Crop Updates

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Crop Updates 2002 - Geraldton

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Welcome to Geraldton Regional Crop Updates 2002 which is part of the joint Department of Agriculture and Grains Research & Development Corporation initiative aimed at the timely dissemination of technical information for grain growers.

Congratulations to the Geraldton Regional Crop Updates reference group for putting together a topical and relevant list of speakers and poster displays for growers in this region.

The topics cover both problems and issues like diamond back moth and grain sprouting which were particularly evident in the past year and longer term issues like planning enterprise mixes, crop breeding strategies and the application of biotechnology.

We welcome guest speaker Harry Nesbitt to talk on the experiences of an Australian agricultural professional in South East Asia, Rob Taylor tramline farmer from Queensland and leading researchers from Perth and other regions to the regional update.

Although the primary aim of the Crop Updates Program is to ensure research results are made available to growers a related aim is to foster networks and communication across the industry. In that context I encourage all to take the opportunity to build the grower, agribusiness, technical adviser, researcher network.

Also I take the opportunity to encourage growers and agribusiness colleagues to visit the new regional office laboratory facilities in Marine Terrace to maintain their connection with Department officers and to provide ongoing input into R&D planning.

The new complex provides our regional research officers, Paul Blackwell, Kevin Walden, Jat Bhathal, Darshan Sharma, Peter Newman, Andrew Blake and Martin Harries and their assistants with modern facilities to complement their field trials with detailed laboratory studies.

The final message in this foreword to the Geraldton Regional Crop Updates is to encourage participants to provide feedback on the event to the organisers. The Crop Updates program is underpinned by a commitment of continual improvement based on feedback from participants.

John Allen
REGIONAL DIRECTOR
DEPARTMENT OF AGRICULTURE
The 2002 Geraldton Regional Crop Update is proudly supported by:

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# GERALDTON REGIONAL CROP UPDATE 2002

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Taking the Why out of Wyalkatchem - the new widely adapted wheat variety

Steve Penny, Department of Agriculture

KEY MESSAGE

Performance of the wheat variety Wyalkatchem both in crop variety testing over the last five years, and commercially in 2001, indicate that it is widely adapted. The additional attributes of sturdy grain quality, disease resistance and tolerance to aluminium and boron toxicity make the variety a competitive option over other major wheat varieties grown in Western Australia.

ADAPTATION

Wyalkatchem has stable yield performance both across the Agzones and in a range of different seasons. In the two contrasting seasons of 1999 and 2000 Wyalkatchem has been ranked amongst the top varieties and was consistently the highest yielding variety in trials in the dry season of 2000. Preliminary data suggest the variety also performed well in 2001.

Table 1. Yield of Wyalkatchem and other major wheat varieties over the last ten years, expressed as % of Westonia (number of trials in brackets)

<table>
<thead>
<tr>
<th>Agzone</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wyalkatchem</td>
<td>101 (16)</td>
<td>99 (22)</td>
<td>100 (11)</td>
<td>101 (24)</td>
<td>105 (25)</td>
<td>99 (4)</td>
<td>101 (102)</td>
</tr>
<tr>
<td>Brookton</td>
<td>100 (34)</td>
<td>97 (45)</td>
<td>101 (24)</td>
<td>95 (52)</td>
<td>96 (51)</td>
<td>99 (10)</td>
<td>97 (216)</td>
</tr>
<tr>
<td>Carnamah</td>
<td>99 (43)</td>
<td>98 (54)</td>
<td>97 (31)</td>
<td>93 (61)</td>
<td>95 (58)</td>
<td>94 (10)</td>
<td>96 (263)</td>
</tr>
<tr>
<td>Westonia</td>
<td>100 (38)</td>
<td>100 (44)</td>
<td>100 (21)</td>
<td>100 (55)</td>
<td>100 (56)</td>
<td>100 (13)</td>
<td>100 (227)</td>
</tr>
</tbody>
</table>

Wyalkatchem regularly attains higher grain protein than other high yielding varieties, with a mean of 11.6% protein compared to 10.9% for Westonia in variety trials in 1998 and 1999 (18 observations). This is complimented by lower screenings than other varieties in many cases, with 0.5% for Wyalkatchem compared to 0.7% for Westonia (27 observations).

Grain quality data indicate that Wyalkatchem is a preferable variety over Westonia in areas of high black point risk. Trial sites selected based on a high incidence of black point pressure indicate that Wyalkatchem had a mean incidence of 5.7% compared to 8.8% for Westonia (55 observations).

Trial data from 1998 through to, and including, 2001 indicates that Wyalkatchem is similar to Westonia in its tolerance to both acid and boron toxic soils. Only Westonia and Ajana have consistently out yielded Wyalkatchem in acid tolerance trials. Westonia is the only variety that marginally out yields Wyalkatchem in boron tolerance trials.

AGRONOMIC FACTORS

Wyalkatchem is the shortest variety released in Western Australia, being 16 cm shorter than Spear. This gives it an advantage over Westonia in situations where stubble handling is a potential problem. Despite the very short straw of this variety it has a coleoptile length similar to Calingiri and 5-10 mm shorter than Westonia.

Wyalkatchem is a mid season variety that reaches flowering two days later than Westonia and 10 days earlier than Carnamah, on average, making it suitable for sowing in mid May onwards. The yield response of Wyalkatchem to plant density appears to plateau in the average population range of around 100 plants/m², which is equivalent to a seeding rate of around 45 kg/ha and above.
Where other high yielding varieties, including Arrino, Brookton, Calingiri and Westonia, have given average yield responses to applied nitrogen of around 10 kg/kg of N, Wyalkatchem responds at a lower rate of 5 kg/kg of N. Wyalkatchem has shown to be more protein responsive than yield responsive to inputs of nitrogen, when compared to these other varieties. This suggests that Wyalkatchem is, whilst still competitive in high input situations, more suitable for low input farming systems than other high performing varieties. This variety may be of particular benefit in wheat on wheat situations.

**DISEASE MANAGEMENT**

Wyalkatchem has useful resistance to several diseases that should enhance the performance of this variety under various disease pressures. It is intermediate in resistance to septoria nodorum blotch and moderately resistant to yellow spot. These characteristics should reduce the need for fungicide control in high input crops. It is susceptible to septoria tritici blotch, similar to Westonia, although this disease has had low impact in Western Australia over the past 5 years.

Wyalkatchem is highly resistant to leaf rust and has moderate resistance to stem rust in Western Australia, and should not require fungicide protection for these diseases. Future changes in the leaf or stem rust strains in Western Australia could impact on the usefulness of this resistance, as with other varieties with specific resistance genes. In the event that stripe rust occurred in Western Australia, Wyalkatchem has intermediate resistance. This may afford it modest protection under late stripe rust attack or enable the disease to be readily managed with fungicide when under greater pressure.

Wyalkatchem is moderately susceptible to powdery mildew (similar to Calingiri) and less prone than Brookton or Cunderdin and marginally less prone than Spear or Westonia.

Limited testing indicates Wyalkatchem is susceptible to flag smut. Routine use of a smuticide seed dressing is recommended for flag smut and stinking bunt.

**ABIOTIC STRESS MANAGEMENT**

The herbicide tolerance to 26 commonly used herbicides was tested across some of the major varieties in field trials at both Mullewa and Merredin in 2001 (Dhammu 2002). The yield of Wyalkatchem was reduced by 1.0 L/ha dicamba at both sites. The yield reduction observed at the Mullewa site from this treatment was in the order of 85%. Although significant yield reductions were induced by this treatment across the other varieties in these trials, which included Westonia and Carnamah, they were not of this magnitude. Both 375 mL Argold® (a.i. cymmethalin), incorporated at seeding, and 0.5 L/ha Paragon® (a.i. picolinafen + MCPA) caused yield reductions of around 10% in Wyalkatchem at the Merredin site (not statistically significant). Wyalkatchem was the only variety that was affected by the Paragon treatment at this site.

Studies of carbohydrate storage and its role in drought tolerance indicate that Wyalkatchem is classified in the medium range when compared to other major varieties. Based on this research Wyalkatchem may be less tolerable to terminal drought conditions than the varieties Ajana, Brookton and Westonia.

Wyalkatchem has been classified as susceptible to sprouting under Western Australian conditions, making it slightly more tolerable than Brookton or Cunderdin, which are very susceptible. Therefore Wyalkatchem may not be the ideal choice in areas with a high risk of sprouting.

**ACKNOWLEDGMENTS**

This work has been funded by the GRDC. Thanks go to Wal Anderson, Rob Loughman, Robin Wilson, Bill Lambe, Harmohinder Singh, Darshan Sharma, Dean Diepeveen, Noel Murphy, Paula Reeve, Fran Hoyle, Ben Curtis and Mohammad Amjad.

**REFERENCE**


Paper reviewed by: W. Anderson and R. Loughman
Reducing the risks in producing durum wheat in Western Australia
Md Shahajahan Miyan and Wal Anderson, Department of Agriculture

KEY MESSAGE
The grain yield and quality data obtained from the trials do not support the use of high rates or split applications of nitrogen in the low and unreliable rainfall environments.

BACKGROUND
Current durum production in Western Australia is mainly concentrated in the low and medium rainfall cereal zones of the Western region. At the low rainfall sites, moisture is the major limiting factor and so chemical fallowing or good legume rotation influence the crop growth, grain yield and quality where the cropping options available to growers are limited. Returns from durum wheat can be more profitable compared to bread wheat when farmers achieve grain protein over 11.5% (DR1 or 2 grades), but much less than bread wheat where protein is lower. The purpose of this research is to develop recommendations for the management of grain yield and quality of durum wheat based on rotations and N-fertiliser strategies.

METHODS
In 2001, two trials were conducted at Mukinbudin comparing rotations and N rates, and one trial at Narembeen comparing two durum varieties with one bread wheat at 2 N rates. Both trials used farm scale machines on soil types and rotations common in the region. Site details are in Table 1.

Table 1. Site details

<table>
<thead>
<tr>
<th>Site</th>
<th>Soil type</th>
<th>Previous crop</th>
<th>Top soil pH (CaCl₂)</th>
<th>P bicarb.</th>
<th>OC (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Mukinbudin</td>
<td>Clay</td>
<td>Lentil</td>
<td>6.8</td>
<td>19</td>
<td>0.63</td>
</tr>
<tr>
<td>B. Mukinbudin</td>
<td>Loam</td>
<td>Fallow</td>
<td>7.1</td>
<td>12</td>
<td>0.70</td>
</tr>
<tr>
<td>C. Narembeen</td>
<td>Clay</td>
<td>Medic</td>
<td>7.9</td>
<td>18</td>
<td>1.21</td>
</tr>
</tbody>
</table>

The Mukinbudin trials were sown on 27 May 2001. The plots were completely randomised with three replications, and five rates of N (0N, 25 kg N/ha, 50 kg N/ha, 25 kg N/ha at seeding + 25 kg N/ha at tillering, 60 kg N/ha at seeding). Site B was sown following a chemical fallow in the previous season.

At the Narembeen site, Tamaroi and Wollaroi durum and Machete bread wheat were sown on 18 May 2001. The experiment was laid out as a completely randomised design with three replications.

RESULTS
Results in Table 2 show that there was no significant effect of the N application on grain yield, 1000-grain weight and gross margin despite the increase in grain protein. It appears that an N application of less than 25 kg/ha would have ensured protein sufficient to achieve DR1 (13%), thus maximising the gross margin. Splitting the N application between sowing and tillering did not increase yield or protein at either site.

At Narembeen, Machete out yielded the two durums, but only Wollaroi responded significantly to the addition of N fertiliser (Table 3). Grain protein was also increased by N fertiliser, lifting the level in both durums to DR2 (11.5%), but 35 kg/ha was insufficient to increase protein in Machete to the level required for Australian Hard (11.5%). The relatively low legume content in
the pasture year could probably explain the disappointing contribution of the medic pasture to grain protein at this site.
Table 2.  Effect of chemical fallow and a lentil crop on grain yield and quality of Tamaroi durum wheat at Mukinbudin, 2001

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (kg/ha)</th>
<th>1000 grain wt. (g)</th>
<th>Protein (%)</th>
<th>Gross margin ($/ha)</th>
<th>Yield (kg/ha)</th>
<th>1000 grain wt. (g)</th>
<th>Protein (%)</th>
<th>Gross margin ($/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0N</td>
<td>2010</td>
<td>41</td>
<td>12.2</td>
<td>671</td>
<td>2325</td>
<td>45</td>
<td>11.9</td>
<td>760</td>
</tr>
<tr>
<td>25N</td>
<td>2034</td>
<td>43</td>
<td>13.2</td>
<td>696</td>
<td>2320</td>
<td>45</td>
<td>12.5</td>
<td>759</td>
</tr>
<tr>
<td>50N</td>
<td>2024</td>
<td>42</td>
<td>13.5</td>
<td>667</td>
<td>2360</td>
<td>45</td>
<td>14.3</td>
<td>840</td>
</tr>
<tr>
<td>25N + 25N</td>
<td>2024</td>
<td>42</td>
<td>13.5</td>
<td>666</td>
<td>2352</td>
<td>45</td>
<td>12.9</td>
<td>766</td>
</tr>
<tr>
<td>60N</td>
<td>2054</td>
<td>42</td>
<td>13.5</td>
<td>663</td>
<td>2338</td>
<td>44</td>
<td>13.7</td>
<td>784</td>
</tr>
<tr>
<td>LSD: 0.05</td>
<td>ns</td>
<td>ns</td>
<td>0.9</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>1.7</td>
<td>ns</td>
</tr>
</tbody>
</table>

Despite the lower grain yield of Wollaroi its gross margin at 35 kg/ha of N was as good as that of Machete. This illustrates the capacity of durum to achieve equal or better returns than bread wheat where soil and rotational conditions suit.

Table 3.  Effect of nitrogen fertiliser on grain yield and quality of durum and bread wheat at Narembeen, in 2001 following medic pasture

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (kg/ha)</th>
<th>Kernel weight (mg)</th>
<th>Grain protein (%)</th>
<th>Gross margin ($/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machete N0</td>
<td>2770</td>
<td>42</td>
<td>8.7</td>
<td>573</td>
</tr>
<tr>
<td>Machete N35</td>
<td>2920</td>
<td>41</td>
<td>10.5</td>
<td>723</td>
</tr>
<tr>
<td>Tamaroi N0</td>
<td>2030</td>
<td>42</td>
<td>8.4</td>
<td>465</td>
</tr>
<tr>
<td>Tamaroi N35</td>
<td>1990</td>
<td>40</td>
<td>12.7</td>
<td>637</td>
</tr>
<tr>
<td>Wollaroi N0</td>
<td>2030</td>
<td>43</td>
<td>10</td>
<td>518</td>
</tr>
<tr>
<td>Wollaroi N35</td>
<td>2430</td>
<td>42</td>
<td>12.1</td>
<td>745</td>
</tr>
<tr>
<td>LSD: 0.05</td>
<td>230</td>
<td>ns</td>
<td>1.1</td>
<td>65</td>
</tr>
</tbody>
</table>

CONCLUSIONS

These results confirm earlier data presented at UPDATES from trials in the eastern wheatbelt which have shown that if durum is grown on neutral to alkaline clay soils following good quality legume pastures or crops, its profitability will equal or exceed that from bread wheat. The risk of failing to meet the protein standards for DR1 or DR2 can be reduced by the addition of relatively low rates of N fertiliser which are usually more than repaid through the premiums obtained. The evidence from these trials, plus considerable data from bread wheat trials in the eastern wheatbelt, indicates that the expectation of an economic return from split applications of N is low.

ACKNOWLEDGMENT

Ms Louise Evans for technical assistance, Mr Kennedy Miller and Mr Dudley Squire for the use of their land, time and equipment.

GRDC Project No.:   DAW 503
Paper reviewed by:  Wal Anderson
Optimum time of application for phenoxy herbicides on new wheat varieties

Terry Piper and Harmohinder Dhammu, Integrated Pest Management Unit, Department of Agriculture, Centre for Cropping Systems, Northam.

BACKGROUND

As resistance to the SU herbicides becomes more widespread in weeds, especially wild radish, phenoxy herbicides will become more important to farmers. Indeed, good farmers should be using more phenoxy in their weed control programs before they are cursed with SU resistance. This will extend not just the life of the SU's but also the other Group B products, and allow for a more sustainable herbicide rotation program on the farm.

Phenoxys are more demanding in their application timing than SU's. They act as plant growth hormones, and if they are applied during the period when the wheat seedling is forming its embryonic heads, serious growth abnormalities can result. They also have serious effects if applied during pollen formation, resulting in missing grains in the head. Both effects can lead to large yield reductions. The plant is phenoxy safe from the end of ear formation (double ridge) to the start of pollen formation, with a few days leeway in application time. There can be a safe window before ear initiation (double ridge) but this is risky and not sanctioned on any labels. Another safe period occurs during grain filling, at the milky to soft dough stage. This is useful for late radish control, but is only registered in NSW and Qld.

The exact stages of head formation and ear development can only be determined by dissecting a wheat seedling under a microscope. It is impractical for a farmer to do this, so the product label will give a leaf development score as an indication of when to spray. For 2,4-D products this is Z15 (Zadoks scale, five fully emerged leaves). MCPA is not as active, and can be applied at Z14. The hormone effects are also rate related, so that Brominal M or diuron/MCPA (where 200 g/ha of actual MCPA rather than the 625 g/ha in 1.25 of amine is applied) can be used at Z13. Similarly diuron/2,4-D can be used earlier than straight amine.

The Zadoks growth stage is used as an approximation of the internal ear development, but different varieties develop at different rates relative to their leaf score. A very short season variety such as Kalannie will have finished its ear development by perhaps leaf 4, while a long season variety like Spear may not do so until leaf 8. Ear development in tillers may be a leaf behind the main stem ear. Thus to be more accurate in phenoxy timings, it is necessary to grow varieties, dissect some seedlings, and calibrate each variety's development with leaf number. This has been done for some newer varieties in a series of trials over the last two years.

A range of phenoxy herbicides has been applied to these varieties at weekly intervals to determine any head distortions, and any effects on yield. At the same time the internal development of the seedlings is being monitored. We will record. This will enable us to produce an up to date guide for optimum phenoxy timings on a range of current wheat varieties.

RESULTS TO DATE

Table 1. Wheat development rate vs emerged leaf number

| Varieties |  | Double ridge | Terminal spikelet | Span |
|-----------|--------------------------------------------------|------------------|-----------------|
|           | Site     | Avon | WHRS | Avon | WHRS | Avon | WHRS |
| Amery     |          | 4.4  | 4.8  | 6.8  | 6.6  | 2.4  | 1.8  |
| Westonia  |          | 4.6  | 5.1  | 7.0  | 7.1  | 2.4  | 2.0  |
| Kargarin  |          | 5.2  | 5.1  | 7.0  | 7.1  | 2.4  | 2.0  |
| Brookton  |          | 5.4  | 5.7  | 7.0  | 7.1  | 2.4  | 2.1  |
| Camm      |          | 5.4  | 5.1  | 7.0  | 7.1  | 2.2  | 1.7  |
| Calingiri |          | 6.0  | 6.6  | 7.4  | 7.5  | 1.4  | .9   |
Trials at Avondale and Wongan Hills in 2000. There is up to 1.8 leaves difference in the start of ear initiation (double ridge) between varieties at a single site, and 2.2 leaves difference when site differences are included. Similarly there is over 1 leaf difference in the finish of ear development. This adds complexity to the selection of safe spraying times.

Table 2. Deformed heads (as % of total) and yield (as % of unsprayed control) for two varieties at Wongan Hills 2000

<table>
<thead>
<tr>
<th>Spray timing -&gt;</th>
<th>% Deformed heads</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Z14</td>
<td>Z15</td>
</tr>
<tr>
<td>Amery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCPA amine</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>MCPA ester</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>2,4-D amine</td>
<td>33</td>
<td>0</td>
</tr>
<tr>
<td>2,4-D ester</td>
<td>54</td>
<td>6</td>
</tr>
<tr>
<td>Calingiri</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCPA amine</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>MCPA ester</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>2,4-D amine</td>
<td>22</td>
<td>13</td>
</tr>
<tr>
<td>2,4-D ester</td>
<td>31</td>
<td>26</td>
</tr>
</tbody>
</table>

Note the increasing % of deformed heads with 2,4-D compared to MCPA, and with the longer season variety Calingiri. Note also that high levels of deformed heads do not result in yield losses.

The results so far are preliminary, and we will need to fully analyse the results of 2001 trials to make more definite recommendations. In addition to straight yield data, the 2001 trials will be analysed for grain quality.

However, we can say at this stage that:

- Brookton appears to be sensitive to phenoxy
- Head distortions are poor indicators of yield
- Amine formulations are safer than Ester
- Higher rates result in greater yield loss.
- Applying phenoxy herbicides to moisture stressed plants outside the recommended window can cause significant yield reductions.
- High rates of 2,4-D late, to control large radish may be risky for sensitive varieties such as Brookton and/or when crop is under moisture stress
- Variety specific information is required for early application

Rule of thumb - safe phenoxy application begins at Double Ridge stage + one leaf

ACKNOWLEDGMENT

This work was part funded by GRDC project DAW 618 “Evaluating herbicide tolerance in new crop varieties” and by Nufarm Australia Ltd.

Project No.: GCV Crop Variety testing and GRDC DAW 618
Beware of wheat variety interactions with row spacing and seed rate
Mohammad Amjad and Wal Anderson, Department of Agriculture

KEY MESSAGES
• New wheat varieties may be responsive to higher seeding rate but may also be sensitive to wider row spacing.
• The long season variety Camm was found to be better suited to wide row spacing at five seeding rates compared to the short season variety Westonia and the mid-season variety Cascades. This result has implications for seeding systems that use wider rows as a tool to improve stubble and weed management.

