a solution to the shortcomings of lucerne. It is shallow-rooted and very drought tolerant. Lucerne may only survive summer drought by its deep roots accessing a water supply. On many EP soils lucerne dies in the more constrained, shallow soils.

The third option *Cullen australasicum*, a native perennial legume, has been as persistent and productive as lucerne in previous South Australian studies. These results suggest that Cullen species will have adaptations to both survival and productivity traits that make them suitable for further development as perennial pastures in the low rainfall Mediterranean climate of upper Eyre Peninsula.

These three perennial species were considered worthy of continuing evaluation to compare to lucerne at a range of Eyre Peninsula sites. To review 2010 results see EPFS Summary 2010, p 141.

How was it done?
Six lines of forage perennials: Lucerne, Sulla, Cullen and three Tedera lines were established at four Eyre Peninsula sites in 2010 to represent four rainfall and soil type regions: Minnipa (325 mm), Rudall (350 mm), Edillilie (400 mm) and Greenpatch (450 mm). Soil types varied from red sandy loam (Minnipa, pH 7.7 -7.8 CaCl$_2$), calcareous sand (Rudall, pH 7.7-8.1 CaCl$_2$), slightly acidic, shallow duplex (Edillilie, pH 6.4-7.5 CaCl$_2$) and an acidic sand over clay (Greenpatch, pH 4-5.1 CaCl$_2$) in the 0-0.6 m soil profile.

Table 1 Plant establishment and persistence (plants/m$^2$) from 2010 (Minnipa 2011) until 2012

<table>
<thead>
<tr>
<th></th>
<th>Minnipa</th>
<th>Rudall</th>
<th>Edillilie</th>
<th>Greenpatch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tedera 27</td>
<td>17</td>
<td>16</td>
<td>5</td>
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<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Cullen</td>
<td>17</td>
<td>17</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Sulla</td>
<td>40</td>
<td>18</td>
<td>7</td>
<td>6</td>
</tr>
</tbody>
</table>
In 2010 the trials were hand sown in 3 x 2 m plots replicated twice; Minnipa 2 June, Edillilie 22 July, Rudall 30 July, then re-sown on 18 September and Greenpatch 11 October. The Minnipa site was desiccated with an unplanned broad spectrum herbicide in March 2011. A replacement site was established at Minnipa on 2 May 2011, 5 x 1.5 m plots with 2 replicates were hand-sown into rows at 0.5 m row spacings.

What happened?

The trials were measured for biomass and plant numbers at each flowering time. 2012 rainfall and the months sampling was carried out in 2012 were; Minnipa (237 mm, January, May, July and October), Rudall (320 mm, January, April and May then site abandoned), Edillilie (385 mm, January, February, April, May, July, October, November and December) and Greenpatch (450 mm, January, April and May then site abandoned). Soil water measurements were collected in November 2012 at the Edillilie site to compare water use of species being evaluated.

The Sulla plant densities had declined after 2 summers at all 3 sites (Table 1). Cullen numbers declined at both the higher rainfall neutral to acidic Greenpatch and Edillilie sites, and reduced numbers at the Minnipa site in line with other entries. Lucerne plant numbers have trended lower at the 3 initial sites. The Tedera 27 and 37 have similar to lower numbers at all 4 sites while Tedera 42 has maintained or increased numbers over the 18 and 30 month period.

Over the study period the entries that produced more biomass than the site mean, the average of all entries, were lucerne at Minnipa, Cullen and Tedera lines 27 and 42 at Rudall, Lucerne and Sulla at Edillilie and Tedera lines 27 and 42 at Greenpatch (Table 2). Tedera line 37 produced less than the site mean at all 4 sites.

Soil water content at Edillilie declined over the 12 months under all the entries apart from lucerne (Table 3), which returned to the 2011 figure. The abandonment of the Rudall and Greenpatch sites in May 2012 was in response to the Cullen (Rudall) and Tedera (Rudall and Greenpatch) having shown their improved adaptation in terms of productivity and persistence to these constrained sites compared to lucerne with low productivity and plant numbers supporting the decision. The continuation of the 2 sites on the “better” cropping soils until April 2013 will assess the drought tolerance of these lines over the third and to date driest summer period of the study.

What does it mean?

Both the Tedera and Cullen are only partially developed lines and will continue to be progressed through an intensive selection process in terms of establishment, management, persistence and animal production issues. However, these trials are giving an indication as to the potential role of “improved” lines of these perennial pasture species in the EP environment and farming systems.

