Section One

Section Editor: Nick "I've gone to Canada" Booth

PIRSA Rural Solutions, Cleve

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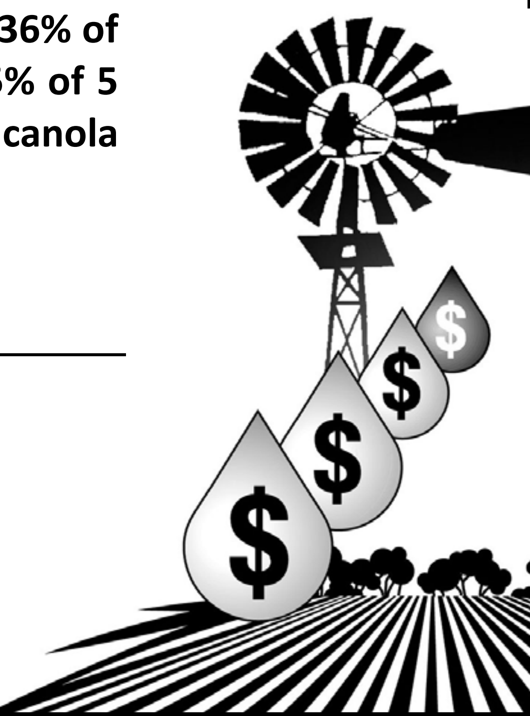
Cereals

2000 will be remembered as a year of contrasts and a year to remember across Eyre Peninsula. Grain receival records were broken at several sites and quality was generally regarded as very good. The areas across Eastern, Upper and Western EP, which had been looking the best 'ever', were hit hard with a dry period during grain fill, which certainly sapped yield potential and contributed to high screenings in several districts. The total amount of wheat delivered on EP was approximately 1.58 million tonnes (136% of 5 year average), 530,000 tonnes of barley (125% of 5 year average) and nearly 50,000 tonnes of canola (155% of 5 year average).



AusBulk

Farmer Wheat Trials on Upper Eyre Peninsula

Nick Booth, PIRSA Rural Solutions, Cleve

Location
Rudall
Noel & Ben Hampel
Tuckey Ag Bureau

Rainfall
Average annual: 330 mm
2000 total: 421 mm
Average GSR: 270 mm
2000 GSR: 341 mm

Paddock History
1998 Wheat trials
1999 Wheat trials

Soil
Type: Sandy loam over clay
pH (water): 7.5
Organic carbon: 0.85%
P (Colwell): 26 mg/kg

Plot Size
40m x 4.8m

Replicates
Three

Other Factors
Moisture Stress in September

Why do the trials?

With the pressure to increase cropping intensity, there has been a trend towards consecutive wheat cropping. This trial aimed to assess the agronomic performance of selected varieties as a third wheat crop compared to results for non wheat on wheat situation.

TUCKEY AGRICULTURAL BUREAU WHEAT ON WHEAT TRIALS

How was it done?

Twelve wheat varieties were sown onto a third consecutive wheat stubble and treated as follows:

- Harrowed to smash up stubble
- Sowing date: 9th June 2000 – 28 row International combine
- Seed rate: 70 kg/ha for all wheats
- Fertiliser rate: DAP (18:20:0:1) at 80 kg/ha for all varieties
- Herbicides: Spray-Seed® @650 ml/ha and Trifluralin® @900 ml/ha pre-sowing; MCPA 500® @ 650 ml/ha post emergent

Variety	Yield (t/ha)	Protein (%)	Screenings (%)	Gross Income* $/ha
Sunfield	2.55	13.2	7.5	489.91
Camm	2.48	13.8	6.7	489.99
Stiletto	2.01	14.3	7.6	393.72
Excalibur	2.21	12.8	7.6	406.86
Machete	2.09	14.8	7.3	336.09
Spear	2.17	13.6	9.0	420.88
Trident	2.51	13.9	6.6	468.84
Westonia	2.67	13.1	8.6	512.78
Frame	2.12	13.5	3.7	431.13
Janz	2.79	12.3	19.4	380.30
Barunga	2.26	13.1	14.7	307.61
Silverstar	2.81	12.7	20.8	383.49

**Income based on AWB Harvest Payment prices delivered to Rudall*

What Happened?
Rudall ~30 km west of Cleve

ARNO BAY AGRICULTURAL BUREAU WHEAT TRIALS 2000

How was it done?

Eleven wheat varieties were sown to compare the performance of current varieties with more recent releases.

- Worked back March 2000
- Sowing date: 22nd May 2000 – 24 row combine
- Seed rate: 60 kg/ha for all wheats
- Fertiliser rate: DAP (18:20:0:1) at 60 kg/ha for all

Variety	Yield (t/ha)	Protein (%)	Screenings (%)	Gross Income* $/ha
H45	2.49	8.3	3.3	409.66
Silverstar	2.65	8.1	4.4	424.80
Kite	2.4	8.6	3.6	423.00
Blade	2.23	9.0	2.1	402.23
Excalibur	2.33	8.6	3.5	385.94
Yitpi	2.55	8.0	4.8	405.83
Frame	2.3	7.9	2.5	381.55
Durum 1996	1.71	8.3	3.7	214.50
Westonia	2.69	8.2	3.4	438.85
Machete	2.06	8.2	4.8	327.38
Krichauff	2.48	8.2	4.4	387.60