AIM
The aim of this work was to establish the effect of row spacing on optimum seeding rate for some of the newer wheat varieties grown on the South Coast.

METHOD
Experiments were conducted on sandplain and mallee soils at Gibson and Salmon Gums during 2000. There were 90 treatments with three replications:
- 3 varieties - Westonia, Cascades, Camm (i.e. early, medium and late maturity).
- 5 target plant populations (50, 100, 150, 200, 250 plants/m²).
- 3 row spacings (180 mm, 240 mm, 360 mm); and
- 2 nitrogen rates (23 kg N/ha and 46 kg N/ha for mallee soils, 37 kg N/ha and 60 kg N/ha for sandplain soils).

RESULTS
Average yield responses to plant population and row spacing at Salmon Gums are presented in Figures 1 and 2. There were no significant interactions of N rate with variety, row spacing or seed rate.

Figure 1. Yield response of wheat sown at 3 row spacings and 5 target plant populations.

Figure 2. Yield response of 3 wheat varieties sown at 3 row spacings.
• The higher yield was achieved with the narrow row spacings (180 mm) at all plant populations (Figure 1).

• On average, higher seeding rates (over 150 plants/m² or 70 kg/ha) had no beneficial impact, or reduced yield, at the wider row spacing. Similar effects were recorded for weed competition (data not shown).

• The yield decline in wider rows was greater in Westonia and Cascades than in Camm (Figure 2). This effect was consistent across both sites (Table 1).

• The response of Camm at wider row spacing can be partially explained by its higher green leaf area and dry matter production. This may also help to explain the observed advantage of weed competition at all row spacing and plant populations.

• Grain protein and screenings were higher with wider rows than narrower rows in both experiments (data not shown).

Table 1. Effect of row spacing on wheat yield on mallee and sandplain soils (yield from 180 mm row spacing taken as 100% and in bracket is actual grain yield)

<table>
<thead>
<tr>
<th>Soil type/variety</th>
<th>Row spacing</th>
<th>180 mm</th>
<th>240 mm</th>
<th>360 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grain yield (% of 180 mm treatment yield)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mallee soils</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All varieties</td>
<td>100 (1.59 t/ha)</td>
<td>96</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>Camm</td>
<td>100 (1.68 t/ha)</td>
<td>95</td>
<td>91</td>
<td></td>
</tr>
<tr>
<td>Cascades</td>
<td>100 (1.32 t/ha)</td>
<td>96</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Westonia</td>
<td>100 (1.77 t/ha)</td>
<td>97</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Sandplain soils</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All varieties</td>
<td>100 (3.30 t/ha)</td>
<td>92</td>
<td>78</td>
<td></td>
</tr>
<tr>
<td>Camm</td>
<td>100 (3.60 t/ha)</td>
<td>98</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Cascades</td>
<td>100 (2.80 t/ha)</td>
<td>90</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>Westonia</td>
<td>100 (3.50 t/ha)</td>
<td>93</td>
<td>78</td>
<td></td>
</tr>
</tbody>
</table>

CONCLUSION

Variety interaction with plant population and row spacing is a complex issue and needs to be considered in the scenario of current farming systems where it may be desirable to increase row spacing and plant population to improve soil, weed and stubble management.

ACKNOWLEDGMENTS

The research was undertaken as a joint venture between the Department of Agriculture and the South East Premium Wheatgrowers Association (SEPWA). The project is funded by GRDC (DAW 584) and the Department. Thanks to all the participating farmers and project advisory team. The cooperation and technical assistance of Veronika Reck and Pam Burgess are gratefully acknowledged.

KEY WORDS

wheat agronomy, row spacing, seeding rate, plant population

GRDC Project No.: DAW 584
Paper reviewed by: Wal Anderson
High impact of soil type and seasonal rainfall on optimum wheat seed rate

Raffaele Del Cima and Wal Anderson, Department of Agriculture

KEY MESSAGES

- Our results suggest that soil type and seasonal rainfall were the major factors influencing the differences in optimum seed rate of wheat.
- Experiments in clay loam soils, especially on sites that received more rainfall during the growing season (> 325 mm), had higher optimum seed rate [rainfall < 325 mm, optimum seed rate 61 kg/ha; rainfall 325-450 mm, optimum seed rate 75 kg/ha].
- In sandy soils, the optimum seed rate was greater with higher seasonal rainfall but lower than in clay loam soils [rainfall < 325 mm, optimum seed rate 41 kg/ha; rainfall > 450 mm, optimum seed rate 67 kg/ha].
- Higher optimum seed rates were only associated with high yields on clay soils.

AIM

The objective of the experiments was to investigate factors such as rotation, soil type, and rainfall that could affect the optimum seed rate of wheat, which is defined to be at the optimum yield level.

METHODS

Seventeen experiments (cultivar x seed rate) were conducted in 1996-1998 in the central and northern wheatbelt under a range of crop rotations, soil types and seasonal rainfall. Yield response curves were fitted to each data set to estimate the optimum seed rate and a regression technique was used to indicate the site factors that most affected the optimum seed rate. The relationship between yield and optimum seed rate was also examined using graphical techniques.

RESULTS

The results are summarised through the figures below.

Figure 1. Regression tree showing the relationship between optimum seed rate, soil type (S, with labels s, c, sl and cl for sand, clay, sandy loam and clay loam), and rainfall during the growing season (RF, with labels L indicating < 325 mm, M from 325 mm to 450 mm and H more than 450 mm). Y indicates the yield (t/ha). Numbers inside the ellipses and rectangles (nodes) are the average seed rates for each group. Numbers below these shapes are a measure of the variability accounted for by each grouping of records from the experiments.
Figure 2. Relationship between optimum seed rate and yield at optimum with site number. Results were produced for each soil type examined (where s, sl, c and cl denote sand, sandy loam, clay and clay loam respectively) and rainfall range (H > 450 mm, M from 325 to 450 mm and with no labels if less than 325 mm). Each envelope represents the spread of the responses of the cultivars in each experiment, the bold triangles represent the mean optimum yield and optimum seed rate of each experiment.

ACKNOWLEDGMENT

Mario D’Antuono provided the statistical analyses. Melanie Kupsch gave competent technical assistance. GRDC and the Department of Agriculture jointly financed the project.

GRDC Project No.: DAW 487
Paper reviewed by: Shahajahan Miyan
Crop management affects seed vigour of the resulting grain

Darshan Sharma, Wal Anderson, Anne Smith, Sheena Lyon and Melaine Kupsch, Department of Agriculture

KEY MESSAGE

- Paddock for seed requires different management from yield. Seed vigour apparently depends upon seed composition and climatic situation at the time of seed development rather than just grain yield.

- The appropriate strategy for quality seed production would be to sow at the optimum time of sowing and apply sufficient quantities of NPK (may be slightly higher than the grain crop to avoid any deficiency). An adequate level of trace elements is also essential to ensure high quality seed.

- Frost can affect seed germination and a germination test is required in spite of seed grading.

- Preliminary lab germination tests of acceleratedly aged seed of low and high falling numbers showed seed vigour decline in one but not for other two varieties tested. Experiment will be repeated and reported in the agmemo.

AIMS

High germination percentage and rapid field emergence are essential features of seed vigour. While high field emergence is important to ensure optimum plant density, germination speed is important for competitive advantage against weeds and early establishment under unfavorable conditions. Also, some reports in literature indicate that an advantage of just a fraction of a day in emergence time can ultimately lead to a significant advantage for vigorous seedlings.

METHOD

Tests: All data reported here comes from field tests. The tests were conducted on a weed free, sandy loam soil. Moisture level throughout the conduct of experiment was sufficient to support unhampered emergence.

Fifty seeds were evenly spaced in 5-mm wide, 3-cm deep and one-meter long furrows made in softened and leveled soil. Soil was gently pressed from both sides to ensure even depth of seeding. The fusion line was sealed using a small press wheel. All treatments were replicated six times and a control was planted after every five experimental rows.

Material: Seeds for time of sowing contrasts were collected from trials in 1998, 1999 and 2000 seasons. Seeds for frost contrasts were made available by Craig White. Seeds for nutrition contrasts were collected from two factorial experiments involving N, P, K and Trace elements.

RESULTS

Results from some factors influencing seed vigour are presented here. It is important to note that the magnitude of these differences may be expected to vary under less favourable conditions. Current experiments were conducted under minimal environmental stress. As such they indicate trends and not magnitudes.

Nutrition:

All of the applied nitrogen, potassium, phosphorous and trace element treatments applied to the grain crop influenced vigour of the seed. However, the response to some nutrients differed between sites and varieties. This is not unexpected given that the sites could differ for nutrient status while varieties are known to differ for nutrient uptake.
**Emergence Percentage:** Application of N, K and trace elements improved speed of emergence of Brookton, which had a lower average germinability than Carnamah. The data suggests that there was a genetic factor that resulted in reduced emergence vigour at both levels of applied nutrients. Data from a wider range of varieties and field conditions are needed to understand this result completely.

**Emergence Speed:** Within a given seed production site, Carnamah germinated faster than Brookton. Vigour was improved with appropriate Nitrogen, Potassium and Trace element applications (see Figure below). Phosphorous applied to the grain crop at another site also improved emergence speed (see Figure below).

**Frost:**

**Emergence Percentage:** %Emergence declined in some but not all the sites. Emergence declined for variety Perenjori which, experienced 20% stem and 80% head frost, while no difference was seen in Brookton which, experienced only 10% frost on each of the stem and head. Further, when seeds of the same size (2.8-3.1mm) from the frosted and unfrosted bulks were compared, similar reductions were apparent. This suggests that frost associated reduction in germinability is independent of seed size.

**Emergence Speed:** Contrary to expectation, seed lots that suffered seed viability decline with frost did not show significant reductions in speed of emergence.

**Time of Sowing:**

**Emergence Percentage:** Percent emergence did not decline for any of the varieties in seasons that had a relatively unstressed finish in 1998 & 1999. However, in seeds from 2000, Brookton suffered a heavy decline in germinability with delayed seeding in comparison to the 1999 seed lot despite similar viability at earlier TOS.

Varietal differences in seed germinability related to time of sowing were also evident. Viability declined significantly for Brookton and Wyalkatchem but not for Carnamah. Comparison of yield components reveals that TOS-related decline was associated with both the maturity group and the ability to adjust number of grains per unit area in response to stress.

**Emergence Speed:** Speed of field emergence was not influenced with time of sowing in any trials or varieties.

**CONCLUSION**

Seed for next year should be kept from a crop sown at variety's optimum time of sowing. Adequate nutrition of seed crops is must for high seed vigour. Do not assume that seed graded from frosted crops will have normal germinability. While every effort should be made to produce quality seed, seed testing is always worth!

**KEY WORDS**

Wheat, Seed Vigour, Germination, Field emergence

**ACKNOWLEDGMENTS**

Craig White for supplying frosted seed samples, Daya Patabendige for Phosphorous contrasts and Stan Johnson (Narangalu) for field site.
Lupin Breeding & Agronomy - Where to Next?

Dr Mark Sweetingham, Leader, Grain Legume Research & Industry Development, Department of Agriculture, Western Australia

The Department of Agriculture is endeavouring to work with all stakeholders to position it’s lupin R&D to maximise economic benefit to the grains industry in WA. To do this we must learn from the past and re-assess new opportunities.

Since the 1970s lupins have grown to be the largest and most successful grain legume crop in Australia. The Geraldton region became the world leader in lupin production due to a concerted breeding and agronomic research effort, linked to an innovative farming community. Researchers, advisers and growers worked together to devise the optimum agronomic inputs for lupin cultivation. In 1979 the first truly viable production package was demonstrated. The simple but key elements were:

- right variety (Illyarrie)
- pre-sowing simazine
- sow early
- high seeding rate.

The role of lupins in sandplain farming systems was researched on the leased East Chapman research annexe where weed control, disease, nutrition, grazing management and wind erosion were investigated using large 8.5ha plots under different rotations and establishment techniques. Knowledge on sowing depth, rhizobia, insect control, P and Mn fertiliser also became available.

Continuous cropping wheat-lupins (1:1) emerged as the most profitable rotation for the yellow sandplain. Lupins were direct drilled into wheat stubble, often with culti-trash discs. The dramatic increase in wheat yields under this regime was primarily due to the removal of brome and ryegrass in the lupin phase, the reduction in wheat root and leaf diseases and the biologically fixed nitrogen. In addition, the high grazing value of lupin stubbles fuelled the exponential expansion of the crop through the 1980s. Escalating production necessitated the development of export markets, a task successfully achieved by the Grain Pool of Western Australia through this period.

The 80s saw the emergence of several serious lupin diseases, notably root rots, brown spot and CMV. Agronomic adjustments to minimise the impact of these diseases were developed and embraced by growers. Better crop establishment systems evolved and breeders continued to make significant progress with the release of the higher yielding phomopsis resistant Gungurru in 1989. The albus lupin (Kiev Mutant) also developed a strong following on the red soils.

The rapid onset of herbicide resistance in the 90s, saw the unravelling of continuous wheat-lupin system. Resistance, which first appeared in ryegrass to the grass selectives and SUs, is now emerging to glyphosate and triazines. Growers have been forced to take many and varied approaches to combat resistance in grasses and are beginning to contend with resistance in wild radish. Many strategies, such as delayed sowing and crop-topping, have impacted negatively on lupin crop performance. The adoption of triazine tolerant canola, new pasture options and green/brown manuring strategies have reduced the area of lupins sown.

The outbreak of anthracnose in 1996 had a further negative impact on industry confidence. It wiped-out albus lupin production, which was pushing above 40,000 ha at the time. In 1999, it caused havoc in narrow-leaved lupins in high rainfall areas adjacent to blue lupins harbouring the disease in the Irwin and Greenough shires. Fortunately, the broad genetic base of the breeding program meant that resistance was relatively easy to identify. The release of Wonga and Tanjil has gone a long way towards stabilising the industry, although these varieties are still susceptible to pod infection where disease pressure is high and have herbicide tolerance limitations. The importance of clean seed and fungicide treatment has been demonstrated and adopted.
Anthracnose has created a short-term complication for the breeding program because much of the advanced material in the pipeline is either anthracnose susceptible or potentially carrying the triazine sensitivity associated with Tanjil, used as the parent for anthracnose resistance.

**FUTURE BREEDING**

Increasing the profitability of growing lupins requires some combination of increasing yields, decreasing input costs and increasing the value of the grain.

*Breeding still holds the key to increasing the profitability of lupin production.*

As a relatively young crop, yield potential is still being pushed higher through improved matching of physiological traits to specific environments, improved pest and disease resistance, improved herbicide tolerance and better harvestability. Breeding also offers a means to increase returns by increasing the nutritional value of the grain and/or enhancing its processing characteristics for specific end uses.

The resources available for lupin breeding are finite and are significantly less than that going into major crops like wheat. Therefore we must choose our breeding priorities and keep the list of desirable traits down to a manageable number. The current priorities are listed in Table 1.

### Table 1. Priority objectives of the WADA lupin breeding program

<table>
<thead>
<tr>
<th>Species</th>
<th>Agronomic characteristics</th>
<th>Grain quality characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>L. angustifolius</td>
<td>Yield&lt;br&gt;Anthracnose resistance (stems &amp; pods)&lt;br&gt;Phomopsis resistance (stems &amp; pods)&lt;br&gt;Harvestability (height to 1st pod, lodging &amp; shattering resistance)&lt;br&gt;Herbicide tolerance (simazine, metribuzin)&lt;br&gt;Aphid resistance&lt;br&gt;CMV resistance&lt;br&gt;Brown spot (&amp; Pleiochaeta root rot) resistance&lt;br&gt;Early vigour (weed competitiveness)&lt;br&gt;BYMV resistance/escape</td>
<td>Low alkaloids&lt;br&gt;Crude protein %&lt;br&gt;Thinner seed coat&lt;br&gt;Seed size uniformity&lt;br&gt;Dehulling efficiency</td>
</tr>
<tr>
<td>L. albus</td>
<td>Anthracnose resistance&lt;br&gt;Yield&lt;br&gt;Herbicide tolerance (simazine, metribuzin)</td>
<td>Low alkaloid&lt;br&gt;Large seed size</td>
</tr>
<tr>
<td>L. luteus</td>
<td>Yield (earlier flowering &amp; podding on branches)&lt;br&gt;Aphid resistance&lt;br&gt;Anthracnose resistance&lt;br&gt;CMV resistance&lt;br&gt;Herbicide tolerance (simazine, metribuzin)</td>
<td>Low alkaloids&lt;br&gt;Thinner seed coat</td>
</tr>
</tbody>
</table>

The narrow-leafed lupin WALAN 2141, targetted for commercial release in 2003, promises:
- equivalent or slightly higher yield potential to Belara and Quillinock
- anthracnose resistance (better than Kalya but not quite as good as Wonga and Tanjil)
- metribuzin tolerance better than Wonga and Tanjil (similar or better than Belara)
- higher protein than Belara (similar to Wonga and Tanjil)
- aphid resistance better than Belara
- greater vigour and harvest height (similar to Danja).

Other varieties approaching release include:
- yellow lupin replacement for Wodjil with better aphid tolerance and yield potential (2003)
- The first Lupinus atlanticus variety suited to well drained heavier soil-types of higher pH (2003).
A range of pre-breeding support activities are in progress or are planned in WADA and at CLIMA (Centre for Legumes in Mediterranean Agriculture). These include:

- a joint program with Russia and Poland to get Fusarium wilt resistance into Australian varieties
- mutation breeding for thinner seedcoats and herbicide resistance to new chemical groups
- transgenic research for broad spectrum disease resistance and high sulphur protein
- a feasibility study of the commercial development of the very high protein and oil pearl lupin (*L. mutabilis*) for WA.

**MARKET SIGNALS**

The Hi Pro Feed and Hi Pro Food initiatives developed by the Grain Pool of WA signal the beginning of a new era in relation to lupin grain quality.

It is vital that we target grain quality attributes required by end-users. For the traditional feed markets, protein and metabolisable energy are valued, whereas for aquaculture, protein alone is the over-riding price driver. For the food ingredient industry, functional protein components, dietary fibre and nutraceutical components such as isoflavones are central. For almost all uses the kernel is more valuable than the seed coat providing an obvious breeding target (Table 2).

### Table 2. Matching lupin grain quality to specific end-uses

<table>
<thead>
<tr>
<th>End use</th>
<th>Price driving quality factor (breeding target)</th>
<th>Processing by end-user</th>
<th>Priority lupin species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow feed</td>
<td>rumen by-pass protein, energy</td>
<td>flaking, extrusion</td>
<td><em>L. angustifolius</em></td>
</tr>
<tr>
<td>Pig, poultry feed</td>
<td>crude protein, sulphur amino acids, low non-starch polysaccharide, low alkaloid</td>
<td>dehulling, coarse grind</td>
<td><em>L. angustifolius</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>L. luteus</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>L. albus</em></td>
</tr>
<tr>
<td>Aquaculture feed</td>
<td>crude protein, low non-starch polysaccharide</td>
<td>dehulling, extrusion</td>
<td><em>L. luteus</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>L. angustifolius</em></td>
</tr>
<tr>
<td>Protein isolates</td>
<td>specific conglutin fractions with functional properties</td>
<td>dehulling, chemical/biochemical extraction</td>
<td><em>L. angustifolius</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>L. luteus</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>L. albus</em></td>
</tr>
<tr>
<td>Nutriceuticals</td>
<td>genistein, vitamin E ?, lutein ?</td>
<td>chemical/biochemical extraction</td>
<td><em>L. angustifolius</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>L. luteus</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>L. albus</em></td>
</tr>
<tr>
<td>Baking flour</td>
<td>To be determined (expect protein and lecithin)</td>
<td>dehulling, milling, grading</td>
<td><em>L. angustifolius</em></td>
</tr>
<tr>
<td>Traditional snack</td>
<td>‘Kiev-type’: large seed, blemish free</td>
<td></td>
<td><em>L. angustifolius</em></td>
</tr>
<tr>
<td></td>
<td>‘Lupini type’: very large seed, bitter, blemish free</td>
<td></td>
<td><em>L. albus</em></td>
</tr>
</tbody>
</table>

* A poultry only

It is not necessarily the case that getting lupins into aquaculture or human food markets will increase returns to growers. A recent quote, in relation to the rapidly expanding Asian aquaculture industry, ‘that just two Chinese provinces could take the entire Australian lupin crop’ in itself does not help us a great deal.

The strategy must be to target end-uses where lupins have a competitive advantage and will therefore command a premium.

Within the aquaculture sector, it seems likely that the intensive and sophisticated salmon industry may be our best target. As a human food there appears to be an opportunity to develop high-value protein isolates enriched with the nutraceutical genistein from lupin more economically than is the case from soybean.
FUTURE ON-FARM PRODUCTION RESEARCH

All of the above described potential is of limited benefit if we can’t keep lupins in the farming system.

Future agronomic research should be strongly interactive with the breeding effort. For example, wider row spacing systems may require a different plant architecture. Most varieties have some sub-optimal characteristics and therefore have specific agronomic requirements. Additionally lupins will require a level of quality assurance and perhaps environmental management standards that will influence agronomic practises.

It is critical that agronomists work with growers to work out a new position for lupins in the farming system alongside new pasture and cropping options, particularly in the context of continuing weed and disease management challenges.

There is good deal of research already happening or planned in this area (Table 3) conducted by agribusiness, grower groups and the Department. Greater coordination would be valuable.

If wool prices encourage higher sheep numbers on farm we should not forget the grazing value of lupin stubbles.