Acknowledgements

Thanks to Matt Dunn at Rudall, Shane Nelligan at Edillilie and Arnd Enneking at Greenpatch for allowing the use of their land for this trial.
Establishing and managing perennial phase pastures
Roy Latta and Suzie Holbery
SARDI, Minnipa Agricultural Centre

Key messages
• Under-sowing perennial legumes to barley failed in 2012.
• Over-cropping established lucerne with a cereal produced a viable crop yield but suppressed lucerne to the extent the population declined.

Why do the trial?
The introduction and use of perennial legume pastures on Eyre Peninsula is often restricted by shallow constrained soils, not suitable for deep rooted perennials. The project “Evaluation of perennial forage legumes on Eyre Peninsula” outlined in the 2012 EP Farming Systems Summary aimed at identifying and promoting perennial options for these constrained soils.

However there may also be a role for perennials as phase pastures in cropping systems to address weed, pest and disease issues that require an extended break. Phase pastures can be described as pastures that require establishment at the commencement of each phase, as opposed to a self-regenerating annual medic pasture.

The trials reported are based on evaluating opportunities to integrate well adapted perennial legumes into cropping rotations as breaks between extended periods of cropping. Lucerne due to its partial winter dormancy and summer activity is one option. Sulla as a second option has performed well in current trials (EPFS Summary 2012, Evaluation of perennial forage legumes on Eyre Peninsula), and differs from lucerne in that it is a biennial and summer dormant.

The time required for successful establishment of the perennial is an issue whereby a full season’s production can be lost before any grazing can be undertaken. An option to address this is to under-sow the final year of the cropping phase with the perennial. An establishment trial was established at Edillilie and a commercial demonstration site on Minnipa Agricultural Centre (MAC) to assess under-sowing lucerne and other alternative perennials.

The other component evaluated was the over-cropping of established lucerne pastures with a cereal crop to assess the opportunity to produce an economic field crop while producing high quality stubbles and a summer forage supply. This addresses the ongoing cost and risk of failure when establishing a perennial. A trial and a demonstration site were established at Minnipa in 2012.

How was it done?
Under-sowing perennials
At Edillilie lucerne, Sulla, Cullen and Tedera were sown on 7 June 2012 both as monocultures and in alternate rows with Hindmarsh barley crop sown @ 60 kg/ha and 30 kg/ha in 6, 0.25 m and 3, 0.5 m spaced rows respectively by 5 m plots. All plants within plots were counted on 14 September and again on 5 December. Total plot biomass samples were collected on 19 October and 5 December. Grain yield comparisons between the 6 and 3 row barley plots were estimated from biomass collected at anthesis (19 October) and calculated from harvest indexes. Due to bird damage it was not possible to harvest complete plots. Comparative soil water contents in the 0-20, 20-40 and 40-60 cm profiles were collected on 20 November.

A demonstration site on MAC in paddock North 4 was sown on 6 June with Hindmarsh barley @ 35 kg/ha with 60 kg/ha of DAP at 30 cm row spacing. Lucerne (SARDI 10) was then sown @ 2.5 kg/ha in the inter-row, with no further fertiliser applied. Plant establishment counts were collected on 26 November, 8 December and 8 January from 100 1 m x 0.6 m quadrants.
Over-cropping established lucerne
At MAC in the agronomy paddock, lucerne was established in June 2011 in 20 m x 6 row plots, sown with GPS guided 2 cm auto steer. In 2012 sown rows of lucerne were removed with broad spectrum herbicides to allow for 5 sowing configurations (Table 1). On 24 May 2012 wheat was sown with 60 kg of DAP and at a sowing rate representative of the number of rows sown, 60 kg/ha 6 rows, 30 kg/ha 3 rows etc. On 9 July Bromoxyl and Hoegrass® was applied for broad-leaved weed and annual ryegrass control, it also suppressed lucerne production over winter. Measurements taken included soil water content pre-seeding, 19 April, and post harvest, 30 October, in 0.3 m soil profile sections down to 0.9 m, lucerne plant numbers on 4 June and again with biomass sampling on 29 October, from the complete plot. The wheat grain yield was calculated from plot weights collected with a Kingaroy harvester on 29 October.

