7.3 IMPROVING YIELD AND PROTEIN CONTENT OF CROPS BY DEVELOPING
PHASE AND LEY FARMING SYSTEMS USING ALTERNATIVE PASTURE LEGUMES

Researchers:
Xianguang Zhang, Pedro Evans, Tony Wright and Penny Riffkin
Agriculture Victoria, DNRE, Pastoral and Veterinary
Institute, Hamilton

Experiment sites:
Gnarwarre, Hamilton and Streatham

Background:
This GRDC- and DNRE-funded project has been
undertaken to identify those alternative pasture
legume species that, when sown in rotation with
crops, have the capacity to improve crop plant
productivity in the high rainfall zone of southern
Australia.

Those trials, based on previous years' experimental
research, were conducted to further collect
information on (1) pasture performance in terms of
herbage dry matter (DM) production, pasture seed
yield, and self seedling regeneration; and (2) crop
grain yield and quality characteristics. Pasture
legumes are being assessed in either a 1:1 or a 2:1
pasture : crop rotation patterns.

Following the pasture phase, a crop is direct drilled
onto the ground when regenerated pasture seedlings
are sprayed out. Canola was introduced into the
system research in 2000 and grown at both
Gnarwarre and Streatham sites. The likely
association between pasture performance and
subsequent crop yield productivity response was
therefore quantified.

Experimental treatments and related cultural
practices:
At Gnarwarre, the Triazine-tolerant cultivar Pinnacle
was direct drilled into the soil on 8th June at a depth
of 2-3 cm using a cone seeder, with a sowing rate of
5 kg/ha. The fertiliser Super + trace @350 kg/ha was
applied at sowing time. Telstar @100 ml/ha was
used once to control RLEM; and Select @100 ml/ha
was sprayed to control some grasses. The crop was
hand-harvested on 14th December, with a sample of
a 2 m² quadrat cut per plot being collected to
determine grain yield. At Streatham, an early
maturing cultivar Surpass 400 was sown on 16th
August at a rate of 8 kg/ha, with seed direct drilled
into the soil. The use of fertilisers etc were as per
Gnarwarre; and a sample was harvested on 4th

In addition, the herbage DM production of five
different pasture legumes over growing seasons was
assessed at both Gnarwarre and Streatham sites. At
the Hamilton site, the performance of 4 subterranean
clover entries was closely monitored.

Sponsors:
GRDC and DNRE

For further details contact:
Xianguang Zhang Dr.,
Research Scientist, Agriculture Victoria –
Hamilton
Phone: 03 5573 0923 Fax: 03 5571 1523
E-mail: xianguang.zhang@nre.vic.gov.au
Results:

Pasture legume performance: HAMILTON

Following a 7 t/ha wheat crop (cv. Silverstar) in 1999 without the application of N fertiliser, the four subterranean clover entries (eg. Leura, Enfield, Trikkala and a mixture) showed excellent pasture regeneration in Autumn 2000, ranging from 2379 (in Trikkala) to 4282 plants/m² (in Leura). A total herbage DM of nearly 10 t/ha had accumulated on Leura or Trikkala paddocks with regenerated plants, resulting in a growth rate of ca. 45 kg/ha-day over the growing season.

Pasture legume performance: GNARWARRE AND STREATHAM

Balansa clover showed the best self regeneration among all pasture species at both sites, but due to the different sampling dates and environmental conditions, great variation also existed between the two sites (Table 1). Good herbage DM production from those five pasture legumes were recorded, with Arrowleaf clover producing the highest due largely to its longer seasonal growth and erect growth habit with thick stems.

Table 1: Pasture legume regeneration and herbage DM production at Gnarwarre and Streatham in 2000

<table>
<thead>
<tr>
<th>Pasture species</th>
<th>Regeneration rate (plants/m²)</th>
<th>Herbage DM (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gnarwarre</td>
<td>Streatham</td>
</tr>
<tr>
<td>Balansa cv. Bolta</td>
<td>2013</td>
<td>7102</td>
</tr>
<tr>
<td>Persian cv. Nitro</td>
<td>498</td>
<td>6269</td>
</tr>
<tr>
<td>Subclover cv. Leura</td>
<td>770</td>
<td>6390</td>
</tr>
<tr>
<td>Red clover cv. Astred</td>
<td>383</td>
<td>28</td>
</tr>
<tr>
<td>Arrowleaf cv. Tas 663</td>
<td>675</td>
<td>517</td>
</tr>
</tbody>
</table>

A Seedling counts were made from soil cores or quadrat samples, depending on their densities, on 7th June and 18th May at Gnarwarre and Streatham, respectively. Values are the pooled data over plots.