Table 3. Agronomic research priorities relevant to the Geraldton region

<table>
<thead>
<tr>
<th>Seeding technology</th>
<th>Improving establishment, weed control and minimising root disease on non-wetting soils and in partially moist seed beds.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pests &amp; Disease</td>
<td>Anthracnose, brown spot and root rot – variety specific recommendations; Virus and aphids – decision support and new threats from perennial legumes; Root disease and insect pest implications of pasture legumes in the rotation.</td>
</tr>
<tr>
<td>Nutrition</td>
<td>Potassium and sulphur nutrition – effects on grain yield and quality (protein, and alkaloids).</td>
</tr>
<tr>
<td>Weed control</td>
<td>Herbicide resistance management; variety specific recommendations.</td>
</tr>
<tr>
<td>Protein</td>
<td>Knowledge effects of region, soil type, season; Foliar nitrogen possibilities; Variety specific recommendations to optimise profit (protein and yield); Late season rhizobial nitrogen fixation.</td>
</tr>
<tr>
<td>Systems</td>
<td>Rotations and cropping sequences. Tramelining and controlled traffic. Wide row spacing opportunities. Lower input packages for low yield potential situations.</td>
</tr>
</tbody>
</table>

Western Australia has enjoyed the status of world leader in lupin technology and production for the past 30 years. Signs are emerging, in Europe in particular, that we will not remain in this position without maintaining or increasing our current R&D effort in breeding, farming systems agronomy and product development.
A decision support system for control of aphids and CMV in lupin crops

Debbie Thackray, Jenny Hawkes and Roger Jones, Centre for Legumes in Mediterranean Agriculture and Department of Agriculture

KEY MESSAGES

- Aphid outbreaks and CMV epidemics are sporadic in lupins, and for virus control, insecticide applications are not recommended, as they are inefficient at controlling spread of virus by aphid vectors.
- A decision support system (DSS), for use by advisers and growers, forecasts the need for integrated control measures at seeding to diminish virus spread by aphids in lupins.
- The DSS successfully forecasted aphid arrival and build-up, CMV spread, resulting yield losses and infection of harvested seed in lupins in different locations within the WA grainbelt.
- A general forecast for the growing season will be made available in April 2002 through the Internet ([http://www.agric.wa.gov.au](http://www.agric.wa.gov.au) under CMV in search), PestFax, TopLine, radio, etc.
- Personalised forecasts of likely yield losses based on rainfall and temperature for the user's location, level of CMV infection in seed and sowing details, will be obtainable using the Website.
- The Website also provides background information on CMV and aphids, management recommendations, photographs of aphids and virus symptoms, maps predicting different risk areas, and an explanation of the forecasting model and DSS.

BACKGROUND

Widespread cucumber mosaic virus (CMV) infection poses major limitations on grain yields in lupins, particularly in high rainfall agricultural zones of WA, but its epidemics are sporadic. Aphids also cause sporadic yield losses due to direct feeding damage. CMV is spread in lupin crops by both colonising aphids such as green peach aphid (Myzus persicae) and non-colonising aphids such as oat aphid (Rhopalosiphum padi). Annual and perennial weeds surviving the summer are the main reservoirs of aphids between growing seasons, while CMV is introduced to crops by sowing infected lupin seed.

Planning for CMV control should be done before planting crops, so that integrated control recommendations can be followed at seeding. A forecasting/decision support system (DSS) allows growers to anticipate CMV epidemics and use the integrated control strategy when needed. This strategy includes control measures like planting seed with minimal virus content, promoting early canopy development and stubble retention. The success of systemic pyrethroid applications in controlling barley yellow dwarf virus (BYDV) during the critical first 12 weeks of cereal crop growth has led to attempts to control CMV in lupins in a similar way. However, unlike BYDV, CMV is transmitted non-persistently by aphids so like many other similarly transmitted viruses, it is difficult to control with insecticides. In high value seed crops, regular applications of pyrethroids could be worthwhile for CMV control, but otherwise control is insufficient and uneconomic with single or double applications.

METHODS

In the grainbelt of south-west Australia, the survival of aphids over summer/early autumn determines the likelihood of early aphid arrival and consequent damaging virus epidemics in lupin crops. Abundance of over-summering green plant material is dependent on rainfall. The simulation model that forecasts aphid outbreaks and CMV epidemics in lupin crops therefore uses rainfall during late summer and early autumn to calculate an index of aphid build-up on broad-leaved weeds and crop volunteers in each locality before the winter growing season starts. The index is used to forecast timing of aphid immigration into crops in different localities. For each location, aphid build up, CMV spread from sowing infected seed, likely yield loss and infection of harvested seed are calculated, based on local climate data, lupin variety, level of CMV in seed sown, sowing date and plant density.
RESULTS
The model was validated with 3 years' detailed field validation data from four different grainbelt sites, and with previous field experiment data representing a wide range of pre-growing season rainfall scenarios, sowing dates, levels of seed infection and plant densities. It gave reliable predictions for aphid arrival in lupins for all sites and years. Predictions for CMV spread were also reliable (Figure 1). Predictions for peaks in aphid population numbers during the growing season were generally good but occasionally too low and early. Predictions for yield loss from CMV infection compared favourably with historical field experiment results for different sites. The model was incorporated into the DSS for use in forecasting CMV risk. The inputs required from the user are location, lupin variety, level of seed infection, sowing date, and plant density. Predictions are given for aphid arrival date, CMV spread, potential yield losses, transmission of CMV into harvested seed and whether applying integrated control measures at seeding is warranted. Maps illustrating the risk from CMV for different areas in the WA grainbelt are produced from the DSS outputs for different localities and levels of seed infection with CMV.

Figure 1. Actual incidence of CMV in lupin field experiments compared with model predictions for incidence at Badgingarra over four years.

CMV/APHID WEBSITE AND DECISION SUPPORT SYSTEM
A general forecast of CMV risk based on DSS predictions for the coming growing season in the WA grainbelt will be made available in April through the CMV/aphid Website (http://www.agric.wa.gov.au under CMV in search), PestFax, TopLine, rural radio, etc. Forecasts will be updated regularly during the growing season using the latest climate data. The Website will provide growers and advisers with access to the general risk forecast using maps to illustrate CMV risk in different areas, and will offer personalised predictions of likely yield losses from CMV and the need for integrated control measures at seeding. These predictions will be based on climate data for the user's location and seeding details (lupin variety, level of CMV in seed sown, sowing date and plant density). The Website also provides background information on CMV and aphids, photographs of aphids and CMV symptoms, management recommendations for CMV and aphid control and an explanation of the forecasting model and DSS. Further refinement of the DSS will provide reliable forecasts for peaks in aphid populations and the need for insecticide applications to control aphid feeding damage in spring, thereby avoiding unnecessary costs, and providing an environmentally responsible approach to control. A DSS for bean yellow mosaic virus (BYMV) in lupin is also being developed.

ACKNOWLEDGMENTS
This work was supported by the Grains Research and Development Corporation. We thank Art Diggle, Françoise Berlandier, and Entomology and Plant Virology Staff for their contributions.

KEY WORDS
CMV, aphids, model, decision support system

GRDC Project No.: UWA 290
Paper reviewed by: Roger Jones and Martin Barbetti
Moisture delving for better lupin establishment

Dr Paul Blackwell, Department of Agriculture, Geraldton District Office.

KEY MESSAGE

Wet soil delving through a 50mm dry layer can provide 80% of the lupin establishment from sowing fully wet sand. This can be 50% better than double disc seeding in equivalent conditions.

BACKGROUND

Lupin growers on the northern sandplains are faced with many occasions when summer or early autumn rain has resulted in a wet subsurface and a shallow dry surface. From a long term study of the meteorological record Abrecht (1994) showed there is a 25% chance of getting at least 18 dry days after an opportunity for wet sowing before the 5th of May. This shows that in at least 1 in 4 cases, surface soil will easily dry after summer or early autumn rain. When there is a shallow dry surface (40-100 mm deep) many current designs of soil openers will result in the seed being placed in a mixture of wet and dry sand. This results in poor crop establishment and early vigour. Current strategies for better weed control also encourage the opportunity to use knockdown herbicides and avoid fully dry sowing for better weed management in lupins. This results in waiting till after an early rain for a germination of weeds, by which time the surface soil has dried again. In 2000 the Williamson family, of Pine Ridge Farms Yuna, developed a ‘V’ shaped closer which reduced the mixing of wet and dry sand when sowing through a dry layer (Blackwell et al. 2000). This proved successful in farm use and enabled the lower, wetter sand to be placed near the seed, using a process of ‘delving’ where the wet soil is lifted closer to the surface as it slides up the point and the shank of the tine. Delving is a method devised in the UK for mixing clay with peat in fen soils, the clay being lifted from depths of up to 1m. The same principles have been used to lift and mix clay with water repellent sand (Blackwell et al. 1994). Wet sand delving is on a much smaller scale (up to about 0.3 m). The idea has also be tried in the early '90's by Lindsay Olman of Pindar, who used a vertical plate welded to the underside of a ducksfoot point to bring moist soil to the surface through a dry layer. The potential value of such shallow delving methods encouraged further investigation and quantification of the concept.

METHODS

Three different moisture conditions at seeding were created by irrigating dry soil and protection from natural rain with a rainfall shelter; fully wet (WET), a 50 mm dry layer over wet soil (50mmDRY) and a 75 mm dry layer over wet soil (75mmDRY). Belara lupins were sown on 4 May with three different delving methods; deep wide delving (DWD), shallow wide delving (SWD) and shallow narrow delving (SND). Deep delving dug to 250 mm, shallow delving to 125 mm. Wide delving used a 50 mm wide point, narrow delving used a 12 mm wide point. The control comparison (nil) was double disc openers, which give very little vertical soil movement. All points were on a ‘C’ shaped spring tine and were followed by a ‘V’ shaped closer a trailing sprung boot and a 50 mm wide presswheel. The crop had no natural rain till 17 days after seeding. Crop establishment and growth stage were measured regularly, as well as grain yield and simazine damage; further technical details are in the full paper. The physical dimensions of the delving systems and the soil moisture conditions are summarised in figure 1.

RESULTS

The establishment 17 days after seeding, Figure 2, showed that for an early May seeding into sand with 50 mm of dry soil over moisture, deep wide delving (50 mm point working at 250 mm depth) could result in about 80% of the establishment in wet conditions by the same equipment. The DWD treatment was also 50% better than soil opening systems with no delving. Delving showed no establishment penalties in wet sand, nor did it work well when the dry layer was 75 mm deep.
CONCLUSIONS

Wet soil delving through a 50mm dry layer can provide 80% of the establishment from sowing fully wet sand. This can be 50% better than double disc seeding in equivalent conditions. Delving success seems very sensitive to the depth of dry sand.

References
Abrecht 1994. Historical analysis of several lupin sowing strategies

KEY WORDS Establishment, dry soil, wet delving
Project No.: GLP
Paper reviewed by: Bob French
What lupin root disease is that?
Geoff Thomas, Bill MacLeod, Mark Sweetingham, Huaan Yang, Department of Agriculture

INTRODUCTION
Root and hypocotyl diseases can cause significant problems in lupin crops, reducing stand density, vigour and yield of crops. Once root diseases have become evident in a crop, very little can be done to reduce their effects, however it is vital that the cause is correctly identified to allow appropriate management procedures to take place before the next lupin crop. Correct identification can be made from symptoms in other crops on the same land, above ground symptoms in lupin plants and from lesions on roots and hypocotyls. AGWEST plant laboratories diagnostic service can accurately determine what pathogens are responsible for root rot problems in crops. This paper will outline the major root and hypocotyl diseases of lupins, the most prominent symptoms (which help with diagnosis both in the paddock and laboratory) and possible control measures.

SYMPTOMS

Pleiochaeta root rot
Caused by the fungus which is responsible for brown spot of lupins. Spores of the fungus are produced on leaves of brown spot infected plants and enter the soil as these infected leaves are defoliated. Symptoms, which are often widespread within a paddock, are wilting and death of seedlings or generally poor growth of plants. Infection produces dark brown lesions on the tap root which can result in stripping of the outer layer of the root or in severe cases completely rotting off the root. Tap roots are susceptible for 6-8 weeks after germination, however newly emerging lateral roots remain susceptible for much longer and exhibit symptoms similar to tap roots.

Rhizoctonia diseases occurring in patches
There are two major diseases which cause patches in narrow leaf lupins; Rhizoctonia bare patch and Eradu patch. They are caused by different species of the soil borne fungus Rhizoctonia.

Rhizoctonia bare - patch
Roughly circular patches with distinct edges, possibly elongated along in direction of cultivation, become apparent three to four weeks after sowing. Plants within patches are stunted or dead, the tap root and lateral roots can be pinched off by dark brown lesions. Occurs on most soil types and causes similar patches in most other crops and pastures. Equally affects all lupin varieties and species.

Eradu - patch
Roughly circular patches with distinct edges, become apparent seven to eight weeks after sowing. Patches may have ‘doughnut’ appearance with most severely stunted or dead plants nearest the edge. Red-brown lesions occur on the tap root often with the outer layer of the root often stripped off, lateral roots can be pinched off by red-brown ‘spear tipped’ lesions. Most common on the sandplain soils in the northern agricultural area. Does not cause patches in other crops except Barley. Equally affects all lupin varieties does not affect yellow lupins (cv. Wodjil) or Albus lupins.

Rhizoctonia diseases causing hypocotyl lesions
Three separate strains of the soil borne fungus Rhizoctonia (ZG3, ZG4 and ZG6) can cause hypocotyl rot of lupins, one of these strains (Rhizoctonia ZG6) causes both hypocotyl rot and a root rot. The symptoms and management for all three strains of hypocotyl rot are the same. The majority of inoculum is found in the top 5 cm of soil and the fungus can survive in soil for at least two years. Diseased plants do not occur in patches, but may have a clumped distribution with several seedlings in a row showing symptoms. From emergence until about 8 leaf stage infected seedlings wilt and die as lesions grow and rot through the hypocotyl. Most leguminous
crops and pastures are also susceptible to infection. This disease is most common in lupin crops following a legume pasture phase. The fungus is more virulent in warmer weather and in drying soil profiles, therefore very early sowing should be avoided in disease prone paddocks. Damage of seedlings by pre-sowing herbicides can also increase incidence of hypocotyl rot. Most common on the sand and sandy loams of the west midlands, northern wheatbelt and south coast.

*Rhizoctonia hypocotyl rot* (ZG3 & ZG4)

This is the most easily diagnosed of all root diseases, it causes reddish-brown and slightly sunken lesions on the hypocotyl. Major losses appear to result from reduced plant vigour and reduced establishment and stand density.

*Rhizoctonia root and hypocotyl rot* (ZG6)

Produces reddish-brown and slightly sunken lesions on the hypocotyl and root lesions, on both tap and lateral roots, which are also reddish-brown and if pinched off have ‘stubby’ ends. Major losses appear to result from reduced plant vigour and reduced establishment and stand density.

**MANAGEMENT OF ROOT DISEASES**

*Pleiochaeta root rot*

The majority of *Pleiochaeta* spores are present close to the soil surface, therefore use deeper sowing (> 5 cm) to place seed below spore layer. When establishing both lupin and rotational crops use tillage systems which reduce the incorporation of spores from the soil surface lower into the soil profile. Measures which reduce brown spot in preceding lupin crops, such as stubble retention and good phosphorous nutrition, will reduce soil inoculum. Inoculum decreases over time, consequently longer rotations between lupin crops will also reduce root rot.

*Rhizoctonia bare - patch*

Reduced by deep cultivation with a narrow tine below seed (10-15 cm) or deep ripping (25–30 cm), this cultivation control does not carry over between seasons and so must be repeated as part of the sowing operation for each crop. New patches are easily initiated from infected soil carried on machinery, therefore preventing spread of soil from infected paddocks reduces spread of this disease. Crop rotation, fungicide seed dressing and lupin variety have no effect on incidence of bare-patch.

*Eradu - patch*

Severity of patches are reduced by two years of pasture prior to lupin cropping but are increased following barley. Yellow lupins and Albus lupins are resistant to Eradu-patch and can be substituted for narrow leafed lupins in disease prone paddocks (except where anthracnose is endemic). New patches are easily initiated from infected soil carried on machinery, therefore preventing spread of soil from infected paddocks reduces spread of this disease. Cultivation, fungicide seed dressing and lupin variety have no effect on incidence of Eradu-patch.

*Rhizoctonia hypocotyl rot*

Shallow sowing (2-3 cm) exposes less of the hypocotyl to infection, furrow sowing techniques which allow seed to be sown deeper whilst being covered with less soil may be beneficial. Increasing seed rate in disease prone paddocks can compensate for losses in establishment. Care should be taken with rates and timing of pre-sowing herbicides in prone paddocks to avoid increasing seedling susceptibility to infection. Both Rovral® and Sumisclex® can reduce the severity of hypocotyl rot, use of the maximum recommended may be advantageous in paddocks with known history of rhizoctonia hypocotyl rot.

*Rhizoctonia root and hypocotyl rot*

Shallow sowing (2-3 cm) exposes less of the hypocotyl to infection, however increases the likelihood of root rot. Both Rovral® and Sumisclex® can reduce the severity of hypocotyl rot (but have no effect on root rot), a combination of slightly deeper sowing with the maximum recommended rate of fungicide seed dressing may provide control of both hypocotyl and root rot. Furrow sowing techniques which allow seed to be sown deeper whilst being covered with
less soil may also be beneficial. Care should be taken with rates and timing of pre-sowing herbicides in prone paddocks to avoid increasing seedling susceptibility to infection. Increasing seed rate in disease prone paddocks can compensate for losses in establishment.

FURTHER READING
Farmnote 43/87 ‘Rhizoctonia diseases of lupins’ MW Sweetingham, WJ MacLeod and GC MacNish.
Farmnote 11/97 ‘Patch diseases of lupins in Western Australia’ WJ MacLeod and MW Sweetingham.
<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Symptom above ground</th>
<th>Hypocotyl</th>
<th>Tap root</th>
<th>Lateral roots</th>
<th>Other Hosts Management</th>
<th>Sowing</th>
<th>Rotation</th>
<th>Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhizoctonia solani (ZG 1)</td>
<td>Patch with distinct edge, elongated along cultivation, apparent 3-4 weeks after sowing</td>
<td>None</td>
<td>Dark brown lesion severing root</td>
<td>Dark brown lesions severing root</td>
<td>All agricultural plants</td>
<td>Tillage below seeding depth (10-15 cm or deep rip)</td>
<td>No effect</td>
<td>2-3 year pasture phase preceding lupin crop</td>
</tr>
<tr>
<td>Rhizoctonia sp.</td>
<td>Patch with distinct edge, most severely stunted plants at edge of patch, apparent 7-8 weeks after sowing</td>
<td>None</td>
<td>Reddish-brown lesion stripping outer layer</td>
<td>Reddish-brown ‘spear tip’ lesions</td>
<td>Barley</td>
<td>Shallow sowing (or furrow sowing) with increased rates of Rovral® and Sumisclex®</td>
<td>No effect</td>
<td>Avoid following extended period of legume pasture</td>
</tr>
<tr>
<td>Rhizoctonia solani (ZG3 &amp; ZG4)</td>
<td>Thin stand, wilting plants, seedling death</td>
<td>Reddish-brown sunken lesions</td>
<td>None</td>
<td>None</td>
<td>Legume crops and pastures</td>
<td>Deeper sowing in furrows combined with increased rates of Rovral® and Sumisclex®</td>
<td>None</td>
<td>Extend period between lupin crops</td>
</tr>
<tr>
<td>Rhizoctonia solani (ZG 6)</td>
<td>Thin stand, wilting plants, seedling death</td>
<td>Reddish-brown lesion, can be pinched off with stubby end</td>
<td>Reddish-brown lesions, can be pinched off with stubby end</td>
<td>Reddish-brown lesions stripping outer layer or completely rotting through root</td>
<td>None</td>
<td>Deeper sowing (5 cm) and reduce incorporation of surface soil through soil profile</td>
<td>None</td>
<td>Yellow lupins are resistant</td>
</tr>
</tbody>
</table>
Pleiochaeta infection in pastures and lupins
Geoff Thomas, Huaan Yang, Mark Sweetingham, Department of Agriculture

INTRODUCTION
Legume pastures, particularly serradella, are becoming more important in the rotations of many farms. This may have disease implications for grain legume crops such as lupins. The fungus Pleiochaeta setosa has been isolated from brown lesions on serradella leaves from 2 sites in WA (Bunbury, Carrabin). But it appears to be a different ‘strain’ than that regularly isolated from lupins which causes brown spot and root rot. If the two strains are capable of infecting their alternate hosts, there could be implications for rotations involving serradella and lupins. This paper describes experiments designed to determine the host specificity of the two strains.

METHODS
Under glasshouse conditions, narrow leaf lupin (cv. Yorrel), serradella (cv. Paros) and biserulla (cv. Casbah) were grown in soil inoculated with either the lupin strain or serradella strain of Pleiochaeta setosa and disease severity measured on roots and hypocotyls. Similarly leaves of the same species were spray inoculated with spores of both strains to determine susceptibility of leaves to infection.

RESULTS
The lupin strain caused severe infection of leaves and roots of lupin and minor infection of leaves, roots and hypocotyls of serradella. The serradella strain caused severe leaf infection and minor root infection of both lupins and serradella. Both isolates caused infection in biserulla.