An over-cropping demonstration site was established at MAC in the Enrich paddock on 24 May 2012 when a 1 ha paddock of lucerne sown in 2009 had wheat and DAP both @ 60 kg/ha sown into half the paddock. Comparative biomass and lucerne plant numbers between treatments were estimated.

What happened?
Winter rainfall at Edillilie in 2012 was average (150 mm) but below average in spring (50 mm). At Minnipa it was similar, average over winter (100 mm) and low in spring (24 mm).

Table 1 Lucerne (L) and 2012 wheat (W) sowing configurations at Minnipa, 2012

<table>
<thead>
<tr>
<th>Treatment</th>
<th>LLLLLL</th>
<th>LWLWLW</th>
<th>LWWLWW</th>
<th>LWWWWL</th>
<th>WWWW</th>
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<tr>
<td>LWLWLW</td>
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<td>LWWLWW</td>
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<tr>
<td>WWWW</td>
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Table 2 Plant numbers (plants/m²), total biomass (tDM/ha), grain yield (t/ha) and soil water content (mm/0-0.6 m) at Edillilie in 2012

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant type</th>
<th>Sowing configuration</th>
<th>Plant numbers (plants/m²)</th>
<th>Total biomass (tDM/ha)</th>
<th>Grain yield (t/ha)</th>
<th>Soil water content (mm/0.06 m)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>14 Sept</td>
<td>5 Dec</td>
<td>5 Dec</td>
<td>5 Dec</td>
</tr>
<tr>
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<td></td>
<td>1.3</td>
<td>101</td>
<td>108</td>
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<tr>
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<tr>
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<tr>
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<td>13</td>
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<td>0.01</td>
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</table>

Table 3 Lucerne (L) plant numbers (plants/m²), total biomass (tDM/ha), wheat (W) grain yield (t/ha) and soil water content (mm/0-0.09 m) in the over-cropping trial at Minnipa, 2012

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Row configuration</th>
<th>Plant numbers (plants/m²)</th>
<th>Total biomass (tDM/ha)</th>
<th>Grain yield (t/ha)</th>
<th>Soil water content (mm/0.06 m)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>4 June</td>
<td>29 October</td>
<td>29 October</td>
<td></td>
<td>2.6</td>
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<tr>
<td>WWWW</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>19</td>
</tr>
<tr>
<td>LWLWLW</td>
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<td>0.02</td>
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<td>1.9</td>
</tr>
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<td>0.07</td>
<td></td>
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<tr>
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<tr>
<td>LLLL</td>
<td>11</td>
<td>8.5</td>
<td>1.40</td>
<td></td>
<td>96</td>
</tr>
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</table>
Established perennial legume numbers at the Edillilie site (Table 2) correlated with the 2 sowing densities; however number declined more in the alternate row sowing treatments than the monoculture. Biomass figures reflected the poor growth in the alternate row treatments plus the poor adaptation of the Cullen to the site. Estimated barley grain yields reflected the wide alternate row spacing. Soil water contents measured on the 22 November were variable, they trended higher under the monocultures but were much higher than prior to sowing when a site average of 62 mm was measured.

Lucerne densities in the North 4 demonstration site at Minnipa were counted 3 times to measure any decline. The barley yielded 1.4 t/ha. Counts on the 26 November, 20 December and 8 January 2013 totalled 9, 6 and 3 lucerne plants/m² respectively.

Over-cropping established lucerne with wheat in the agronomy paddock resulted in the loss of lucerne plant numbers and the suppression of lucerne biomass production (Table 3). The wheat yields reflected both the number of crop rows in each treatment plus the edge effect of the LWLWLW configuration compared to LWWWWL. Soil water content at the commencement of the study was 101 mm/0-0.9 m soil profile. The over-cropping demonstration site in the Enrich paddock established 21 plants/m² in 2009 and produced 10 t DM/ha from November 2010 to January 2012. On 20 August 2012 the wheat lucerne mixture had produced a total of 2.1 t/ha dry matter (wheat 1.2 t/ha, lucerne 0.9 t/ha), the lucerne monoculture 1.9 t/ha (lucerne 1.3 t/ha, weeds 0.6 t/ha) from 16 and 13 plants/m² respectively.

What does it mean?