B Cumulative DM with Arrowleaf extending to late January 2001. Red clover was re-sown to make up its poor self regeneration.

Canola grain yield:

The average canola density was 76 plants/m² at Streatham as against 60 plants/m² at Gnarwarre, with Bolta-based plots showing the highest density (100 and 85 plants/m² respectively). Plants grew more vigorously at Streatham than at Gnarwarre, and a higher average yield (1160 vs 704 kg/ha) was thus harvested at Streatham although the canola was delayed in its sowing by 2 months. Statistics indicated highly significant differences in the canola grain yield at both sites (in 2000), which are derived from the different treatments in 1999 (Table 2).

Table 2. Relationship between pasture herbage DM production (kg/ha) in 1999 and canola grain yield (kg/ha) in 2000 based on pooled experimental data of 6 different treatments (Astred not included due to the trial design) at Gnarwarre and Streatham

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Gnarwarre</th>
<th>Streatham</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolta</td>
<td>5340</td>
<td>1235</td>
</tr>
<tr>
<td>Contin. crop</td>
<td>0</td>
<td>232</td>
</tr>
<tr>
<td>F/N (50 N)*</td>
<td>2000</td>
<td>370</td>
</tr>
<tr>
<td>Leura</td>
<td>4770</td>
<td>867</td>
</tr>
<tr>
<td>Nitro</td>
<td>6320</td>
<td>1016</td>
</tr>
<tr>
<td>Tas 663</td>
<td>3790</td>
<td>502</td>
</tr>
</tbody>
</table>

* Assuming the 50 kg/ha N applied to the plots of the treatment “fallow/nitrogen” (F/N) equals to 2000 kg/ha herbage DM since 1 tonne of pasture legume DM is estimated to fix biologically 25 kg N.

Plants from those pasture-based treatments showing higher herbage DM production (in 1999) were found to produce higher grain yields, with the Bolta-based treatment producing the highest yield (1235 kg/ha and 1377 kg/ha at Gnarwarre and Streatham respectively). The yield from Nitro-based treatment ranks second. Whilst the continuous crop treatment resulted in the poorest grain yield, particularly at Gnarwarre site (232 kg/ha). Therefore, a close linear correlation between canola grain yield (y in kg/ha) in 2000 and the herbage DM production (x in kg/ha) in 1999 was detected among the 6 treatments as at Gnarwarre: y = 0.1524x + 139.25 (r² = 0.8115); and at Streatham: y = 0.0599x + 957.01 (r² = 0.9021).
Conclusions:

The pasture-crop rotation system has so far been successfully established in these sites, with the pasture plant productivity improved year by year. This is characterised by the building up of large pasture seed banks (data not shown) and good self regeneration following a crop phase.

Balansa, Persian and subterranean clovers are the preferred pasture legumes for this desirable farming system in the high rainfall zone, being able to produce large herbage DM at the early growing stages. On the other hand, Arrowleaf clover has great potential to extend the pasture growing season and to provide more quality pasture onto mid-summer.

Canola crop greatly benefits from these pasture legumes with higher DM production for at least its higher grain yield. This was achieved under the condition of no N fertiliser application throughout the system research. Similar positive responses in terms of grain yield and protein content has been reported previously with the wheat crop from this research. This encourages us to gather more useful information about the differential crop responses to the greatly improved pasture legume production under this farming system.

Other factors to be considered:

These results have so far demonstrated the successes and the effectiveness of the pasture legumes under the current 1:1 pasture : crop rotation system in improving plant performance of a subsequent crop. However, the establishment of a sustainable farming system in southern Australia entails more thorough research and will definitely benefit from trials with larger plots for such a system research, so that animal production in the pasture years can also be determined, and seed contamination across small plots minimised.