Table 1: Pathogenicity of lupin and serradella isolates of Pleiochaeta setosa on leaves, roots and hypocotyls of narrow leaf lupin (cv. Yorrel), Serradella (cv. Paros) and Biserulla (cv. Casbah)

<table>
<thead>
<tr>
<th>Pleiochaeta</th>
<th>Lupin</th>
<th>Serradella</th>
<th>Biserulla</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strain</td>
<td>Leaf</td>
<td>Root</td>
<td>Hypo</td>
</tr>
<tr>
<td>Lupin</td>
<td>+++</td>
<td>+++</td>
<td>-</td>
</tr>
<tr>
<td>Serradella</td>
<td>+++</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

- = no infection, + = minor lesion, ++ = moderate lesion, +++ = severe lesion

SUMMARY
The serradella strain of Pleiochaeta setosa appears capable of causing significant levels of infection in lupins (particularly leaves). Whilst the serradella strain has only been confirmed from two sites it is of potential concern with the increasing level of serradella in rotations where lupins are grown.

Both serradella and biserulla are susceptible to infection from the lupin strain of Pleiochaeta setosa, again having implications for production of these species in rotations containing lupins.

Further testing of other pastures will be carried out in the future and growers are urged to examine pasture (particularly serradella) paddocks for leaf and root rot symptoms which resemble those caused by Pleiochaeta setosa in lupins and could be confused with K deficiency.

REFERENCE
Integrated management strategies for virus diseases of lupin

Roger Jones, Crop Improvement Institute, Department of Agriculture, and Centre for Legumes in Mediterranean Agriculture, University of WA

KEY MESSAGES

- In 2001, a review of available control measures for virus diseases of lupin lead to further refinements and additions to the integrated disease management strategies for CMV and necrotic BYMV, and the development of a preliminary strategy for non-necrotic BYMV.

BACKGROUND

The two most important viruses causing diseases in lupins in the ‘grainbelt’ are bean yellow mosaic (BYMV) and cucumber mosaic (CMV), both of which are aphid-borne. There are two types of BYMV strains, necrotic and non-necrotic, the latter having more yield limiting potential because it spreads faster in narrow-leaved lupin crops infecting many more plants. CMV is introduced into lupin crops by sowing virus-infected lupin seed while aphids spread BYMV into the growing crop from adjacent virus-infected, clover-based pastures. Grain yield losses are substantial when virus spread by aphids is sufficient to cause high incidences of infection within crops. Over 15 years of research on virus diseases of lupins, a series of control measures have been devised and incorporated into integrated management strategies developed specifically for CMV and necrotic BYMV. These strategies were gradually improved and expanded as understanding of the epidemiology of viruses in lupins improved and the results of field experiments involving potential control measures became available. The strategies were designed to cause few additional labour demands, and minimal disruption to normal farming operations or extra expense. In 2001, a review of available measures lead to further refinements and additions to the management strategies for CMV and necrotic BYMV, and to development of a preliminary strategy for non-necrotic BYMV.

RESULTS

The individual measures combined within the integrated management strategy for each virus were: sowing seed stocks with minimal virus contents, sowing cultivars with inherently low seed transmission rates and isolation from neighbouring lupin crops (CMV only); perimeter non-host barriers and avoiding fields with large perimeter:area ratios (BYMV only); promoting early canopy development, generating high plant densities, adjusting row spacing, direct drilling into retained stubble, sowing early maturing cultivars, maximising weed control and crop rotation (both viruses). Recommendations to apply insecticide were included solely for spraying high value seed crops (CMV only) or virus-infected pastures next to crops (BYMV only). Table 1 lists each control measure, briefly summarises its mode of action, indicates whether it is appropriate for CMV, necrotic BYMV or non-necrotic BYMV, and the extent which farmers have adopted it as a component of each management package. For each virus, the table also indicates whether a control measure is based solely on our detailed understanding of virus epidemiology in lupin crops, or is derived from the results of replicated field experiments investigating the effectiveness of individual measures.

CONCLUSIONS

- Comprehensive integrated virus management strategies developed for controlling CMV and necrotic BYMV in lupin were updated, refined and added to, and a preliminary strategy devised against non-necrotic BYMV.

KEY WORDS

Lupin, pasture, disease, virus, losses, productivity, risks, threat, integrated control measures.

ACKNOWLEDGMENTS

The Grains Research and Development Corporation funded much of the research that lead to these management packages.

Paper reviewed by: Martin Barbetti
Table 1. Components of integrated disease management strategies devised against CMV and BYMV in narrow-leafed lupin crops

<table>
<thead>
<tr>
<th>Control measure</th>
<th>Mode of action</th>
<th>CMV</th>
<th>Necrotic BYMV</th>
<th>Non-necrotic BYMV</th>
<th>Adopted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sow seed with &lt;% ‘threshold’ infection for type of crop (seed or grain) and ‘virus risk’ region</td>
<td>Minimises initial virus infection source within crop</td>
<td>Yes¹</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Sow cultivars with low ‘intrinsic’ seed transmission rates in high virus risk regions</td>
<td>Minimises initial virus infection source within crop</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Sow perimeter non-host barrier crop in between adjacent pasture and lupin crop</td>
<td>Decreases virus spread into crop from external pasture source</td>
<td>No</td>
<td>Yes¹</td>
<td>Yes</td>
<td>Sometimes</td>
</tr>
<tr>
<td>Promote early crop canopy development</td>
<td>Shades over infection sources within crop (seed-infected and/or early infected plants) and diminishes aphid landing rates</td>
<td>Yes¹</td>
<td>Yes¹</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sow at high seeding rates to generate high plant densities</td>
<td>Minimises infection sources (seed-infected and/or early infected plants) and diminishes aphid landing rates. Dilutes numbers of infected plants</td>
<td>Yes¹</td>
<td>Yes¹</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sow at narrow row spacing (healthy seed) or at wide row spacing without lowering the seeding rate (untested seed)</td>
<td>Narrow spacing diminishes aphid landing rates. Wide spacing with high plant densities within rows shades over seed-infected plants</td>
<td>Yes¹</td>
<td>Yes¹</td>
<td>Yes</td>
<td>Sometimes</td>
</tr>
<tr>
<td>Maximise stubble groundcover using minimum tillage procedures that minimise soil cultivation</td>
<td>Diminishes aphid landing rates until crop canopy develops</td>
<td>Yes¹</td>
<td>Yes¹</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Spray high value seed crops with pyrethroid insecticide</td>
<td>Suppresses virus spread by killing or repelling aphids</td>
<td>Yes¹</td>
<td>No</td>
<td>No</td>
<td>Sometimes</td>
</tr>
<tr>
<td>Spray adjacent pasture with pyrethroid insecticide in high virus risk regions</td>
<td>Suppresses virus spread within external pasture infection source by killing colonising aphids</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Mixed cropping with non-host</td>
<td>Diminishes virus spread</td>
<td>Yes</td>
<td>Yes¹</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
Table 1. Continued

<table>
<thead>
<tr>
<th>Control measure</th>
<th>Mode of action</th>
<th>CMV</th>
<th>Necrotic BYMV</th>
<th>Non-necrotic BYMV</th>
<th>Adopted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoid fields with large perimeter: area ratios adjacent to pastures in high virus risk regions</td>
<td>Decreases spread of virus into crop from external pasture source</td>
<td>N/A</td>
<td>Yes</td>
<td>Yes</td>
<td>Sometimes</td>
</tr>
<tr>
<td>Sow early maturing cultivars</td>
<td>Decreases final infection incidence reached, especially in prolonged growing seasons</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Isolation from neighbouring lupin crops</td>
<td>Decreases spread of virus from any external infected crop source</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Sometimes</td>
</tr>
<tr>
<td>Maximise weed control</td>
<td>Minimises potential weed virus infection sources within crop (especially clovers for BYMV)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Crop rotation</td>
<td>Avoids volunteer seed-borne lupin plant infection sources within crop</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

1 Based on results from large-scale replicated field experiments in ‘grainbelt’. N/A = not applicable.
Beating ascochyta blight in chickpea

Martin Harries, Department of Agriculture

INTRODUCTION

The search is on for better agronomic methods and varieties to manage ascochyta blight (Ascochyta rabiei). Experience in dealing with ascochyta blight is increasing, and a robust package has been tested over the past three seasons. Essentially the management package is the same for this year as in the previous year, but a number of new fungicides and varieties were tried in 2001.

The other option that is available to growers, if they are not confident with the chickpea management package is to switch to legumes other than chickpea. The most promising of these for the mid-west medium and low rainfall regions are Field Pea and Lentil. These crops are suited to the current cropping system.

RESULTS AND DISCUSSION

PLANT BREEDING

Improved lines, with good resistance to ascochyta blight have been identified for both desi and kabuli type chickpea.

Trials throughout the state have seen five kabuli varieties bulked in Carnarvon, these varieties are to be put to the test in the mid-west again next year so that the highest yielding and most resistant can be selected. The desi situation has also improved markedly from where we were last year at this time. We now have the newly released variety, Howzat, which does have better resistance to the disease than the other varieties of chickpea available in Australia.

Howzat is a newly released variety of desi chickpea bred by the NSW Department of Agriculture. In the eastern states is has shown to have a useful level of resistance to ascochyta blight. The variety also has a good seed size and acceptable seed colour. This variety was evaluated in a number of trials throughout the 2001 season. Yields of Howzat were similar to Sona this year but it must be noted that the wet end to the season would have favoured Howzat as it is a slightly longer season variety.

The other promising development in desi breeding comes from our WA Department of Agriculture’s chickpea breeding team lead by Dr Tanveer Khan. Three lines are of most interest having good resistance to the disease, better than Howzat. These three lines were selected for promotion in the breeding program on the merit of good seed size, colour and yield, indications are that the release of one or more of these lines as a variety will be of great benefit to the industry.

Table # 3: Data averages from 2000 season state-wide trials

<table>
<thead>
<tr>
<th></th>
<th>Yield % of Sona</th>
<th>Seed weight mg</th>
<th>Seed colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>SONA</td>
<td>100</td>
<td>196.3</td>
<td>Cream</td>
</tr>
<tr>
<td>HEERA</td>
<td>95</td>
<td>194.2</td>
<td>Cream</td>
</tr>
<tr>
<td>WACPEA 2075</td>
<td>147</td>
<td>181.9</td>
<td>Tan/brown</td>
</tr>
<tr>
<td>WACPEA 2078</td>
<td>124</td>
<td>159.5</td>
<td>Light cream</td>
</tr>
<tr>
<td>WACPEA 2095</td>
<td>135</td>
<td>171.4</td>
<td>Light cream</td>
</tr>
</tbody>
</table>

THE MANAGEMENT PACKAGE

The management package is the same as last year, fine tuning of the package is focussing around the best selection and use of fungicides.
Two major aspects were investigated this year including: the best strategies by which to use protective fungicides, chlorothalonil and dithane and testing of systemic fungicides in the hope that they would be effective when used after the plant has been infected, a few days after a rain event.

**BEST UTILISATION OF CHLOROTHALONIL (BRAVO) AND DITHANE (MANCOZEB)**

The results below, from a trial comparing a range of fungicide application strategies, again confirm a number of points. Mancozeb (Dithane) used alone is expensive because it does not work. Applying Bravo (chlorothalonil) throughout the season results in the least infection and highest yield. It is interesting to note that alternating between chlorothalonil and dithane, starting with chlorothalonil, did give good results at Mingenew this year. Throughout the state similar trials showed various combinations of chlorothalonil and dithane to be quite effective. It is likely that this practice would be less successful in a wetter year. Even in the dry 2001 season using chlorothalonil throughout the season cost approximately $25.00/ha more in fungicide than using dithane for half of the applications while it returned from $50.00 to $112.00 per ha more than a mixed fungicide strategy.

**Table 2. Fungicide application strategy trial, sown 15th June 2001 at Mingenew**

<table>
<thead>
<tr>
<th>18-Aug</th>
<th>3-Sep</th>
<th>21-Sep</th>
<th>18-Oct</th>
<th>Disease score</th>
<th>Yield</th>
<th>Grain value @ $450/tonne</th>
<th>Fungicide costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil</td>
<td>Nil</td>
<td>Manco 2 kg</td>
<td>Manco 2 kg</td>
<td>2.7</td>
<td>0.26</td>
<td>$117.00</td>
<td>$52.00</td>
</tr>
<tr>
<td>Manco 1 kg</td>
<td>Bravo 1 L</td>
<td>Manco 1 kg</td>
<td>Bravo 1 L</td>
<td>2</td>
<td>0.41</td>
<td>$184.50</td>
<td>$76.00</td>
</tr>
<tr>
<td>Bravo 1.5 L</td>
<td>Manco 1 kg</td>
<td>Bravo 1 L</td>
<td>Manco 1 kg</td>
<td>0.7</td>
<td>0.8</td>
<td>$360.00</td>
<td>$88.50</td>
</tr>
<tr>
<td>Bravo 1.5 L</td>
<td>Bravo 1 L</td>
<td>Manco 1 kg</td>
<td>Manco 1 kg</td>
<td>0.8</td>
<td>0.66</td>
<td>$297.00</td>
<td>$88.50</td>
</tr>
<tr>
<td>Bravo 1.5 L</td>
<td>Manco 1 kg</td>
<td>Manco 1 kg</td>
<td>Bravo 1 L</td>
<td>1</td>
<td>0.68</td>
<td>$306.00</td>
<td>$88.50</td>
</tr>
<tr>
<td>Bravo 1.5 L</td>
<td>Bravo 1 L</td>
<td>Bravo 1 L</td>
<td>Manco 1 kg</td>
<td>0.3</td>
<td>0.75</td>
<td>$337.50</td>
<td>$100.50</td>
</tr>
<tr>
<td>Bravo 1.5 L</td>
<td>Bravo 1 L</td>
<td>Bravo 1 L</td>
<td>Bravo 1 L</td>
<td>0.3</td>
<td>0.91</td>
<td>$409.50</td>
<td>$112.50</td>
</tr>
</tbody>
</table>

P<0.001 P<0.001

**SYSTEMIC FUNGICIDES.**

Recent studies done in Israel suggested that the systemic fungicides could be useful as a curative fungicide treatment for ascochyta blight on chickpea. These trials used Triazole fungicides and gave good protection to plants against ascochyta blight when applied up to 3 days after infection.

Currently the only chemical means of controlling ascochyta blight is by the use of protective fungicides, applied prior to rainfall events to stop infection. While there is no doubt that good control can be obtained with protective fungicides management can be difficult. The grower must be vigilant and spray prior to a rain event. There is a chance that the crop will be sprayed unnecessarily if the predicted rain does not eventuate.

Several trials were run throughout the northern and central regions. Results from all of these trials indicated that most of the new fungicides tested did not give adequate protection against ascochyta blight. These tests included, Score, Folicur, Tilt, Nustar, Bavistin, and Amistar. Work will continue in this area this year.

**CHOOSING AN ALTERNATIVE TO CHICKPEA**

**THE BENEFITS OF FIELD PEA AND LENTIL ARE SIMILAR INCLUDING:**

- Low input costs
- Legumes, provide a break and nitrogen input
- Grow in a wide range of soils, many of the ‘chickpea soils’
- Drought tolerant
✓ Diseases can be easily managed at little or no cost
✓ Sown at the end of the program
✓ Opportunity for cheap knockdowns
✓ Machinery not in demand at the same times as cereals
✓ A good range of herbicide options
✓ Desiccation for harvest and weed control
✓ Stable prices and markets
✓ Worst case situation is a weedy low yield crop. In this situation green or brown manure is still a positive result if variable costs were kept low.

THE NEGATIVES ARE SMALL IN COMPARISON AND CAN BE OVERCOME

High initial cost of lentil seed, about 85cents per kg. In most contracts you can hold onto seed and bulk up your own.

Harvesting, it does not have to be such a hard task. Trials show that it only takes about one week for the grain of field pea and lentil to reduce from 50% to 15% if it is desiccated. Also trials show desiccation early to give higher yields as harvest losses are reduced.

Early harvest, in late October is easily achieved with desiccation well before the header is needed for cereals. Don't leave peas and lentils in the paddock until after cereals, you are looking at about 30% yield loss on high value grain, reduced quality and increased volunteers.

CONCLUSIONS

The management package for ascochyta control in chickpea has not changed from last year. Protective fungicides work but the correct use of these chemicals will have a large affect on returns. Systemic fungicides have not shown to prevent or cure ascochyta blight. Howzat is an option for consideration this year and is the most resistant variety available. WA breeding of well-adapted ascochyta blight resistant desi and kabuli chickpea is well advanced.

If you are not confident in the chickpea management strategy and are looking for ways to included legumes in your rotation look into peas and lentils. There are great benefits to be gained without much effort.
DBM in Canola

Kevin Walden, Department of Agriculture, Geraldton.

INTRODUCTION

In the last two seasons the diamondback moth (DBM) (*Plutella xylostella*) has caused considerable damage to canola in WA. In 2000 the most severe damage occurred in crops east of Geraldton while last year damage was reported from locations throughout the Northern Agricultural Region and from some locations in Central and Southern Regions.

On the world scene, DBM is ranked as the major insect pest of a large number of commercially grown cruciferous plants, including canola. The annual bill for managing the pest is estimated to be well in excess of $2 billion.

Will DBM become the major pest of canola in WA? And if so, how will it be managed?

POTENTIAL PEST STATUS

Trials conducted last year demonstrated that during winter the number of DBM larvae in a canola crop can dramatically increase over a short period of time. A low-density population of less than 10 larvae in 10 sweeps of an insect net in July can develop into over 1000 larvae in 10 sweeps by September. The trials also indicated that large numbers of DBM cause both significant yield reductions (in one trial over 60% of the yield was lost) and affect grain quality (grain weight decreased by up to 30% and oil content dropped from 40% to 34%).

If the large populations of the last two years become the norm then DBM has the potential of becoming the major pest of canola. Winter temperatures of the last two years have been well above average enabling DBM to develop quickly and winter rainfall has been below average, which may have enhanced survival. Whether these are key factors that enable DBM to build up to such large numbers will be investigated over the coming seasons and will further define its pest status. While we await a more definitive definition of DBM’s pest status, for the present we will assume that DBM is a major pest and the Department of Agriculture will develop management strategies accordingly in consultation with Agribusiness and canola growers.

ASPECTS OF DBM BIOLOGY THAT NEED TO BE CONSIDERED IN THE DEVELOPMENT OF A MANAGEMENT STRATEGY

- **Origins**

Knowing the origin of DBM outbreaks is fundamental to predicting future outbreaks and developing resistance strategies if necessary. The key issue is whether DBM can survive in cropping regions over summer. If they do not survive the key issue becomes from where outside the cropping region do they originate. It has been stated that in WA outbreaks originate as a consequence of cyclones forming a “green bridge” of host plants that enables DBM to continue breeding over summer, however, this was never proved. Extensive surveys last summer and autumn using a grid of pheromone traps and regular sampling of potential DBM habitats demonstrated that host plants, including wild radish, that germinated in response to summer rain did not produce any detectable DBM populations. Investigations aimed at identifying the origins of DBM outbreaks will continue.

- **Movement**

Studies in other countries have indicated that DBM can migrate and disperse over long distances. Moths can remain in flight for several days and cover hundreds even thousands of kilometers. Major insect pests in WA, such as the Australian plague locust (*Chortoicetes terminifera*) and the native budworm (*Helicoverpa punctigera*), use migration as a survival strategy to escape from cropping regions when they become inhospitable then return when conditions improve. It is possible that DBM moves some distance to establish populations in canola crops. Once breeding begins, the extent of moth movements and the likelihood of populations being established in other canola crops is not known.
• **Development and Survival**

The eventual size of a DBM infestation depends on the size of the initial population, the amount of time available for it to develop, the rate of development and the proportion of insects that survive to complete each generation. The initial size of a population depends on the number of moths invading the canola crop and their fecundity. The time available is determined by when the first eggs are laid in the crop. The rate of development is related to temperature with more generations being completed during warmer periods. The proportion surviving will depend on the intensity of key mortality factors such as heavy rainfall and natural enemies.

In 2000, large populations of DBM were established in canola crops soon after germination. In 2001, populations were not noticeable until mid-July yet there was sufficient time for large populations to develop. In the Northern Agricultural region DBM can complete more than six generations over autumn and winter and four generations in canola crops. With female moths able to lay almost 200 eggs, it is possible for large infestations to develop from a single, low density moth invasion.

There does not appear to be the diversity or abundance of predators and parasites associated with both DBM and aphids in canola as there is with the native budworm and aphids in lupins. Consequently it is unlikely that natural enemies will regulate DBM numbers to levels where the use of insecticides is not required. However, in 2000 a fungal disease (*Zoophthora radicans*) killed large numbers of DBM larvae in many canola crops in the Northern Agricultural Region. Although it was stated that the fungus caused DBM populations to crash in the middle of winter, this was never proved. Further studies are required to get more definitive information on the potential impact of the fungus on DBM populations.

• **Resistance**

Throughout the world DBM has developed resistance to insecticides. The situations where this has readily happened is where the moths have a high fecundity and reproductive potential, where there is a rapid turnover of generations, a long growing season, extensive areas of crucifers, and frequent insecticide applications. There is the potential for DBM to develop resistance to insecticides in WA. Insecticides are used to control DBM not only in canola but also in cruciferous horticultural crops (e.g. cabbage, cauliflower, broccoli, radish, turnip, Brussels sprouts). The significance of insecticide treatments in canola and horticultural crops in exacerbating levels of insecticide resistance and how the potential problem is managed will to a large extent depend on the origins of DBM that invade both canola and horticultural crops.