The dry spring conditions may have contributed to the failure to establish perennials under a barley crop at Edillilie due to an increased competition for soil water between an established annual crop and an establishing perennial; however the trial gave no such indication. There was a similar amount of water under the under-sown plots in the 0-0.6 m soil profile or within the 0.2 m profile subsections as the monocultures, plus the soil water contents were all much higher than the pre-seeding site average, thus there was no deficit. Crop nutrients were applied similarly to all treatments therefore the most likely conclusion is one of shading to explain the increased decline in plant numbers in the under-sown treatments. The under-sowing demonstration at Minnipa was considered a failure as a decline from 9 to 3 plants/m² by early January and an expected further decline prior to the seasonal break, is unlikely to constitute a productive pasture component.

The over-cropping trial showed the capacity of the wheat, with the addition of registered herbicide treatments, to suppress lucerne to the extent where the population declined. There was no major addition or decline in soil water contents measured at harvest between the wheat and lucerne monocultures in response to average winter rainfall. This suggests that the site provided no deeper access to the perennials over the course of the study than the cereal, which followed a lucerne stand that would have the soil water profile near to plant lower limits. Any further work should be undertaken on a deeper soil type. The demonstration showed some potential to increase production from a lucerne stand, plus compete with weeds volunteering into a monoculture, through sowing a cereal crop into the lucerne inter-row. It may also improve subsequent lucerne productivity by lightly cultivating the soil and applying fertiliser for both an immediate and long term production benefit.

Acknowledgements

Thanks to Terry Blacker, Ian Richter and Wade Shepperd for technical and operational support, Peter Treloar at Edillilie for allowing the use of the land for the trial.
Establishing perennial shrubs for mixed farming systems on Eyre Peninsula

Jessica Crettenden and Roy Latta
SARDI, Minnipa Agricultural Centre

Why do the trial?
Current challenges facing farming systems in Australia, and on the Eyre Peninsula, including seasonal variability, alternative competing industries and technological advances, are the drivers for change from a reliance on annual legumes and grasses towards more sustainable perennial options. Out-of-season summer rainfall has also emphasised the need to utilise perennial plants that can better cope with an increasingly variable climate and provide green feed at the time of year when producers often have to supplement feed livestock.

How was it done?
A trial to explore the process of establishing a perennial shrub feed base using a direct seeding method was established on the Minnipa Agricultural Centre in 2011 with the shrub species selected as the best performed for survival, growth, biomass and palatability following grazing of the Enrich™ forage shrub trial in the same year (EPFS Summary 2010, pp 138-9 and EPFS Summary 2011, pp 135-8). The focus of the trial was to determine a more labour and cost efficient method to establish a perennial shrub feed base in order to make the system attractive to farmers.

Key messages
- Difficulty in establishing perennial fodder shrubs, cost and labour are the major barriers to adoption.
- Direct seeding offers a method of overcoming these issues and provides a profitable and sustainable enterprise for future generations with added benefits of maintaining stocking rates and reducing supplementary feeding, capturing out-of-season rainfall, reducing soil erosion and salinity and providing shade, shelter and feed for livestock.

- A greater understanding of perennial shrub germination, establishment and productive qualities is required to increase survival percentage through the direct seeding method.
- Success rates need to be increased before this sowing technique can become profitable through improved shrub establishment and longevity.

For perennial species to be of commercial value, they need to persist and remain productive. Difficulty in establishing perennial shrubs has been a major barrier to adoption with the main hurdles of establishment being cost and labour for landholders. Direct seeding fodder shrubs offers a method of overcoming these issues and subsequently provides a productive and practical solution to the autumn feed gap in low to medium rainfall areas. Sowing marginal farming land to perennial shrubs also delivers a means of drought-proofing the farm and capturing out-of-season rainfall, with added benefits of maintaining stocking rates over summer with reduced cost and time spent supplementary feeding, reducing soil erosion and salinity and providing shade, shelter and feed to livestock.
The 46 m x 68 m site was established on 1 June 2011 with 4 replicates x 6 species, making a total 64 plots. Weeds were eradicated from the site after herbicide application in late July. Replicates 1, 2 and 3 were sown with a No-till plot seeder to have 3 rows x 9 m with a 1.5 m gap between rows using a mixture of treated purchased and collected seed. Seeding rate was determined by seed weight, viability and establishment percentage (Table 1). Replicate 4 was planted with 18 plants per plot on the site as tube stock (established in a greenhouse on 13 July using the same seed) on 22 August for comparison with the direct seeding method. These plants were watered with 200 ml/plant/day for 5 days after sowing due to dry conditions.