Tests on the levels of insecticide resistance of DBM populations from WA canola crops at Burabadji and Wongan Hills during 1999 indicate very low levels of resistance (resistance ratios* of 5.1 to 6.7). In 2001, resistance levels of populations tested from canola crops at Tenindewa and Wongan Hills were much higher (11.5 to 17.2) but not at a level that would result in significant control failures. However, the levels recorded may have contributed to the lack of acceptable levels of control from a single insecticide application. Also, the trend of increasing levels of resistance is cause for concern and given the history of the rapid development of insecticide resistance in DBM, regular monitoring will be undertaken and a resistance management plan devised.

*resistance ratios are the levels of resistance in the field population being tested compared to a laboratory population that has not previously been exposed to insecticides.

**ASPECTS OF DBM MANAGEMENT PRACTICES THAT NEED TO BE CONSIDERED**

• **Insecticides**

The effectiveness of synthetic pyrethroid insecticides needs to be evaluated again. Trials conducted at Yuna in 2000 demonstrated that most single spray applications controlled 80 to 90% of the larvae depending on the product and the rate of application. Last year canola growers reported that single insecticide applications at high rates were far less effective. New insecticides will need to be evaluated and their cost effectiveness compared to current treatments.
• **Insecticide Application**

The effectiveness and costs of aerial versus ground application were investigated in 2000 and 2001. Marginally better levels of control were obtained by ground application in 2000 and significantly better levels in 2001. There is no obvious explanation for the difference. The levels of control attained by each method have to be balanced against the cost of application, which in the case of ground application includes yield loss from driving over the crop.

**Timing and number of Insecticide Applications**

Trials conducted last year demonstrated that multiple insecticide applications were more effective at controlling DBM than a single application. Trials need to be conducted to determine whether the interval between sprays affects the level of control and whether controlling populations early in their development is more cost effective than delaying control to later in the season.

**MANAGEMENT STRATEGY FOR THIS SEASON**

This strategy may be amended during the season as more information is collected. The outlines of the strategy include:

• Monitoring alternative host plants during autumn and winter to determine the location and size of any early DBM infestations in the cropping region. Regular monitoring of canola crops should begin soon after they emerge.

• Estimating the number of DBM larvae in canola crops regularly using a sweepnet.

• Applying an insecticide if the number of grubs is steadily increasing and they pass the economic threshold level. The threshold is set at 200 grubs per 10 sweeps but this may change as we collect more information from trials. It should be noted that if there is a large number of small grubs (less than 5mm long), numbers are likely to increase very quickly whereas if there are very few small grubs, numbers may be in decline. If there are few small grubs, delay any control measures and survey the crop again in two days time to determine whether numbers are decreasing.

• Estimating the number of DBM larvae at least three days after spraying.

• Applying a second spray if more than 20% of the initial population remains.

• Monitoring the crop regularly after insecticide treatments.

• Continuing to control the DBM if their number increase beyond the threshold and if the crop is potentially high yielding and another spray can be economically justified.
Canola varieties for the Northern Region - 2002

Paul Carmody, Department of Agriculture, Northam

The 2000 and 2001 seasons were challenging for any crop and canola certainly was not excluded. To recall in 2000 there was a late start to seeding and low rainfall during the season, and in 2001, a prolonged dry period after seeding, plus the damage to crops by insects, especially with DBM in the northern region.

Fortunately there is some exciting news with the new canola varieties, in particular those from Pacific Seeds which are highly resistant to the blackleg disease. Variety choice for 2002 has become a lot easier in the northern district as Karoo declines in favour.

If DBM are going to be a high risk in your area – then you’d be well advised to go for the shorter season varieties.

The following tables represent a summary of Department CVT trial in 2000 and 2001, as well as some key industry trials throughout the northern region.

Table 1. Relative seed yield of Triazine tolerant (TT) canola varieties (% of Karoo) in the Northern Region (CVT’s only)

<table>
<thead>
<tr>
<th>Variety</th>
<th>High rainfall 2000</th>
<th>Medium rainfall</th>
<th>Low rainfall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
<td>2001</td>
<td>Mean</td>
</tr>
<tr>
<td>Karoo</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>ATR-Beacon</td>
<td>100</td>
<td>94</td>
<td>97</td>
</tr>
<tr>
<td>ATR-Grace</td>
<td>84</td>
<td>84</td>
<td>95</td>
</tr>
<tr>
<td>ATR-Hyden</td>
<td>121</td>
<td>107</td>
<td>104</td>
</tr>
<tr>
<td>Bugle</td>
<td>87</td>
<td>81</td>
<td>81</td>
</tr>
<tr>
<td>Pinnacle</td>
<td>86</td>
<td>98</td>
<td>85</td>
</tr>
<tr>
<td>Surpass300TT</td>
<td>83</td>
<td>83</td>
<td>83</td>
</tr>
<tr>
<td>Surps501TT</td>
<td>91</td>
<td>106</td>
<td>116</td>
</tr>
<tr>
<td>Surps600TT</td>
<td>92</td>
<td>98</td>
<td>90</td>
</tr>
<tr>
<td>ATR-Eyre</td>
<td></td>
<td>111</td>
<td>111</td>
</tr>
<tr>
<td>No. of trials</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>LSD 5%</td>
<td>15</td>
<td>24</td>
<td>20</td>
</tr>
</tbody>
</table>
Table 2. Relative seed yield of CLEARFIELD Production System varieties (% of Karoo) in the Northern and Central Regions (CVT’s only)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Northern 2000**</th>
<th>Central Region</th>
<th>Central Region</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Med. RF</td>
<td>Low rainall</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2000**</td>
<td>2000**</td>
</tr>
<tr>
<td>Karoo</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>44C71</td>
<td>58</td>
<td>93</td>
<td>135</td>
</tr>
<tr>
<td>46C72</td>
<td>40</td>
<td>54</td>
<td>122</td>
</tr>
<tr>
<td>44C73</td>
<td></td>
<td>164</td>
<td>131</td>
</tr>
<tr>
<td>46C74</td>
<td></td>
<td>115</td>
<td>103</td>
</tr>
<tr>
<td>45C75</td>
<td></td>
<td>115</td>
<td>100</td>
</tr>
<tr>
<td>Surps402CL</td>
<td>162</td>
<td>113</td>
<td>92</td>
</tr>
<tr>
<td>Surps603CL</td>
<td>115</td>
<td>115</td>
<td></td>
</tr>
<tr>
<td>No. of trials</td>
<td>2</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>LSD p = 0.05</td>
<td>30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table compiled by Graham Walton, Research Officer, Department of Agriculture, South Perth

Trials were located at Geraldton, Mingenew, Coorow, Watheroo, Yuna (sown between 10 and 29 May) and at Mullewa (sown 15 June) in 2000 and 2001.

In Table 2 the comparison of varieties in these trials were conducted without the use of herbicides in 2000. In 2001, three trials were conducted comparing the varieties using the CLEARFIELD System.

Table 3. Relative OIl content and disease ranking of Triazine tolerant varieties in comparison to Karoo in WA overall

<table>
<thead>
<tr>
<th>Variety</th>
<th>Height</th>
<th>Maturity</th>
<th>Oil concentration¹</th>
<th>Dept. of Agric. blackleg rating²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karoo</td>
<td>Medium</td>
<td>Early</td>
<td>38.8</td>
<td>4</td>
</tr>
<tr>
<td>ATR-Beacon</td>
<td>Medium</td>
<td>Early - mid</td>
<td>39.8</td>
<td>5</td>
</tr>
<tr>
<td>ATR-Grace</td>
<td>Medium</td>
<td>Late</td>
<td>39.6</td>
<td>7P</td>
</tr>
<tr>
<td>ATR-Hyden</td>
<td>Medium</td>
<td>Early - mid</td>
<td>39.2</td>
<td>6</td>
</tr>
<tr>
<td>TI1 Pinnacle</td>
<td>Medium - short</td>
<td>Mid – late</td>
<td>39.3</td>
<td>6</td>
</tr>
<tr>
<td>Surpass 300TT</td>
<td>Medium</td>
<td>Early</td>
<td>40.9</td>
<td>4P</td>
</tr>
<tr>
<td>Surpass 501TT</td>
<td>Medium</td>
<td>Early - mid</td>
<td>42.7</td>
<td>8+P</td>
</tr>
<tr>
<td>Surpass 600TT</td>
<td>Tall</td>
<td>Mid – late</td>
<td>40.5</td>
<td>6</td>
</tr>
<tr>
<td>ATR-Eyre</td>
<td>Tall</td>
<td>Early</td>
<td>41.8</td>
<td>N/A</td>
</tr>
</tbody>
</table>

¹ Oil % (at 8.5% seed moisture). Limited number of trials in 1999 and 2000.
² The Department of Agriculture ratings for resistance to blackleg combines both the plant survival and stem canker scores. 1 = highly susceptible, 8+ = highly resistant.
Table 4. CAWA INDUSTRY TRIAL SUMMARY - 2001

<table>
<thead>
<tr>
<th>Site</th>
<th>Mingenew</th>
<th>Mingenew</th>
<th>Geraldton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil type</td>
<td>Light</td>
<td>Heavy</td>
<td></td>
</tr>
<tr>
<td>Rainfall 2001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>April - Oct</td>
<td>276</td>
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<td>0.94</td>
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<td>1.27</td>
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<td>536</td>
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<td>Pinnacle</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.25</td>
<td>43.8</td>
<td>533</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

1 The control of ryegrass in the IT plots was unsatisfactory to get a fair comparison of the 2 systems.
Special thanks to member of the MINGENEW-IRWIN GROUP INC;

VARIETIES TO CONSIDER IN YOUR PROGRAM THIS YEAR

**High rainfall:** Surpass 600TT, ATR-Grace, ATR-Hyden, Pinnacle, (ATR-Eyre, a promising variety, but has lower blackleg tolerance than the other varieties) in CLEARFIELD the best are 44C73, 44C74, Surpass 603CL

**Medium rainfall:** Surpass 501TT, ATR-Beacon, in CLEARFIELD the best are 44C73, 44C74, Surpass 402CL

**Low rainfall:** ATR-Beacon, ATR-Hyden (ATR-Eyre and Surpass300TT are promising varieties) in CLEARFIELD the best are 44C71, 44C73

TT CANOLA VARIETY PERFORMANCE - LOW RAINFALL 2001

*From Bevan Addison & Peter Carlton of Elders (with Funding support from GRDC)*

A series of trials were established in 2001 by Elders with funding from GRDC to evaluation the best management of the different varieties in the low rainfall areas of the central east in WA. The following comments are a summary of their findings.

IT varieties were tested along side TT varities but in these trials the differences between IT and TT mean values proved to be insignificant (Refer to full paper Crop Updates 2002). This would suggest that in drier years like late year growers would have been better off growing TT varieties in the eastern grainbelt.

Growers will need to weigh up very carefully the risk of going with a CLEARFIELD variety given the additional cost with the outlook for the season. The best CLEARFIELD lines appear to be either 44C73 or Surpass 402CL but they will need to be seeded as close to the break as possible to maximise their full potential.
In the TT line you cannot go past Surpass 300TT, Beacon or 501TT as these have recently proved to be the most promising for this northern eastern region.

**SUGGESTION FOR 2002:** If possible, include two varieties of different maturity (early and mid) in your cropping program to reduce risk of unpredictable growing season.

**ACKNOWLEDGMENTS**

Graham Walton and Hassan Zaheer, Department of Agriculture for the background paper to this presentation.
Canola establishment and yield with seed size, sowing depth, stubble and seeder type

Glen Riethmuller*, Rafiul Alam**, Greg Hamilton*** and Jo Hawksley*,
Department of Agriculture, *Merredin, **formally Merredin, ***South Perth.

KEY MESSAGE
Large Karoo canola seed (greater than 1.7 mm in diameter) increased establishment by 9.7% and yield by 6.9% (0.07 t/ha) at Mingenew but there was no significant effect on establishment or yield at Coorow. Stubble burning improved the canola yield at Mingenew with no effect on establishment (burning reduced self-sown wheat) but there was no effect of stubble on yield at Coorow.

Large seed also produced more plants, matured earlier and produced a higher yield than small seed, particularly at deeper sowing depths at Merredin.

BACKGROUND
Low plant density and/or uneven plant density and size, has been recorded in 98% of the canola paddocks in crop establishment surveys during 2000 in the Northern and Central Agricultural Regions. In the UK, large seed (>2.0 mm) improved canola establishment from seeding depths deeper than 3 cm. In Canada, seed larger than 2 mm is used to reduce the effects of crucifer flea beetle damage.

Deeper than optimum seeding is often recommended as an option to provide soil moisture to the germinating seed, particularly in moisture limited seeding situations.

AIMS
To investigate the effect of seeding technique and seed size on canola establishment and yield with and without the previous wheat crop stubble at two locations in the Northern Agricultural Region.

To measure the variation in seedling establishment, yield and seed quality at three sowing depths with three seed sizes.

METHODS
Two experiments were designed to observe the establishment of canola in the Northern Region in the 2001 season. The experiments were designed to compare graded to ungraded seed, using different seeding techniques. The experiments were located at Gary Cosgrove’s property (pale yellow loamy sand) at Mingenew and Mike Bothe’s property (reddish loamy sand) at Coorow. The stubble residue from the previous season was wheat.

The experiments were sown on the 8th (Mingenew) and 10th (Coorow) of May, with 20.8 mm of rainfall at Mingenew and 24.6 mm at Coorow on the 7th May. Fresh quality assured Karoo seed from Dovuro was sown at a seeding rate of 5.9 kg/ha for graded (>1.7mm) and 4.6 kg/ha for ungraded seed and both experiments were harvested on the 23rd October.

The plots were sown using an air cone seeder, sowing six rows at 250 mm spacings. The seeding techniques used included; Harrington 13mm wide knife points, 50 mm wide Super Seeder points, 180mm wide full cut points with Loxton rotary harrows or Walker triple discs. ARP 80 mm wide banked and 50mm wide flat press wheels were set at 2 kg/cm width. Seed pressing was done with the 80 mm wide press wheel and a following Janke finger tine attached to the press wheel frame covered the seed with loose soil.

Fertiliser and chemicals were applied using standard agronomy practices. Applications of Agrich (50 kg/ha) was banded below the seed, and urea was topdressed (60kg/ha and 85kg/ha) and sulphate of ammonia (120 kg/ha) were applied during the growing season. Atrazine (2L/ha) and Select (250 mL/ha) plus Hasten were applied to control weeds.
Another experiment was sown at Merredin to observe the establishment of canola at different sowing depths (1.5 cm, 3.0 cm and 4.5 cm), using seed graded into three seed sizes: > 1.7 mm, 1.4 – 1.7 mm, and < 1.4 mm in diameter. The experiment was sown on the Merredin Research Station on a yellow sandy loam, on the 14th May, after 11.8 mm of rain and harvested on the 13th November. The stubble residue from the previous season was wheat.

The experiment was sown using an air cone seeder, sowing six rows at 250 mm spacings, using 13mm Harrington knife points and ARP 80 mm wide banked press wheels set at 2 kg/cm. The seeding rates were; 5.87 kg/ha (>1.7 mm), 3.94 kg/ha (1.4 – 1.7 mm) and 3.39 kg/ha (<1.4 mm) to sow 160 seeds/m² for each treatment.

Fertiliser was topdressed after establishment, to reduce seed damage from toxicity. Double super (88kg/ha) and two applications of urea (33 kg/ha, 99 kg/ha) were applied during the growing season. Standard herbicides and insecticides were used to control pests such as, grass weeds, locusts, and Diamond Back Moth.

**RESULTS**

The establishment of the Northern region experiments of most treatments was between 60 and 90 plants/m². The triple disc was lower establishing than all but the full cut at Mingenew. At Coorow, the treatments using Harrington 13mm knife points with the 50mm press wheels and the press wheels with finger tine following, had a higher establishment than the other treatments. There were 11% more plants established in the stubble than the burnt treatments at Coorow but there was no effect of stubble on yield. Burning stubble improved the canola yield by 19.6% at Mingenew, which was probably due to less self-sown wheat and there was no effect of stubble on establishment (table 1). The larger graded seed averaged 6.9% (0.07 t/ha) higher yielding at Mingenew compared to the ungraded seed but there was no significant effect on establishment or yield at Coorow.

<table>
<thead>
<tr>
<th>Table 1. Canola yield (kg/ha) with stubble, and seed size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed size</td>
</tr>
<tr>
<td>Stubble Burnt (average yield)</td>
</tr>
<tr>
<td>Stubble Retained (average yield)</td>
</tr>
</tbody>
</table>

In the Merredin experiment the larger seed produced more plants than the smaller seed at deeper sowing depths but was similar at the shallow 1.5 cm sowing depth. The yield increased with increasing seed size and the 4.5 cm sowing depth was lower yielding than the 1.5 or 3.0 cm sowing depth (table 2). At the Merredin Research Station Field Day on the 27th September it was clear that the small seed treatments were less advanced since they were still flowering where the largest seed treatments had finished flowering.

<table>
<thead>
<tr>
<th>Table 2. Karoo yield (kg/ha) with seed size and sowing depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sowing depth \ seed size</td>
</tr>
<tr>
<td>&gt; 1.7 mm</td>
</tr>
<tr>
<td>1.4 – 1.7 mm</td>
</tr>
<tr>
<td>&lt; 1.4 mm</td>
</tr>
<tr>
<td>Average</td>
</tr>
</tbody>
</table>

The oil content increased with increasing sowing depth (37.7 - 38.5%). There was no effect of seed size or sowing depth on seed protein (average 25.2%). The smallest seed (<1.4 mm) had a higher admixture (1.63%) than the other seed sizes (average 1.15%) and there was no effect of sowing depth on admixture. The larger seed matured earlier than the smaller seed, which was reflected in the larger seed having lower seed moisture (5.2% vs 6.0%).
CONCLUSIONS

In the Northern region, large seed was again important in 2001, which was also found in 2000. Sowing canola into stubble may not be a great problem provided many weed or wheat seeds are not present. Seeding machinery type was not particularly important this season, which might have been due to the relatively good soil moisture conditions at sowing. It was interesting that the triple disc had the lowest establishment at Mingenew but had the highest yield at Coorow.

At Merredin, the larger seed produced more plants, matured earlier and produced a higher yield than small seed, particularly at the deeper sowing depth of 4.5 cm. This work needs to be repeated on lighter soils and possibly with seed larger than say 1.8 mm in diameter.

The implication for farmers is that if they are going to keep seed, it should be graded heavily. Importantly, the seed should be germination tested to be sure the seed is worth sowing.
Yield losses caused when beet western yellows virus infects canola

Roger Jones and Jenny Hawkes, Department of Agriculture, and Centre for Legumes in Mediterranean Agriculture.

KEY MESSAGE

• In two field experiments in 2001, infection with BWYV that started early and reached 98% and 93% of plants decreased seed yield of canola by 37% and 46% respectively.

BACKGROUND

Beet western yellows luteovirus (BWYV) is transmitted by aphid vectors. In the grainbelt of south-west Australia, aphids spread BWYV to canola and pulse crops from infected weeds, especially wild radish. In surveys in 1998 and 1999, BWYV was found in 59% and 66% of canola crops sampled respectively. In Europe, infection with BWYV is reported to decrease seed yields of canola by 10-35%, and also to diminish oil and increase glucosinolate contents. No yield loss data has been collected for viruses infecting canola in Australia.

METHODS

In the 2001 growing season, at two Department of Agriculture Research Station sites (Badgingarra and Medina), field experiments with BWYV and canola were done to provide yield loss information. To obtain early BWYV spread and high incidences of infection, small numbers of canola plants infected with BWYV and infested with green peach aphids (Myzus persicae) were introduced into plots of some treatments in each experiment. Foliar pyrethroid + imidacloprid insecticide applications were used to suppress BWYV spread differentially within the treatments. Colonising aphids were counted before and after spray applications. Each plot was sampled fortnightly to determine BWYV incidence and the samples tested by TBIA using BWYV specific antiserum. Harvest and threshing was by machine following swathing at Badgingarra and by a mixture of machine and hand at Medina.

RESULTS

In both experiments, BWYV spread very quickly in young plants causing symptoms of leaf reddening and plant stunting that were absent in healthy plants. These symptoms persisted and growth of heavily infected plots was noticeably stunted compared with the lush growth of sprayed plots without infector plants. Spraying at emergence was ineffective in suppressing early virus spread at Badgingarra. Blanket insecticide sprays were eventually needed at both sites to prevent substantial BWYV infection of control plots. At Badgingarra, BWYV infection in plots with infector plants but without insecticide spray treatments (up until 12 weeks from emergence) reached 98% of plants compared with 8% in plots with no infector plants and regular spray treatments starting at emergence, giving yield losses of 37% (Fig. 1). At Medina, BWYV infection in plots with infector plants but without insecticide spray treatments (up until 3 months from sowing) reached 93% compared with 10% in plots with no infector plants and regular spray treatments, giving yield losses of 46% (Fig. 2). Early aphid numbers before plots were sprayed were insufficient to have contributed directly to the yield losses.

CONCLUSIONS

This work shows that, when aphids spread it to canola crops early, BWYV has substantial yield limiting potential in the WA grainbelt. Although the results represent a ‘worse case scenario’, the losses were greater than those reported in Europe and are cause for concern.

KEY WORDS

Canola, oilseed, virus, disease, yield loss, risks.

We thank Brenda Coutts, Lisa Smith, Rohan Prince, Gavin D’adhemar and Stewart Smith for technical support, and the Grains Research and Development Corporation for funding.
Fig. 1. Effect of BWYV on yield of canola cv. Pinnacle, Badgingarra.
A = sprayed at emergence, 4, 8 and 12 weeks + infector plants; B = sprayed at 8 and 12 weeks + infector plants; C = no spray + infector plants; D = no spray – infector plants; E = sprayed at emergence, 4, 8 and 12 weeks - infector plants; F = sprayed at 8 and 12 weeks - infector plants. Starting at 12 weeks, all plots sprayed fortnightly. Bar = lsd.