The success or failure of plant establishment and survival were observed and measured over 2011 and 2012 in anticipation that the site may be grazed once shrubs were established and biomass was sufficient for grazing in following years.

What happened?
Table 1 shows that all of the perennial shrubs established well after some good rain in August and September after sowing, however the germination of spring weeds over many of the plots caused issues as some shrubs were out-competed, reducing plant numbers towards the end of 2011. Shrubs emerged in high density in the direct seeding replicate, however not all survived which allowed improved growth and greater biomass in the living shrubs. The tube stock shrubs were more established than the direct seeded shrubs at time of sowing and had a greater growth before the end of 2011, however were less dense and therefore had similar biomass to the other plots. The successful species included *E. tomentosa*, *A. semibaccata* and *R. preissii* which established well and have grown significantly since sowing. *A. ligulata* also established well but was unsuccessful because of poor survival. Due to lack of shrubs emerging, it was determined that higher seeding rates were required for *A. nummularia* and *A. amnicola* to improve shrub numbers.

Plant size differed between shrub species at the end of 2012 with some species established well enough to graze in 2013; however grazing will have to be delayed until 2014 due to shrub variation over the site. After a particularly dry spring in 2012, *A. semibaccata* has browned off and has ceased growing, however other species are surviving well.

Table 1 Names, seed treatment, sowing rate and survival numbers of perennial shrub species at the Minnipa site

<table>
<thead>
<tr>
<th>Perennial shrub species</th>
<th>Pre-sowing seed treatment</th>
<th>Sowing rate (grams)</th>
<th>Shrub count (number)*</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Atriplex nummularia</em> (old man saltbush)</td>
<td>Soak then leach</td>
<td>0.43</td>
<td>2.59</td>
</tr>
<tr>
<td><em>Atriplex amnicola</em> (swamp saltbush)</td>
<td>Soak then leach</td>
<td>0.18</td>
<td>1.10</td>
</tr>
<tr>
<td><em>Enchylaena tomentosa</em> (ruby saltbush)</td>
<td>Leach</td>
<td>0.48</td>
<td>2.88</td>
</tr>
<tr>
<td><em>Rhagodia preissii</em> (mallee saltbush)</td>
<td>Soak then leach</td>
<td>0.27</td>
<td>1.65</td>
</tr>
<tr>
<td><em>Atriplex semibaccata</em> (creeping saltbush)</td>
<td>Soak then leach</td>
<td>0.25</td>
<td>1.53</td>
</tr>
<tr>
<td><em>Atriplex ligulata</em> (sandhill wattle)</td>
<td>Soak in boiling water</td>
<td>0.74</td>
<td>4.49</td>
</tr>
</tbody>
</table>

*figures in brackets for the shrub count describe the number of shrubs surviving out of the total number recorded in replicate 4 (established from tube stock)*
What does this mean?

Perennial shrubs are a valuable addition to the pasture system, giving farming systems a more predictable feed option during the autumn period, developing unproductive land and complementing rather than competing with the existing feedbase, as a result contributing to whole-farm profitability and sustainability. Establishing perennial shrubs can be quite challenging with many factors affecting success rates including incorrect sowing depth, poor seed quality, seed dormancy mechanisms, weed control and slow germination. Other elements that need to be taken into consideration include site selection (soil quality), seeding rates and timing of sowing, which are issues that need to be trialled before definite outcomes can be produced. Ongoing measurements in autumn and spring will monitor plant survival, growth, plant health, flowering/fruiting, recruitment, edible biomass, as well as defoliation (palatability) and recovery after the first grazing period.

A better understanding of perennial shrub germination, establishment and productive qualities is required to increase survival percentage through the direct seeding method. Cost and labour efficiency is increased through utilisation of direct seeding as opposed to planting seedlings or using other direct niche-seeding techniques, however success rates need to be increased before this practice can become profitable through improved shrub establishment and longevity.

Another trial site will be sown for the next stage of the Eyre Peninsula Grain and Graze 2 research into using direct seeding as a method of establishment in order to make forage shrub grazing systems more broad-acre friendly. Both sites will be evaluated to determine the success of direct seeding of selected native forage shrubs, including the ease of establishment of a cost and labour efficient shrub based grazing system on Eyre Peninsula.