Fig. 2. Effect of BWYV on yield of canola cv. Pinnacle, Medina.
A = sprayed at emergence and then every 2 weeks + infector plants; B = no spray + infector plants; C = no spray – infector plants; D = sprayed at emergence, then every 2 weeks - infector plants. Starting at 3 months from sowing, treatments B and C also sprayed fortnightly. Bar = lsd.
Canola crops can help fuel new bio-diesel industry

Dr Howard Carr, Intellectual Property Officer Grains, Department of Agriculture

The use of bio-diesel as a fuel alternative is attracting world-wide attention because of its environmental benefits and concerns of the declining reserves of fossil fuels. Western Australia (WA) is well positioned to be actively in the emerging bio-diesel industry due to it’s oilseeds and animal production industries.

Mineral or fossil diesel is produced from heavy crude oil, and Australia’s reserves are expected to be nearing exhaustion by 2012. This will have a significant impact on the domestic economy and Australia’s balance of trade. Therefore, alternative fuel sources need to be further explored in Australia.

Bio-diesel has the same combustion properties as fossil diesel, and can be used in existing diesel engines with little or no modification, offering an alternative internal combustion engine fuel. Bio-diesel is the product of a simple chemical reaction using 20 units of animal or vegetable oils with one unit of primary alcohol, usually methanol or ethanol. Methanol is readily and very cheaply produced from natural gas. Bio-diesel is widely used in agriculture and urban transport systems in Europe and the US.

Bio-diesel offers many environmental advantages compared with diesel including low sulphur emissions; approximately 35% less carbon dioxide and sub-10 micron particles; and nearly the same amount of nitrous oxide. Bio-diesel is regarded as one of the most practical solutions available today to assist in reducing greenhouse gases and to meet Australia’s obligations in accordance with the Kyoto Agreement.

CANOLA CHARACTERISTICS

Canola oil is one source of vegetable oil that can be readily used for bio-diesel. There has been a recent expansion of canola production in WA and in 1999-00, just under one million tonnes of canola were produced. In 2000-01 however, production decreased to 350,000 tonnes, due to drought.

The current canola varieties in Western Australia have primarily been bred for human consumption, with high quality and lower quantity oil production. With further plant breeding, industrial oilseeds can be developed to produce up to 30% more oil but at a lower quality that will not be suitable for human consumption. The cost of the oil accounts for approximately 75% of the total cost of bio-diesel production. With increased oil yields, the bio-diesel industry would become more profitable and financially attractive. The industrial oilseeds also have the benefits of being harder plants that can handle adverse conditions such as frost and marginal (low rainfall) conditions compared to conventional canola varieties. The industrial oilseeds are also more insect and disease resistant.

Industrial oilseeds enable the opportunity to further expand the current WA oilseed industry, and improve sustainability and profitability to farmers. The industrial oilseeds for biodiesel will therefore aid both agriculture and the environment, as it is a renewable energy that has many advantages compared to the finite fossil fuel resources.

STRONG OVERSEAS DEMAND

The bio-diesel industry in Europe is experiencing rapid expansion, with 50% growth per annum. At present, bio-diesel in Europe is significantly cheaper than fossil diesel – it currently sells for approximately A$1.65 per litre, which is 15 cents per litre cheaper than fossil diesel.

Europeans cannot source sufficient supplies of vegetable oils to fulfil local demand. Saarberg, a German company which has 80% of the market share in bio-diesel in Western Europe, has shown an interest in WA to produce bio-diesel for the European and Australian market.
European manufacturers and consumers at this stage do not currently accept bio-diesel produced from GM oilseeds. WA has a competitive advantage compared with Canada (who is the largest canola exporter in the world) as 70% of the Canadian canola is GM. However, South-East Asian palm oil is a potential threat to canola oil as it can at times be a considerably cheaper substitute for biodiesel production. The disadvantage with bio-diesel made from palm oil is it is currently not suitable for use in cold climates.

Farmer cooperatives sourcing oilseed grain from members – crushing and extracting vegetable oils and in many cases producing, distributing and retailing bio-diesel – have been highly successful in Europe. Such models could be adopted in WA and have the potential to arrest declining farm profits and establish new regional value adding businesses as well as providing an ideal opportunity to value add. Bio-diesel production could initially be targeted to the export market and, in the future, supply the local fuel industry.

**BIO-DIESEL IN WA**

Amadeus is planning on constructing the first bio-diesel production facility in 2002. They are going to use tallow (animal fats) as the main source to produce bio-diesel.

There are several niche markets within WA who can benefit from bio-diesel and be prepared to pay a premium for bio-diesel. These are:

- The underground mining industry, which has limited hours of operations per day due to the lack of clean air caused from the emissions of fossil fuels;
- Urban bus fleets, whose involvement would be as seen as an important and pro-active initiative showing commitment to the environment and the community; and
- Offshore drilling mud manufacturers are currently producing large amounts of residues on the ocean floors from ocean exploration and oilfields, which are non-degradable. The United Nations Environment Program has arranged with all oil-producing countries to agree to phase out the current mud drilling practice and bio-degradable bio-diesel is an ideal alternative fuel to continue exploration.

**BASIC REQUIREMENTS**

European bio-diesel manufacturers, WA farmers and miners, WA regional business communities and alternative energy advocates are keen to see the development and commercialisation of new high-yielding oilseed varieties suited to broadacre farming. And Western Australia already has the basic requirements – natural gas, canola oil, land and port facilities – needed to become a significant producer and exporter of bio-diesel.
Nutrition in 2002:– Capitalising on variability

Bill Bowden, Department of Agriculture WA, Northam

KEY MESSAGE

- Flexibility is the key to your fertiliser strategies. Plan for unpredictable seasons and get your advisers to give you the answers to the “what happens if…?” questions.
- Use the diagnostic power of windrow effects – and make a mint.
- Nutrient budgetting has its place in determining fertiliser requirements, but you need to know the nutrient status/fertility of your paddocks, so use paddock records, soil tests or direct diagnostics.
- Potassium nutrition is such an enormous issue, that every farmer should be re-assessing his/her farm’s potassium status. Get soil tests done and monitor your different paddock situations regularly.

INTRODUCTION

I was asked to give a talk on “Nutrition in 2002: decisions to be made as a result of last season”. Last year I gave such a talk many times. It is a routine and boring talk where I look at the idiosyncrasies of the season (plus/minus summer rains, early/late break, with/without strong leaching rains, high/low production giving good/bad cash flow with the degrees of freedom to spend high/low amounts on fertiliser). This region enjoyed any of the above conditions (good season in the west, poor in the east, summer rain in the north and east but not in the south and west) so any general statement from me will be wrong for all but a few situations. This is the nature of average recommendations and packages across a whole range of agronomic management areas (and for that matter, most fields of human endeavour). In another context, it is known as “the tyranny of the mean” – the average is used because it is easily understood, but most of the individual situations (particularly in biology and sociology) behave differently from the mean.

In recognising this truism, I have spent my career trying to develop (fertiliser recommendation and other) systems which allow individuals to make their own choices given the best information we can muster on variation with season, site and management. This means presenting options rather than recipes, dollar and yield response functions rather than prescribed rates. The approach means the decision maker/manager needs to know “what happens (to production quality and dollars) if….?” he/she chooses or is forced to spend more or less on fertiliser, or “what happens if….?” next year is a good or bad season, or “what happens if….?” she/he decides to break this variably yielding paddock up into 2? 4? 8? or continuously variable, management units?

So, go out and apply the existing methods of making nutrition decisions but make sure you do not rely solely on a recipe or package answers. Get estimates of nutritional status which take account of last season’s effects and which are tailored to your individual situation. Make sure you get answers in dollar and production terms of “what happens if….?” you change the levels of input, placement, source etc and particularly “what happens if….?” 2002 is a good, bad or average season. If hard pressed, your fertiliser company advisers/agronomists and certainly your consultants, can get such answers for you.

In preparing for this talk, I asked 14 advisers/farmers with connections in the northern region, which of the many possible topics they thought I should address. Topics suggested included nutrient budgetting, potassium deficiency, nitrogen dynamics, NP placement, ripping interactions, getting the most from your fertiliser dollar, acidity, windrows, timing of N, the impact of summer rain, canola nutrition, curtains of fertility, precision placement, pros/cons of NOT mixing soil. I would love to do half an hour on each, but will use that list as license to pick and choose a couple of topics to illustrate my theme which is: “managing to take advantage of what information we have on variability”.

Burnt windrow effects

Often in crops following burnt windrows, you observe yield variability with better growth on the windrows than off. We have been pushing the use of this effect for the diagnosis of nutritional
and soil fertility problems for a few years now. It is far easier to diagnose a nutritional problem from the comparison of plant and soil analyses from paired, good and bad areas in a crop when you know that the variation is due to some simple management difference. The crop is a very good bioassay of its own problems. Traditional diagnostic methods, which compare individual samples from problem areas with nebulous, textbook critical levels which vary with age and stage of the crop, are far more difficult to interpret.

Last season, we had many reports of residual effects of burnt windrows. Most of them have revealed potassium deficiency as the major problem. Responses to the liming effect of burning the windrows have been seen in some circumstances. The effects are seen not only with crops following canola windrows, but also for crops following cereal and lupin windrows. We have now seen major responses for following crops of wheat, oats, barley, faba beans, lupins, peas and canola. Despite the late start to the season, we have seen responses to applications of potassium up to 8 weeks after seeding and we have seen major residual effects from potassium dressings applied across windrows last year. An example from Rod Birch’s place at Coorow is given in the table below. The main problem is potassium deficiency. Its correction – even in the year of the crop in which it was diagnosed – returns a small fortune.

<table>
<thead>
<tr>
<th>2000/2001 crop</th>
<th>Canola/wheat</th>
<th>Lupin/wheat</th>
<th>Lupin/wheat</th>
<th>Lupin/wheat</th>
</tr>
</thead>
<tbody>
<tr>
<td>On</td>
<td>Off</td>
<td>On</td>
<td>Off</td>
<td>On</td>
</tr>
<tr>
<td>Soil K (mg/Kg)</td>
<td>40</td>
<td>33</td>
<td>60</td>
<td>35</td>
</tr>
<tr>
<td>Soil S (mg/Kg)</td>
<td>6.3</td>
<td>2.4</td>
<td>6.4</td>
<td>5.6</td>
</tr>
<tr>
<td>Plant K %</td>
<td>2.1</td>
<td>0.8</td>
<td>3.7</td>
<td>1.7</td>
</tr>
<tr>
<td>Plant S %</td>
<td>0.69</td>
<td>0.71</td>
<td>0.43</td>
<td>0.54</td>
</tr>
<tr>
<td>Plant P %</td>
<td>0.51</td>
<td>0.68</td>
<td>0.42</td>
<td>0.68</td>
</tr>
<tr>
<td>Plant wt g</td>
<td>4.8</td>
<td>2.2</td>
<td>0.6</td>
<td>0.2</td>
</tr>
<tr>
<td>Grain (kg/ha)</td>
<td>Nil K</td>
<td>1993</td>
<td>140</td>
<td>2648</td>
</tr>
<tr>
<td>+ K</td>
<td>1998</td>
<td>1032</td>
<td>3341</td>
<td>2410</td>
</tr>
<tr>
<td>*windrow</td>
<td>Nil K</td>
<td>$556</td>
<td>$191</td>
<td>$436</td>
</tr>
<tr>
<td>response</td>
<td>+ K</td>
<td>$299</td>
<td>$140</td>
<td>$210</td>
</tr>
<tr>
<td>Grain size (mg)</td>
<td>Nil K</td>
<td>34</td>
<td>25</td>
<td>41</td>
</tr>
<tr>
<td>+ K</td>
<td>34</td>
<td>34</td>
<td>43</td>
<td>41</td>
</tr>
<tr>
<td>Farmer Paddock (kg/ha)</td>
<td>1600</td>
<td>2400</td>
<td>3500</td>
<td>3300</td>
</tr>
</tbody>
</table>

*On” refers to on the windrow. *Off” refers to between the windrows. *Net $300/t canola, $150/t wheat

There are big and long term dollars to be made by correcting problems diagnosed in this way, so keep your eyes open for such effects in 2002 and capitalise on them; the remedies to some of the problems diagnosed in this way, have been extremely cost effective.

**Potassium nutrition**

Potassium (K) deficiency is the emerging giant for crop nutrition in WA. We have always known that our light soils are very low in K. Through continued crop removal and redistribution, K deficient crops can be found anywhere in WA. The predicted run down of soil K reserves has been exacerbated by more cropping, higher yields and in latter years, the expansion of the hay industry. The potassium removed in a tonne of hay is three times that in a tonne of grain – and you cut more hay than you harvest grain!

You can now get responses to K which match those for N. Both nutrients cost similar amounts so the application of K is now very cost effective in responsive situations. Use soil testing to work out if your soil is at marginal levels of K. On all but the gutless, low organic matter sands in high rainfall areas, K does not leach out of the root zone and has a relatively high residual value. So when in doubt about the adequacy of your soil K levels, bung some on if the bank balance allows it. Don’t worry about which phase of the rotation you put it on, just make sure you don’t put it too close to the seed.

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If we judge by the diagnostic windrow effect, the K status can vary quite markedly around a paddock. You will note in the above table that K has had a marked effect on grain size – which correlates negatively with screenings and reflects post anthesis water use efficiency as well as green leaf area duration. In some parts of the world, potassium is known as the poor man’s irrigation.

**Season to season variability**

Adapting your management is one of the best ways to capitalise on seasonal variation. When you have a good season letting you grow large amounts of legume crops or pastures (eg 1999, 2001 in west?) then you can obviously think about using less nitrogen fertiliser on your non-legume crops in the following year (2000, 2002 in west). Again, if you have significant summer rain (>50mm in an event, eg last 3 summers in the north and east) then you can expect extra nitrogen mineralisation and the need for less nitrogen at seeding. However, you should try to retain flexibility in your nitrogen fertilising policy. If you get significant leaching rains (eg the 2nd Moora flood at the end of May in 1999) you need reserves of dollars to buy and apply late nitrogen – particularly where your yield potential is high because of deep, stored soil moisture from those leaching and/or summer rains. It may be worth trying to increase your ability to be able to change your nitrogen inputs, depending on how the season is proceeding. Last year, with early sown canola on an early break, yield potentials looked promising and we were predicting high nitrogen requirements. However in many regions, there was a 6-week drought after seeding, which made nonsense of earlier nitrogen recommendations. If less N had been applied at seeding with the option to apply more later if the season warranted it, was a good policy last year. It would also have gone well in the wet season of 1999 when much of the seeding N was lost to leaching – though then, many growers would have had problems getting onto their country to apply the later dressings demanded by the big crops. The policy of a small amount of nitrogen at seeding with the option to apply more in the next 6-8 weeks depending on the nature of the season has its attractions. Do we have the storage facilities or the delivery plans to be able to use this flexible strategy?

This year we will be releasing our latest-and-greatest nitrogen calculator, SYN (select your nitrogen). It is designed to let you put in the specifics of your situation (rotation, tillage, soil type, fertiliser preferences and timing) and it lets you see the impact of any real and/or imagined rainfall pattern on nitrogen availability, yield, quality and dollar returns from wheat, barley and canola.

**Small scale, vertical and horizontal soil/nutrient heterogeneity**

The no-till revolution introduced some anticipated nutritional problems which, except for some depth of sampling difficulties, seem not to have had a major effect yet. We predicted major problems resulting from the positional unavailability of nutrients concentrated near the surface of the soil. This would be particularly so for crops which grow in the summer (lucerne, sorghum etc) or crops like lupins which have a large demand for nutrients in the spring, when the surface soils are subject to drying and wetting cycles. 2001 gave several examples of this effect where early in the season, there were some very phosphate deficient crops and pasture at reasonable soil test levels, probably due to the very dry conditions after seeding.

Fertile soils have soil immobile nutrients like phosphorus, copper, zinc and manganese spread down the profile so that they are available for uptake when the surface soil is dry. In the past, cultivation was used to facilitate this distribution to depth. If we are not going to bring back the mouldboard plough, we will have to think of different strategies for keeping nutrients in moist soil (at depth).

To make a soil profile homogeneously fertile down to 15-20 cm requires large inputs of nutrients. However, the question has been asked: - “can we save fertiliser by developing ‘curtains’ of high fertility to depth which can provide for the crop demand for available nutrients through time?” The principle has been used before in a range of areas (banding layers versus mixing, ripping, preferred pathways, lime penetration and banded placement, Weipa red mud reclamation) and should be explored for our agriculture. What is possible quantitatively will certainly depend on soil and season. Calculations of the production and dollar consequences of short and long term processes will have to be made. Simple management factors such as row spacing, plant density, levels of application, sources of nutrient (liquids versus solids, particle size, solubility etc) as well as the dynamics of supply and demand, will have to be considered.
Precision sowing and placement (Beelines, tramlines) will probably have to be planned into the system because each crop plant has to be able to “see” the fertility “curtain”.

**Large scale, vertical and horizontal soil/nutrient heterogeneity**

Increasingly we will be able to make extra dollars by managing within paddock variability as revealed by the increasing use of yield mapping, remote sensing and radiometrics. Once the variability is recognised, it is necessary to answer the “why is it so?” questions. Once we know why one area is high yielding and another is not, we require decision aids which help us calculate the profits and/or losses through time, of addressing the variation with different management options. These decision aids will also have to estimate the transition costs of going from uniform management to variable management systems. Is it more efficient to manage uniformly or in 2, 4, 8 or even continuously varying units? How does the variable management fit into or change the rotation or fencing requirements? What is the impact on the current farming system, and how is it necessary to change that system to accommodate the management responses to variation?

Reviewer:- Peter Metcalfe
Impact of biotechnology on international agricultural research, production and marketing

Sandy Forbes, 2000 Australian Nuffield Farming Scholar sponsored by Grains Research and Development Corporation

INTRODUCTION

I was awarded the 2000 GRDC Western Grain Grower Scholarship to study the impact of biotechnology, in particular genetically modified crops, on international agricultural research, production and marketing. I undertook my study in Canada, USA and the UK and met with public and private researchers, growers and marketers.

In 2000 there were 44.2 million hectares of GM crops grown, 58 percent soybeans, 23 percent corn, 12 percent cotton and 6 percent canola. Four countries account for 99% of global GM area. The USA is the biggest producer with 30.3 million hectares, Argentina 10 million, Canada 3 million and China 0.5 million. In Australia, GM cotton is currently the only GM crop grown commercially. Given that these countries represent our major competitors for global markets, I was keen to determine the issues surrounding GM crops from development of the technology, grower experiences with GM’s and marketing issues and how these would impact on our decision to adopt GM crops in Western Australia.

RESEARCH

I think the importance of biotechnology research on the future of agriculture is captured in a statement made by Colin Merritt, Monsanto, Cambridge, UK “Monsanto is no longer pursuing any further development work on new chemicals – all developmental research will now be in the area of biotechnology”. This statement was confirmed recently when Monsanto outsourced chemical business to Nufarm. Investment by large multinational “Life Science” companies such as Monsanto is an indicator of the future of biotechnology in agriculture.

The extent to which companies and government invest in research is influenced by consumer views in that country and potential market of the final product. There is large investment in research in Canada where genetically modified crops such as Roundup Ready® and Liberty Link® canola are widely grown and testing is not under any great threat of sabotage by the public. Conversely, in the UK, the research into products such as Roundup Ready® Sugarbeet and Oilseed Rape is progressing more slowly as field testing is restricted by threats of sabotage by a very anti GM public and companies have to direct more resources to public relations.

Collaborative research between government and the private sector and government incentives for biotech research are commonplace. The Canadian Federal government operates a matching investment initiative fund and federal and provincial tax credit schemes, enabling companies to do research for 30% of the cost. The Canadian government released an Innovation White Paper in September 2001 that outlines the plan to make Canada a leader in biotech by 2010 and providing between $12 - $20billion Canadian to achieve this.

The majority of crop transgenics have been in the area of input traits such as Roundup Ready® Canola and BT® Corn with production benefits for growers. The move is now towards capitalising on the benefits of output traits such as enhanced oil qualities in canola. Biotech companies such as Monsanto and Aventis are now marketing products which benefit consumers through enhanced output traits in an attempt to both capitalise on investment in research and win back consumer confidence in GM’s. The market for pharmaceutical, nutraceutical and industrial enhanced output trait products is also a very lucrative one.

The area of research and what can be achieved with biotechnology is very broad with large investments in a number of areas of research: Some examples are:

Roundup Ready® Wheat—There is a big question mark against its release due to market implications for US and Canada as major world wheat producers.
Terminator gene – This can solve the problem of volunteer Roundup Ready® wheat, outcrossing to conventional varieties and pre harvest sprouting. It has been developed in the labs and it looks unlikely that Aventis will commercialise this due to public concerns over control by multinationals of seed stocks.

Roundup Ready® Alfalfa

Modified Corn Starch – Dow Agroscience is working on bio plastic production from transgenic corn.

Spider Silk – developed from goat’s milk using strands of protein to create a silk like fabric used in aeronautics.

Phyto Remediation – using genetically modified plants to clean up oil spills by detoxification or uptake by plants.

Pharmaceuticals – using anti coagulant properties from leeches in canola for cost effective anti coagulant production.

Nutraceuticals – Enhanced nutritional content of foods eg Golden Rice®

PRODUCTION

Commercial production, like research, is very much determined by public sentiment towards GM’s. USA, Argentina and Canada are the leading producers of GM crops in the world whereas there is no commercial production of GM crops in the UK at present.