Acknowledgements

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Cowell Enrich project: Perennial shrubs, options for soil constrained areas

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DEWNR – Sustainable Farming Systems, Natural Resources Centre, Eyre Peninsula

Key messages
- Non-productive land is being utilised by using perennial shrubs for erosion control and ground cover.
- Livestock can maintain condition in the short term on native perennial grazing systems during the summer feed gap.
- Magnesia affected areas can be reduced under a shrub-based system with increased ground cover.

Why do the trial?
Ground cover has always been an issue on low rainfall areas of Eyre Peninsula. The aim of this project was to increase the productivity of areas that were continually suffering during the dry years and affecting the escalation of salt induced magnesia soils. Ground cover is vital to reduce the impact of magnesia soils caused through the evaporation of moisture from the soil, thus creating a wicking effect and bringing the salts to the surface. These areas become more noticeable and spread in the dryer years, however, these areas can be minimised through increasing ground cover and shading to keep the soil cooler during the summer period.

Farming properties in these cropping areas are in need of good quality stock fodder reserves that can sustain ground cover over the crucial summer period. Woody perennial grazing systems are an alternative option to fill the feed gap on these soil types. They also offer the potential to move sheep into these smaller areas of perennial shrub systems at high stocking rates, thus resting paddocks during times of low feed availability.

How was it done?
In 2008 Future Farm Industries CRC (FFICRC) and Eyre Peninsula Natural Resources Management Board (EPNRM) established a one hectare trial site using 15 mainly native shrubs selected from a potential 50 species of perennial shrubs, already trialled at Monarto, SA. These were divided into 4 replicated plots of 15 species x 36 plants each at Elbow Hill south of Cowell. Two other sites were established at Minnipa and Piednippie in 2009 (EPFS Summary 2011, pp135-138).

The shrub biomass, recovery and the sheep grazing preference have been monitored during autumn and spring each year since establishment. From the research and observations of the initial small plot trial, 4 varieties have since been selected and established in 2010 into a larger trial site of 4 ha at the same location.

What happened?
Although the Eastern EP has had significantly below average rainfall since establishment of the shrubs in 2008, there has been good survival (up to 80%) and significant ground cover establishment consisting of native grasses, rye and barley grasses, medics and blanket weed in the inter-row, due to the grazing pressure and timing. Shrub growth range has varied, with species ranging from over one metre in height to a stunted 20 mm as indicated by canopy volume (Figure 1).

Grazing of the shrubs has occurred in autumn since 2009 at high stocking pressure of 80-120 DSE/ha until the majority of leaf material was consumed. Stock were moved from one replicate to the next when the majority of leaf matter was removed from most of the shrubs. Each year grazing preference was recorded to establish the palatability of the selected shrubs. Whilst some of the saltbush varieties were left until last in replicate 1, by the time the sheep entered replicate 4, the shrubs were grazed more evenly, therefore, indicating sheep become more accustomed to the varieties over time.

The larger trial site was split in two (2 ha each) and grazed over a 10 week period as per the small plots at a grazing pressure of 40 DSE/ha.
In 2012 extra measurements of sheep condition/weight were monitored at intervals during the shrub trial grazing period and compared to a control paddock mob. Sheep initially gained weight in each of the 2 ha and small trial plots. The weight gain was mainly due to consumption of the inter-row plants (Barley grass and Blanket weed) before progressing onto the shrubs. Sheep in both shrub trials lost weight after long periods of grazing on shrubs only (Table 2).

What does this mean?
Forage shrubs do provide an option for the non-productive cropping soils in Eyre Peninsula’s mixed farming systems. However, identifying the best mix of shrubs that suit differing soil types and rainfall zones along with inter-row species, is still work that needs to be continued. These trials at Elbow Hill have demonstrated that soil cover can be maintained on these magnesia areas under a shrub based system and through selected grazing. Also inter-row species such as native and annual grasses and medics increase to create a balanced system. This increased inter-row ground cover has meant that supplementary feeding of livestock has not been required during the last two years of these grazing trials.

With the development of these and further sites across EP and continued research into direct seeding (potentially a more cost effective option for establishment), inter-row species and shrub designs, some of the challenges may be overcome when establishing perennial shrub-based grazing systems. While shrubs are not the complete answer, this research in combination with “best practice” land management and farming practices, there is potential to increase productivity and soil cover on some of EP’s more vulnerable soils.

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