Canada: About 55% of the 12 million acres planted to canola in 2000 were either Liberty Link® or Roundup Ready® canola grown by 80% of growers. A report into the impact of transgenic canola on the industry was commissioned by the canola industry and one of the key findings was a reported increase of $5.80/acre net return compared to conventional canola in 2000. This equates to an equivalent increase in price for conventional canola to be around 10% to justify production.

USA: Cotton – 60% of all production is BT ©Cotton – either YieldGuard® for boring insect control or BollGuard® for Bollworm control.

Corn – 16% Roundup Ready® in 2001 - a slight decline from 2000.

Soybean – 60% Roundup Ready®. Weed control was previously difficult in soybean due to its sensitivity to a range of chemicals so the uptake of the GM product is good.

There is excellent farmer acceptance of GM crops due to reduced chemical usage and time required to establish and manage crops. The time factor seemed to be very important to the US farmer as a number in the states I visited had other employment apart from farming.

Both Canadian and US farmers were very concerned about control by large multinational companies over production. In Canada for example, there was strong opposition towards payment of the “Technology Use Agreement” to Monsanto as part of the Roundup Ready® canola package. This is a cost imposed separate to seed and chemical sales aimed at recovering the cost of developing the technology and is about $C15/acre. Farmers were also keen to maintain competition between companies in the marketplace and were concerned by Monsanto investing in many smaller seed companies and reducing competition.

There are also rising concerns, fuelled by media hype, about “superweeds” and outcrossing of resistant genes to conventional types and wild species. Herbicide resistance is also a growing concern amongst producers.

MARKETING

Marketing issues are the key drivers to biotechnology research around the world. Public perception ranges from acceptance of GM’s but with growing concern in the USA to very strong opposition in the UK. What I found most interesting was the limited concern amongst producers in Canada to the market implications of growing GM crops and the attitude of the US in
marketing GM products into the European market. However, given Canada competes with us for our major market for canola to Japan which does not require specific GM labelling for highly processed foods such as canola oil and where public opinion is not strongly anti GM, lack of concern by producers is not surprising. The key issues for marketing are the moving target of consumer preferences in major markets, identity preservation and testing procedures.

In the UK and also most parts of western Europe the recent food issues of BSE, Swine Fever and now foot and mouth disease have further increased public mistrust of science and government food safety regulation and have heightened anti GM feeling. Radical groups such as Greenpeace and Friends of the Earth are extremely active in destroying trials and jeopardising research. Canada and the US are accepting of GM foods but there is growing concern, particularly amongst US consumers after the Starlink® corn episode where corn destined for the animal feed market was found in the human food chain.

Identity preservation is a major issue for separating GM from non-GM products. In Canada there is a small market into Europe for non-GM canola which is identity preserved from GM but there has been an issue of co-mingling. The transport system through the Great Lakes for major grain growing areas of North America with multiple handling of grain makes identity preservation difficult after the event.

A rapid and effective method of testing for presence of GM DNA and observance of maximum limits of GM contaminant into various markets is essential.

CONCLUSION

The study of biotechnology gave me a valuable insight into the GM issue around the world. This will be valuable to me as we make our decisions here on the adoption of GM crops in the future.

In WA we are in an enviable situation where we are currently not growing commercial GM crops and are in the process of making that choice. The issue is not to spoil our chance of getting it right and end up facing the problems that Canada and the US have with GM production. There is no doubt that the technology will provide us with another valuable tool for more efficient production and market segmentation but at the same time we need to ensure we can identity preserve GM’s from each other and from non GM’s. We need to commit resources into developing very good testing and identity preservation systems backed by strong regulatory, research, development and production processes to get it right. All of this needs to be done in an environment of market awareness and the moving target of consumer preferences.

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ACKNOWLEDGMENTS

I would like to thank the Grains Research and Development Corporation for sponsoring the scholarship and to the Australian Nuffield Farming Scholars Association making the scholarship possible and for their ongoing support. I would also like to thank the numerous biotechnology and agricultural industry participants and overseas Nuffield Scholars who took the time to meet with me during my scholarship and who made it such an interesting and rewarding experience.
Australian Crop Accreditation System Variety Selector

Tony Seymour, Australian Crop Accreditation System

With the click of a computer mouse, farmers and farm advisors can now compare the performance of different crop varieties at trial sites across Australia. This new FREE computer-based tool called Variety Selector is a computer database that is simple and fast to use.

Developed by the Australian Crop Accreditation System (ACAS), Variety Selector is a searchable computer database providing access to information on 350 grain varieties from 800 test sites comprising nearly 4,500 trials across Australia.

For the first time, farmers will be able to see how varieties perform in conditions and locations similar to their own, and relative to other varieties in a single national database. With support from plant breeders around the country the data warehouse will eventually provide information on over 1,300 varieties.

Variety Selector also recognises that growers are interested in varieties from all over the country and from public and private plant breeding programs. Previously this type of information has been state specific and often only available in hard copy. With Variety Selector, ACAS has created a national database that can be accessed via a CD ROM and updated regularly through the internet. Variety Selector is free and a CD ROM can be obtained by registering online at www.acas.on.net or fax (03) 9328 5302.

WHAT INFORMATION IS VARIETY SELECTOR DESIGNED TO PROVIDE?

Trial Reports

Trial reports compare variety results provided by plant breeders from over 800 test sites across Australia. Using parameters including year, site, crop and trial type, the user can search for specific trials and view trial reports.

Variety Reports

These reports show predicted average yield comparisons between a base variety and selected variety, based on region, site, sowing period, rainfall range and disease and pest resistance. This report also allows the user to search specific characteristics (eg. Maturity, Disease/Pest tolerance, grain quality et al) relating to a crop or variety.

Variety Comparison Reports

Variety comparison reports allow the user to compare varietal performance for a selected reference variety against other varieties across a range of combined trial results.

HOW OFTEN WILL THE DATABASE BE UPDATED?

ACAS hope to update information whenever it becomes available. Twice-yearly updates are planned and Variety Selector subscribers will be notified when updates can be downloaded.

HOW RELIABLE IS THE INFORMATION?

Reports are based on accredited information and rely on plant breeders providing quality information according to the protocols established by ACAS. ACAS has used Predicted Yields obtained by a combined analysis of all trials over the past years. The analysis and the resultant predicted yield allows for yield variation from site to site and year to year. It is considered that this is the best way of showing growers likely yields in specific regions – and how varieties compare in those regions. Note that these analyses are carried out each year when the latest years trial results are available. For example, after 1998 the yield analyses may have covered
the years 1992 to 1998; after the 1999 harvest they include the years 1992 to 1999. This can result in changes in variety relativity with time, which if significant would require interpretation.

AUSTRALIAN CROP ACCREDITATION SYSTEM

The Australian Crop Accreditation System (ACAS) is a coordinating body that represents the Grains Council of Australia, Grains Research and Development Corporation, Seed Industry Association of Australia and State government agriculture/natural resources departments. Its objective is to provide sound information on the performance and characteristics of field and grain crop varieties to Australian farmers. To achieve this aim, ACAS oversees the work of four national accreditation advisory committees (wheat, barley and course grains, oilseeds and pulses) to ensure that information from variety trials meets its accreditation requirements. The collected information is then made available to farmers through the Variety Selector website.

HOW THE ACCREDITATION PROCESS WORKS

ACAS establishes, develops and publishes protocols for evaluating the quality, disease and agronomic characteristics of grain crop varieties. These protocols are objective, scientific methods for measuring the performance of a variety.

ACAS invites plant breeders, or their agents, to submit the variety information they wish to have accredited. The Accreditation Advisory Committees check the procedures used by the plant breeders to generate this information against the established protocols and provide advice and recommendations to the ACAS Board.

These advisory committees are made up of marketers, end users, processors (where appropriate), grain growers, an expert for agronomy, disease, quality, and a plant breeder.

After considering the recommendations of the advisory committees, ACAS will accredit the information where it conforms to the established protocols and publish this information in a form which makes it easy for users to make valid comparisons between varieties available to them in the marketplace – Variety Selector.

HOW ACAS WORKS

ACAS does not approve varieties in the sense of controlling their release, nor does it provide recommendations on a variety’s use. The right to release varieties rests with plant breeders (public and private) and they exercise their own business, professional and legal responsibilities.

ACAS is a national voluntary system to provide information on the performance of grain and field crop varieties for growers and their advisors. It does not approve them in the sense of controlling their release – nor does it provide recommendations on use.

Its partners representing Government agencies and private industry are the Grains Council of Australia, Grains Research and Development Corporation, Seed Industry Association of Australia and the Standing Committee on Agriculture and Resource Management.

CONTACT FOR FURTHER INFORMATION

For further information in Western Australia contact: Tony Seymour 0419 933 644.

For a program CD please send contact details and e-mail address to Australian Crop Accreditation System: (03) 9328 5302 or PO Box 2054 Hotham Hill VIC 3051.

For a program demonstration look for the ACAS stand in the poster section at the Agribusiness Crop updates and at the Regional Crop updates series.
Prima gland clover - a new variety of pasture legume

Andrew Blake, Department of Agriculture, Geraldton

A new variety of clover is available to farmers this year. Prima is the first variety of gland clover (Trifolium glanduliferum) to be released in Australia. Some of the characteristics of Prima that may interest potential growers include having good insect tolerance, being readily harvestable, having a relatively early maturity and useful hardseed dynamics and an ability to perform on broad range of soil types. It will play an important role in pasture mixtures for a number of soil types and rotational systems.

Prima is an aerial seeding variety so it can be harvested using a conventional header allowing farmers to produce for personal use themselves. When aiming to harvest Prima for seed the pasture should be managed carefully to maximise production and minimise difficulties at harvest by using high seeding rates and controlling weeds. Seed requires scarification after harvest to increase germinability. Only licensed growers can produce Prima seed for sale.

Prima has extremely high levels of tolerance to red-legged earth mites (RLEM) and moderate tolerance of aphids but is susceptible to lucerne flea attack. This RLEM tolerance makes Prima ideal for mixtures where it could act as a back up pasture legume for years with heavy RLEM populations. This insect tolerance is believed related to the presence of the chemical compound coumarin. Hay containing coumarin that is allowed to spoil is of concern to animal health. Despite the risk of livestock injury from Prima hay being considered low, it is recommended that pastures containing high levels of gland clover not be cut for hay. Grazing livestock on Prima whilst green or dry but unspoilt is safe.

The maturity of Prima is very similar to Dalkeith subterranean clover and will suit areas receiving more than 350mm annual rainfall. Prima will grow on a broad range of soil types with the exception of infertile sands, however seed crops should target better classes of soil. Prima can tolerate mild waterlogging.

The level of hardseededness in Prima is high at senescence (80-95%) and will rapidly drop over late autumn to about 40-50% in mid winter. This provides protection against a false break making it an ideal variety to be included in a mixture with other legumes in a crop:pasture rotation.

The performance of Prima in terms of dry matter and seed yield, over a range of soil types is similar to other clovers such as Dalkeith. Machine harvested yields of Prima have ranged from 200 and 700 kg/ha.

Information about the herbicide tolerance of Prima and other annual pasture legumes can be found on page 190 of “The Trial and Demo Reports 2002, Northern Agricultural Region”. 
Perennials in the farming system

Tim Wiley, Department of Agriculture, Jurien CAC

NEED FOR PERENNIALS

Our farming systems have been based on annual crops and pastures. While these systems have worked well in the past in the wheatbelt, they have not been sustainable on the poor sands of the West Midlands. Sandplain farmers have been testing and developing new farming systems based on perennial pastures for more than a decade now. Surveys by the Evergreen group show that increasing productivity of their grazing enterprises has been the driving factor for these graziers.

Wheatbelt farms are based around crop production and grazing has declined for some time now. However weaknesses in these systems have emerged and some farmers are looking for changes. A survey by the Liebe group shows that tackling salinity is the main reason eastern wheat belt farmers are interested in perennials. In the Northern wheat belt it is the development of herbicide resistance that is driving the change in farming systems.

Perennial pastures in theory can address all of the concerns raised farmers. The challenged is not only to learn how to grow and manage them, but also how to integrate them into existing farming systems.

FARMING SYSTEMS AND PERENNIALS

A wide range of pasture options are now available to farmers. When choosing from these options the first thing is to consider what ‘system’ or rotation you will use for a particular paddock. After that you can thing about the pasture species that are suitable for the soil type.

Paddocks that will be cropped will require different pastures species to a permanent pasture paddocks. Permanent pastures should be based on perennials that will persist for a long time. Use as many species in the mix and include an appropriate legume. Annual legumes are very compatible with summer growing perennials.

Cropping paddocks

In cropping paddocks short term ‘phase pastures’ are required. This means either productive annual pastures or short term perennials like lucerne. Lucerne is an excellent pasture option between crops as it not only uses more water and fixes Nitrogen, but also offers a range of options for the non selective control of weeds. While lucerne seedlings are sensitive to many herbicides, mature plants will tolerate a wide range of non selective herbicides. Mature lucerne can effectively be ‘winter cleaned’ using gramoxzone. It will also tolerate many broad spectrum chemicals. One of the challenges with lucerne will be to kill it when the paddock is due to go back into crop.

Cutting lucerne for hay can also very effective at control weeds. Several farmers in the West Midlands have achieved total seed set control of radish by cutting the stand for hay in late spring (1st week of October). While dry land lucerne will not produce high yields of hay by it self, yields can be improved by over sowing lucerne with Cadiz. Cadiz hay has yielded up to 8 t/ha in the northern wheat belt and this represents a high value crop.

3 – 5 year pasture phase
- lucerne on most soil types

1 – 2 year pasture phase
- Cadiz, yellow serradella and Biserrula sandy soils
- Cadiz, yellow serradella, Arrowleaf clover, Frontier Balansa and Biserrula on gravel and loams
- Medic, Cadiz and Persian clover on heavy soils
**PERMANENT PASTURES**

With permanent pastures the choice of species depends on the soil type and soil moisture supply over summer. The most productive and robust pastures will contain a wide range of species. The aim is not try and ‘pick the best species’ but rather to include as many species as possible in the mix.

*Deep poor sands*
- Tagasaste is still the best option

*Yellow sands and duplexes*
- Cadiz, yellow serradella, Biserrula, Blue lupins, Arrowleaf clover
- Rhodes grass, Setaria, Green Panic

*Wet areas*
- Subtropical grasses such as Setaria, Bamatsii Panic, Kikuyu, Para grass, Tall Wheat grass, Rhodes grass
- Strawberry and White clover
- Balansa, Persian, Cadiz, ‘white seeded’ sub clovers and slender serradella
- Italian and perennial rye grass

*Loams and gravels*
- Subclover, Cadiz, yellow serradella, medics, Biserrula, Arrowleaf clover
- Rhodes grass, Setaria, Green Panic, Tall Wheat grass

*Salt land*
- Salt bush, Acacia saligna
- Puccinelia, Tall Wheat grass, Rhodes grass, Bambatsii panic
- Balansa and Persian clover

**TRIALS WITH NEW PERENNIAL PASTURES**

The Department of Agriculture along with the Evergreen group, Mingenew Irwin group, Leibe group, Victoria Plains LCD and Topcrop groups have been testing a wide range of new perennial pasture species over this summer. Include in the trials have been subtropical grasses, subtropical legumes and temperate perennial legumes. These new species have been tested in both plot trial and farmer paddock sowings. Sites have ranged from dry gravel hills to heavy loams and wet valley floors.

In most case the initial establishment from spring sowing has been very good. The germination of the subtropical legumes was very slow and we think this was due to a lack of scarification of the seed. Poor germination of all species has occurred on some wet areas. This may be due to the soil taking longer to warm up, or from an accumulation of salt at the surface due to evaporation. Poor weed control before sowing was another important factor in seedling failure. Weeds that germinated after sowing were not very competitive with the perennial seedlings.

Min till seeders with knife points and press wheel has given the best results. Sowing very shallow with a conventional seeder and then rolling has generally been successful. Germination with triple disc drills been patchy.

In these trials species that are showing promise include:

*Tropical legumes:* Lotononis, Wyns Cassia

*Tropical grasses:* Rhodes, Setaria, Premier Digit grass, Signal grass, Jumbo sorghum, Bamatsii Panic, Jarrah grass

*Temperate perennials:* Range of Lotus species, Dorycnium species, Galega, Melilotus, lucerne
The economics of change for farming systems in the medium rainfall northern sandplain

Caroline Peek and David Rogers, Department of Agriculture, Geraldton

KEY MESSAGES

- When planning to enter into a new enterprise it is important to know what production benchmarks you have to achieve to succeed financially.
- When changing farming systems, different transition strategies can have big effects on the financial position of the farm.
- Production and production efficiency need to be continually improved to offset declining terms of trade. The higher the cost of an enterprise the more important this becomes.

WHY THE WORK WAS DONE

- To do economic evaluations of alternatives to the benchmark wheat/lupin system and to determine whether the new systems will be financially viable.
- To determine the sensitivity of the tested farming systems to production and price.
- To do economic evaluations on the transition from the current benchmark wheat/lupin farming system to alternative systems.

Pasture based alternatives to the wheat/lupin system were chosen as options in this research.

HOW THE WORK WAS DONE

The work was done using the transitional budgeting model that is currently being developed as a decision tool to help the farming community answer questions about changing farming systems. The model has the ability to look at different farming systems over time. The farm entered into the model for the research is a sandplain farm of 3500 ha with 89% cropped. The high level of cropping is resulting in a high risk of herbicide resistance developing.

Comparison of the financial viability of several fully established systems.

The farming systems evaluated were:

1. A benchmark system of wheat, lupin and some canola, pre herbicide resistance (wl).
2. A suggested system to combat herbicide resistance and maintain a high level of cropping. 2 years of a Cadiz serradella pasture followed by 3 years of crop (ppwlw). Cadiz pasture phase in this system was used in several different ways:
   - Dorper sheep run as a prime lamb enterprise.
   - Merino sheep run as a self-replacing wool enterprise.
   - No livestock on the property. Wheat yields were either held at the average or increased by 16% following the Cadiz phase. There was also a reduction in nitrogen and herbicide use in the wheat after the Cadiz brown manure phase.
3. An improved permanent pasture system rotated with wheat and stocked with Dorpers (ppw).

Crop yields were based on the average taken from a recent Planfarm survey. Wheat yields 2.15 t/ha, lupin yields 1.63 t/ha, and canola yields 1 t/ha. Crop yields increased at 1.5% pa. Improved pasture stocked at 6DSE. Costs associated with the farming enterprise were based on averages. Long term average prices were used of $4.50/kg greasy wool, $30 net per prime lamb and cash prices $190/t wheat, $180/t lupins and $290/t canola. Merino lambing rates were set at 95% and Dorper at 120%. To simulate decreasing terms of trade, all costs were increased at 3.5% pa and all returns increased by 2% pa.
Do a sensitivity analysis on two of these systems to price and production.

- Analyse the effects of lupin yield on the cumulative financial position of the benchmark system.
- Analyse the effects of lambing percentages, carrying capacities and product values on the profitability of the ppwlw with Dorper sheep system.

Do a transition analysis for one of the systems

The benchmark wheat /lupin system was moved to the ppwlw with Dorper sheep system option. Three transition scenarios were analysed over a 10-year period:

- Long transition period: 310 ha (10% of cropped area) was sown to first year Cadiz pasture each year.
- Rapid transition period: 620 ha (20% of cropped area) was sown to first year Cadiz pasture each year.
- Delayed but rapid transition period: The farmer cropped until forced in year 5 to start sowing 620 ha of first year Cadiz pasture every year.

The original flock on the farm was a merino flock with 400 ewes. Dorper rams were purchased and a Dorper prime lamb enterprise was bred up from this original ewe flock to match the pasture development. Additional merino ewes were purchased at $30/hd to speed the upbreeding process. Merino lambing rates were set at 95%. Where the early Dorper and Dorper cross flocks consisted of maiden ewes, lambing % was set at 60% increasing to 80%, 110% and finally 120% with the fully established flock. First cross (F1) Dorpers were shorn but no income was received for the fleece. Second cross (F2) and above were not shorn. Rams cost $1000 and were turned over every 3 years.

RESULTS

Comparison of fully established systems

Table 1: The areas in ha in each phase in the different rotations.

<table>
<thead>
<tr>
<th></th>
<th>wl</th>
<th>ppwlw</th>
<th>ppw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total farm area</td>
<td>3500</td>
<td>3500</td>
<td>3500</td>
</tr>
<tr>
<td>Wheat</td>
<td>1550</td>
<td>1240</td>
<td>934</td>
</tr>
<tr>
<td>Lupin</td>
<td>1250</td>
<td>620</td>
<td>100</td>
</tr>
<tr>
<td>Canola</td>
<td>300</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cadiz pasture</td>
<td>0</td>
<td>1240</td>
<td>0</td>
</tr>
<tr>
<td>Improved pasture</td>
<td>0</td>
<td>0</td>
<td>2066</td>
</tr>
<tr>
<td>Unimproved pasture</td>
<td>400</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>Crop %</td>
<td>89</td>
<td>53</td>
<td>30</td>
</tr>
<tr>
<td>Total DSE</td>
<td>1160</td>
<td>8682</td>
<td>13550</td>
</tr>
</tbody>
</table>

Table 2 shows the financial analysis of these systems. The benchmark wheat /lupin farming system is the most lucrative, but is becoming unsustainable. At the livestock commodity prices used in the analyses, the best ppwlw system falls short of the benchmark system. Where the pasture phase is not utilised in the ppwlw system, the crop yields have to be increased and costs reduced to compensate for the losses in the Cadiz pasture phase. A yield boost of 16% in wheat following Cadiz was used in this example but this is not as good as the grazing option. This system may work for farmers that are able to continually achieve higher crop yields than average. The ppw system lacks the area of wheat to allow it to compete with the higher cropping options.
Table 2. Comparisons of the start and end farm operating surplus and the resulting cumulative financial position of the farm after 10 years. Operating surplus includes variable and fixed costs and is not discounted in year 2011

<table>
<thead>
<tr>
<th>Farming system</th>
<th>Operating surplus $/ha 2001</th>
<th>Operating surplus $/ha 2011</th>
<th>Cumulative financial position of farm after 10 years $</th>
</tr>
</thead>
<tbody>
<tr>
<td>wl benchmark system</td>
<td>90</td>
<td>142</td>
<td>2,135,283</td>
</tr>
<tr>
<td>ppwlw Dorper sheep</td>
<td>60</td>
<td>88</td>
<td>1,040,180</td>
</tr>
<tr>
<td>ppwlw merino sheep</td>
<td>61</td>
<td>86</td>
<td>956,673</td>
</tr>
<tr>
<td>ppwlw no stock yield boost in wheat</td>
<td>48</td>
<td>80</td>
<td>748,392</td>
</tr>
<tr>
<td>ppwlw no stock average yield wheat</td>
<td>38</td>
<td>66</td>
<td>261,549</td>
</tr>
<tr>
<td>ppw Dorper sheep</td>
<td>48</td>
<td>61</td>
<td>564,678</td>
</tr>
</tbody>
</table>

Results of the sensitivity analysis

The Dorper flock produces only meat, so stocking rate, lambing % and lamb price are very important to the success of this system (table 3). Achieving 120% lambing at 6DSE and a lamb price of $30 brings this system short of the average benchmark system. If the trend for higher lamb prices ($45 nett or more) continues the ppwlw system then competes well with benchmark wheat/ lupin system.

Table 3: The resulting cumulative position of the farm after 10 years with a range of lamb prices, lambing percentages and carrying capacities for the ppwlw Dorper sheep enterprise

<table>
<thead>
<tr>
<th>Average lambing % / year</th>
<th>Carrying capacity in DSE</th>
<th>10 year average lamb sale value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$25</td>
</tr>
<tr>
<td>100%</td>
<td>4</td>
<td>$168,119</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>$405,415</td>
</tr>
<tr>
<td>120%</td>
<td>4</td>
<td>$438,753</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>$749,553</td>
</tr>
<tr>
<td>140%</td>
<td>4</td>
<td>$679,911</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>$1,016,496</td>
</tr>
</tbody>
</table>

Table 4. The sensitivity of the wheat/ lupin system cumulative position to changes in lupin yield

<table>
<thead>
<tr>
<th>Lupin Yield in T/ha</th>
<th>10 year cumulative position</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.93</td>
<td>$2,752,929</td>
</tr>
<tr>
<td>Average 1.63</td>
<td>$2,135,283</td>
</tr>
<tr>
<td>1.03</td>
<td>$899,990</td>
</tr>
</tbody>
</table>

Table 4 shows that lupin yield also has a big impact on farm profitability of the benchmark system. Poor lupin yield and/or price increases the attractiveness of the livestock enterprise.
Results of the Transitional analysis

Table 5. The progressive financial position of the farm and the annual surplus/deficits for each of the three transition scenarios. The starting balance for the 3 comparisons were zero

<table>
<thead>
<tr>
<th>Year</th>
<th>Long transition period</th>
<th>Rapid transition period</th>
<th>Delayed rapid transition period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cumulative Position</td>
<td>Surplus deficit</td>
<td>Cumulative Position</td>
</tr>
<tr>
<td>2001</td>
<td>$89,191</td>
<td>$89,191</td>
<td>$90,282</td>
</tr>
<tr>
<td>2002</td>
<td>$164,864</td>
<td>$68,537</td>
<td>$140,560</td>
</tr>
<tr>
<td>2003</td>
<td>$214,126</td>
<td>$36,073</td>
<td>$79,338</td>
</tr>
<tr>
<td>2004</td>
<td>$300,795</td>
<td>$69,539</td>
<td>$89,493</td>
</tr>
<tr>
<td>2005</td>
<td>$388,395</td>
<td>$63,536</td>
<td>$76,524</td>
</tr>
<tr>
<td>2006</td>
<td>$517,882</td>
<td>$98,416</td>
<td>$112,043</td>
</tr>
<tr>
<td>2007</td>
<td>$581,192</td>
<td>$21,880</td>
<td>$179,781</td>
</tr>
<tr>
<td>2008</td>
<td>$627,214</td>
<td>-$474</td>
<td>$255,944</td>
</tr>
<tr>
<td>2009</td>
<td>$735,957</td>
<td>$58,566</td>
<td>$340,465</td>
</tr>
<tr>
<td>2010</td>
<td>$852,841</td>
<td>$58,007</td>
<td>$431,464</td>
</tr>
<tr>
<td>2011</td>
<td>$998,857</td>
<td>$77,469</td>
<td>$549,796</td>
</tr>
</tbody>
</table>

Table 5 shows that transition strategies can result in very different financial outcomes for the farm. Establishing a Cadiz pasture and building up a flock to take advantage of this pasture costs money. The long transition finances the change by keeping the wheat area as high as possible until the livestock enterprise starts paying for itself. The cropping buffers the farm from returning a deficit in all but one year. The longer transition period also allows the building of skills to manage a completely different enterprise to cropping. The rapid transition put an increased strain on the farm finances, trying to build up an enterprise while rapidly diminishing the biggest money earner wheat. The delayed rapid transition has worked because the farm is cropped for the first five years and the rapid transition is started from a stronger financial position of $611,276 to help absorb the financial losses that establishing pasture and rapidly building up a flock to match the pasture entail.

CONCLUSIONS

- Farmers need to have knowledge of which farming systems could work for them before they start making big changes.
- Relatively small changes in production capabilities of enterprises and of commodity prices can have huge financial implications, which will influence decisions on change.
- Transition strategies can make a big difference to the financial position of the farm. Maintaining a high level of wheat helps to finance the cost of change.

The model used in these analyses encompasses whole farm economics and will allow individuals to simulate their own farms and use their own figures.

ACKNOWLEDGMENTS

Department of Agriculture Economist Alan Herbert for transforming the idea into spreadsheets and modeller Anne Bennet for continuing development.

NHT Project No.963001, Department of Agriculture Projects: SHQ, SMO

Paper reviewed by: Mike Clarke
Controlled traffic farming - a growers perspective

Rob Taylor, Jimbour Plain, Queensland

WHAT IS CONTROLLED TRAFFIC FARMING?

Controlled traffic is a component of a sustainable management system where there is a system of permanent traffic lanes (tramlines) in a paddock that separates planted areas from wheeled areas. Controlled traffic is a whole farm system incorporating farm layout (drainage & maximizing overland flow), soil structure, agronomic issues, ease of management (timing, flexibility & efficiencies) and machinery matching where all tyres are restricted to permanent tracks.

Controlled traffic is not precision agriculture. Precision Ag as described by Sydney Uni is the observation, identification and optimal treatment of variability in agricultural production processes in a timely manner. This process leads to Site Specific Management. Controlled traffic greatly enhances and can be an integral part of precision Agriculture.

ADOPTION OF & EXPERIENCES IN CONTROLLED TRAFFIC FARMING

Our first step into controlled traffic was to allow easier spraying of wheat and barley fallows. We shifted planting tynes to leave gaps for the boom spray to follow and we extended the boom spray to match the winter crop planter. The advent of cotton growing with its susceptibility to 2,4-D lead to night spraying because of the lower temperature, lower wind speed and higher humidity which also gave greater efficacy of the chemicals. It is very easy to follow the tram tracks at night negating the use of foam markers and with the use of the right nozzles and common sense drift is virtually eliminated allowing the use of 24D right next to cotton crops.

As we reduced our cultivations to zero we found planting into random wheel tracks a major problem. This lead us to plan for our farming system and here we wanted to be with regards to machinery matching. We adopted a two year time frame, at this stage most of our machinery was up for replacement.

We decided to base our machinery widths off the header i.e. 30’. So we ended up with a 30’ planter and a 60’ boom spray. As for wheel tracks we had the Toyota spraying on 60 inch tracks, the tractor on 60 inch, the chaser bin on 120 inch and the header on duals at 120 and 180 inches (duals allowed us to pass a sorghum row between the tyres which stopped a lot of problems at planting. Paddocks were marked out using marker arms on the planter at either planting or fertilizing.

This all seemed to be working well until we started growing corn. The corn had great height variance around the tram tracks. Also when we double cropped the rows around the tram tracks caused a lot of headaches with establishment. Our Department of Primary Industries did some research with single row harvesting which showed large yield decline in the rows next to the tracks.

From this we changed to where we are now, still based on 30’ but with one set of tracks at 120 inches. To do this we changed header tyres and rims, added spacers to the tractor front ends, use a tractor for spraying and changed the axle widths on the boom spray and air seeder bin.

Problems with 120 inch tracks are that machinery manufactures will not give warranty on the front ends. We also have some problems with king pin bearings and front final drive bearings. We have adopted a tighter maintenance program which has reduced bearing failures. Machinery manufactures don’t seem to be willing to manufacture and offer the choice of different length front ends.

Improvements in yields and cropping frequency appeared from the start but maximum benefits seemed to appear at year 5. The benefits of this system have allowed us to grow higher value crops, higher more consistent yields with a greater cropping frequency.
BENEFITS
We have found management efficiencies from reduced overlapping, at harvest (header front full), spray when conditions are right (no foam markers) and greater cropping frequencies.

Benefits from natural resource management including improved soil structure (less compaction) giving greater water infiltration, better plant extraction of water, better drainage less erosion, improved flood management and improved soil biology (e.g. increase in earthworms & ants).

CONCLUSION
Controlled traffic requires a systems approach with a whole of farm plan. You need to plan where you want to be in 5 years. You can modify existing machinery and be prepared to have some compromises. Talk to farmers & advisers to nut out the problems.

So keep on track and have a go.

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Paper reviewed by: Paul Blackwell, Darshan Sharma
Keeping the Knock in the Knockdown

Peter Newman, Department of Agriculture, Geraldton

BACKGROUND

With the majority of growers in the Northern Ag. Region sowing their crops with no-till (ie. knife point) seeding machinery, there is a reliance on the knockdown herbicides for pre-sowing weed control. WANTFA estimate that as many as 70% of W.A.’s farmers sow with no-till and it is likely that for areas such as the Eradu sandplain this figure is closer to 90% plus. Local re-sellers (ie. Elders, Wesfarmers, and CRT in Geraldton) estimate that approximately 90% of the knockdown herbicide sold is glyphosate and the remaining 10% is Spray.Seed®.

In 2001 the first glyphosate resistant population of ryegrass from W.A. was confirmed. In addition to this, trial work has demonstrated that the knockdown herbicides do not give 100% control of grass weeds when they were very small regardless of resistance status. For these reasons we need to review the use of knockdown herbicides and adjust the farming system accordingly to maximise their efficacy and longevity.

TRIAL RESULTS

Resistant population

The glyphosate resistant population from W.A. is from a farm approximately 20km east of Mullewa. The paddock has a history of as few as 8 shots of glyphosate, however this is very difficult to confirm. When tested in the glasshouse the ryegrass population had the following survival rates:

<table>
<thead>
<tr>
<th>Glyphosate 450 rate (L/ha)</th>
<th>Ryegrass Survival (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 L/ha</td>
<td>90%</td>
</tr>
<tr>
<td>2 L/ha</td>
<td>60%</td>
</tr>
<tr>
<td>4 L/ha</td>
<td>30%</td>
</tr>
<tr>
<td>8 L/ha</td>
<td>10%</td>
</tr>
</tbody>
</table>

Knockdown of small grass trials

Trials near Mingenew in 2000 and 2001 showed that neither glyphosate nor Spray.Seed® give 100% control of ryegrass that is less than the 1 leaf stage.

The 2000 trial involved spraying half leaf ryegrass with either 700 mL/ha Roundup Xtra® or 750 mL/ha Spray.Seed® and the paddock was then sown with a triple disc drill (ie. Zero Till). Glyphosate gave 35% control of the ryegrass and Spray.Seed® gave 24% control.

The 2001 trial involved spraying three quarter to one leaf ryegrass with glyphosate at 1L/ha or Spray.Seed® at 1 L/ha and the paddock was then sown with a knife point / press wheel (ie. DBS) seeding machine. Glyphosate gave 79% control of the ryegrass and Spray.Seed® gave 71% control.

Pot trial work by John Moore (Dept. of Agriculture, Albany) in 1995 showed that the glyphosate rate required to reduce ryegrass dry weight by 90% (ie. ED90) was 1767 mL/ha for 1 leaf ryegrass and 1026 mL/ha for 6 leaf ryegrass. This is further evidence to suggest that ryegrass that is 1 leaf or less is difficult to kill with herbicides.

Hair cutting trials

The ‘Hair Cutting’ technique involves spraying wheat at the half leaf stage with Spray.Seed® with the intention of the wheat recovering and the weeds dying. Trial work by Bowran et al. has demonstrated that wheat can recover from an application of Spray.Seed® to yield 95% of the unsprayed where the wheat is sprayed at the half leaf stage or less. Trial work at Mingenew in
2000 and Yuna in 2001 has shown that ryegrass can also recover from Spray.Seed® when sprayed at less than the one leaf stage.

The Yuna trial in 2001 involved spraying wheat at the half to three quarter stage and ryegrass at half to one leaf stage with 0, 0.5L/ha, 1 L/ha and 2 L/ha Spray.Seed®. 1 L/ha Spray.Seed® gave approximately 39% control of the ryegrass. Ryegrass was visibly burnt at the tip by the Spray.Seed® and recovered by completing the emergence of the first leaf. 1 L/ha Spray.Seed® also gave 41% control of the wheat. The recommendation for this practice to be successful is to spray when the wheat is half leaf or less and the ryegrass is greater than one leaf (ie. have the second leaf visible).

Survey results

Thirty-eight growers were surveyed with respect to their attitudes / practices / knowledge to herbicide resistance and Integrated Weed Management. When asked about their attitude towards the double knock technique (ie. glyphosate followed by Spray.Seed® 4 to 7 days later) 80% of growers surveyed said that they were already using this practice and 90% said that they would use it in the next four years. However, glyphosate and Spray.Seed® sales in the region do not reflect this level of adoption.

Fifteen agronomists were also surveyed. When asked to give solutions as to what they believed was the answer to glyphosate resistant ryegrass (they were allowed to list as many as they liked) 13 listed the double knock technique (ie. glyphosate followed by Spray.Seed®) and 10 listed full cut cultivation at seeding.

CONCLUSION

It appears that the answer to both glyphosate resistance and the problem with killing small grass with knockdown herbicides may be a double knock. However, there is more than one type of double knock.

The most widely publicised double knock technique at present involves spraying with a full rate of glyphosate, waiting for 4 to 7 days then spraying with a full rate of Spray.Seed®. Therefore, any glyphosate resistant weeds will be killed by the Spray.Seed®, and any weeds that were too small at the time of the glyphosate spraying may be big enough to be controlled by the Spray.Seed®. It may also be possible for the Spray.Seed® to be applied early post emergent when the wheat is half leaf or less (ie. Hair cutting technique). This double knock technique is agronomically sound but is costly and time consuming and may involve a delay in seeding.

After speaking to growers that have used this double knock technique I have concerns that it has not been done properly as the Spray.Seed® rate is often too low and / or applied to long after the glyphosate.

The other form of double knock involves spraying with glyphosate or Spray.Seed® followed by seeding with full cut cultivation soon after. This technique will reduce the cost of knockdown herbicides and is less time consuming as it involves one less spray and no delay in seeding. Knife points and press wheel seeding machines have been extremely successful, particularly for one pass crop establishment into sandplain soils and for furrow sowing into non-wetting sands. They have also enabled the use of high rates of pre-emergent grass herbicides such as trifluralin. I am not suggesting that we ignore these benefits and go back to the bad old days of full cut at seeding. Rather, there are new seeding machinery options that are a combination of a knife point plus a wide sweep plus a press wheel. They still furrow sow in one pass (with ribbon seeding), trifluralin crop safety is excellent and results with such machinery on sandplain soil near Mullewa in 2001 were excellent.

In the short term with existing no till machinery I believe that the glyphosate followed by Spray.Seed® double knock is the answer. However, in the long term I believe that at least a partial swing back to some form of full cut cultivation at seeding will be necessary to minimise the risk of ryegrass and other weeds developing resistance to knockdown herbicides such as glyphosate.

Project No.: DAW 672
Crop sequences: What are the options
Richard Quinlan, Agronomist, Elders

SUMMARY
Diversity in crop rotations is presently in tatters due to a number of factors. This leaves Western Australia agriculture vulnerable to a number of risks including disease and commodity price, herbicide resistance and environmental issues. Stability of income from agriculture is reliant upon diversity of the enterprise. Growers, agronomists, consultants and research institutions need to place more emphasis on diversity of crop and livestock enterprises to maintain profitability.

Crop sequences, The necessary EVIL!
In one way they add risk because each crop type needs specialty management to ensure its success. Different crops prefer different soil types and climatic zones. The advantages of crop sequences outweigh the disadvantages though and growers must learn to grow them. Some of the advantages are:

- Disease break. Different crop species provide disease breaks to following crops. This includes Eradu patch, Take-all, CCN, RLN, Septoria nodorum, Brown Leaf Spot, Chocolate Spot, Black Spot.
- A greater diversity of chemicals can be used throughout the rotation when there is a diverse rotation. This reduces the selection pressure on any one chemical. Different crops also provide different mechanical methods of weed control such as crop topping, swathing and in the case of pasture the use of grazing. Other enterprises such as lentils and pastures species allow chemical application via wick wipers. This allows still more groups to be used in the rotation to control weeds.
- Diversity in crop sequence provides insurance against any one commodity price slump.
- Weather conditions throughout the season will effect various crops differently. What is a disaster for one crop can turn out to be ideal for another. Last year the end of season rains caused significant problems with staining and sprouting in wheat. Canola and lupins on the other hand benefited greatly from these conditions resulting in good yield increases above what they would have yielded.

All this is good advice but it has got to make money.

Lupin yields in general last year were below average due to the dry conditions. Significant problems due to herbicide resistance in radish and ryegrass populations mean this crop is coming under increasing pressure to perform or be dropped from farmers rotations.

Anthracnose came close to seriously affecting lupin profitability. The affect of anthracnose on the narrow leaf lupins was greatly minimised by the presence (by chance) of 2 varieties with significant anthracnose resistance (Wonga and Tanjil). However, considering the ease at which the disease can be found in blue lupins throughout the district, we may still see significant pain for lupin growers if 2-3 wet seasons can be linked together.

Canola has also had a scratchy existence over the last 2 seasons. This has mainly been due to dry and warm conditions over the growing season. These conditions have not been ideal for canola but perfect for one of its most important pests (DBM). 2002 will see people fleeing the canola industry at rates equal to them taking on the crop from 1997-99.

Chickpeas have also been hit by disaster. August 1999 saw the first case of Ascochyta identified in WA. 2 years on the area of chickpeas has fallen from 50000ha to less than 5000 ha.

The chickpea saga is causing a feeling of déjà vu to some growers who remembered back to September 1996 when Kiev Lupins crops where ploughed in after the first outbreaf of
Anthracnose was identified in Australia. This hampered the ability of farmers to rotate crops especially on the fertile loams in the medium and high rainfall areas.
WHERE TO FROM HERE?

It is hard to imagine broadacre agriculture in WA without pasture. The Dept of Agriculture have done an outstanding job developing pastures species over the last 10 years. In 1990 there was available only a couple of clover and medic species and one serredella. In 2002 there is an unbelievable array of pasture species with attributes tailored to all aspects of the grazing and cropping enterprise. This is a credit to the foresight of the pastures group who have correctly anticipated what agriculture would be like in the new millennium from a decade ago. Essentially if you can’t find a pasture species suited to your farm, then you are not looking. To get full value out of pasture though, it needs to be grazed. Andrew Blake will be highlighting those pastures suitable to this area.

Agriculture in 2002 in the medium and high rainfall zone involves canola. Surpass 501TT is definitely higher yielding than Karoo, but due to other factors such as DBM and aphids, Surpass501TT did not realise its full potential in 2001. Surpass300TT is a very short season variety that may give some protection from both of these insects. Sandplain canola has the most risks, but it can be profitable, especially if your farm is affected by root diseases such as Eradu patch. Ideally, on sandplain, canola should follow a legume due to canola’s requirement for nitrogen. Kevin Walden will have all the answers to keeping insects at bay in canola and keeping canola viable.

Chickpeas: Varieties are the only way up for chickpeas. 2004 will be the earliest growers will be able to obtain chickpea varieties with worthwhile ascocytta resistance. In the meantime farmers need to explore other possibilities.

Fieldpeas grow like weeds and are exceptional fixers of nitrogen. They are also resistant to Pratylechus neglectus and CCN as well as other diseases. They can be crop topped and most weeds can be controlled.

Lentils have also been largely untried in this region. They have requirements for flat paddocks with no stones, but can grow on slightly acidic loams with an increasing pH with depth.

Chickpeas, Lentils and Faba beans and Field peas are always vulnerable to disease. The closer the rotation the higher the losses due to disease. The further the distance from last years stubble the better. With this in mind all these crops would benefit from regional rotations. This is where crops are rotated from region to region, rather than from padock to padock. This requires a high level of co-ordination to be successful, but is an alternative to monoculture.

Also remember that rotations involving other cereals are also advantageous. Barley and oats can provide valuable rotational benefits and should be incorporated into the rotation where possible.
REFERENCE GROUP

Barry Stokes Farmer (Chapman Valley)
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