** Based on AWB Harvest Payment at Arno Bay*

Location
Arno Bay- Gavin Rehn, Arno Bay Ag Bureau

Rainfall— Ave. Annual: 350 mm, 2000 Total: 378 mm
Average GSR: 247 mm, 2000 GSR: 299 mm

Paddock History -
1997 Barunga wheat
1998 Schooner barley
1999 Pasture

Soil Type— Loamy Sand
pH: 7.6 (water)
OC%: 0.78%
Avail P: 17 mg/kg (Colwell)

Plot Size—4m x 40m, Replicates
Three

Other Factors
Some YLS and Leaf Rust (esp. on Excalibur)
Brome Grass in some plots
Dry finish

FRANKLIN HARBOUR AGRICULTURAL BUREAU WHEAT TRIALS 2000

Ten cereal varieties were treated as follows to determine the best cereal rotation following wheat:

- Paddock preparation: Harrowed twice to smash up stubbles
- Sowing date: 7th June 2000
- Seeding rate: Wheat 60 kg/ha , Barley 80 kg/ha , Triticale 100 kg/ha
- Fertiliser rate: 32:10 @ 60 kg/ha.

Miltalie ~ 30 Km NW Cowell

Variety	Yield (t/ha)	Protein %	Screenings %	Gross Income* ($/ha)
Worrakatta	0.61	15.0	6.7	110.87
Frame	0.42	16.0	3.6	86.54
Janz	0.46	15.5	5.5	93.34
Camm	0.66	15.5	6.1	132.94
Tamaroi	0.39	15.7	6.7	52.31
Kukri	0.30	17.2	5.6	48.42
Barque	0.21	15.8	92.4	-
Sloop	0.24	18.3	84.5	-
Tahara	0.26	-	-	-
Tickit	0.28	-	-	-

**Based on AWB pool prices delivered to Cowell*

Location
Miltalie
Rob Jacobs
Franklin Harbour Ag Bureau
Rainfall
Average annual: 300 mm
2000 annual: 240 mm
Paddock History
1997 Pasture (Spraytopped)
1998 Excalibur wheat
Soil
Type: Sandy loam
pH (water): 7.5
Organic carbon: 0.65%
P (Colwell): 21 mg/kg
Plot Size
40m x 4.8m
Replicates
Three
Other Factors
Very dry finish, possibly too much N for the conditions.

MURDINGA AGRICULTURAL BUREAU WHEAT VARIETY TRIAL 2000

How was it done?

Eight wheat varieties (seven bread wheats and the durum Tamaroi) were treated as follows:

Paddock preparation:

- Sowing date: 8th June 2000 - 24 row combine with 18cm row spacing
- Seed rate: 65 kg/ha for bread wheats, 80 kg/ha for durum
- Fertiliser rate: DAP (18:20:0:1) at 70 kg/ha pre-drilled
- Herbicides: Diuron® @ 275 ml/ha plus MCPA ®@ 350 ml/ha early post-emergence

Variety	Yield t/ha	Protein (%)	Screenings (%)	Gross income $/ha*
Krichauff	3.84	11.1	4.1	691.85
Frame	3.47	10.8	4.8	646.55
Westonia	4.47	10.5	4.8	815.86
H45	4.32	10.1	5.1	773.45
Camm	4.15	10.2	5.3	733.63
Yitpi	3.73	10.6	5.2	686.63
Kukri	3.84	10.7	6.5	694.27
Tamaroi	3.31	10.7	6.4	484.27

** Based on AWB Harvest Payment prices delivered Tooligie (bread wheats), Kimba (durum)*

Location
Murdinga
Terry Sheridan
Murdinga Ag Bureau
Rainfall
Average annual: 375 mm
2000 total: 394 mm

Paddock History
1997 Pasture
1998 Wheat
1999 Pasture
Soil Type:
Sandy loam over clay
pH (water): 6.1
Organic carbon: 0.85%
P (Colwell): 31 mg/kg
Plot Size
40m x 4.8m
Replicates
Three
Other Factors
Barley grass, annual ryegrass

CENTRAL EYRE AGRICULTURAL BUREAU WHEAT VARIETY TRIAL 2000

How was it done?

Ten wheat varieties were treated as follows:

- Paddock preparation: glyphosate + 2,4-D ester after March rain
- Sowing date: 18 May 2000 - zero till 29 row triple disc seeder with 19.7 cm row spacing
- Seed rate: 65 kg/ha for bread wheats, 80 kg/ha for durum
- Fertiliser rate: DAP (18:20:0:1) at 63 kg/ha for all varieties plus urea (46:0:0:0) at 37 kg/ha for bread wheats and 74 kg/ha for durum; foliar Zn and Mn early post-emergence
- Herbicides: Trifluralin® @ 1.5 l/ha pre-sowing; Lontrel® at 70 ml/ha plus MCPA LVE® @ 250 ml/ha plus Ally® at 3 g/ha early post-emergence

Variety	Yield t/ha	Protein (%)	Screenings (%)	Gross income $/ha*
Frame	2.74	9.0	12.4	354.53
Yitpi	2.95	9.5	16.3	381.70
Westonia	3.06	9.4	9.3	490.95
Excalibur	2.70	9.9	13.0	349.35
Kukri	2.64	10.2	12.6	447.35
Silverstar	2.95	9.6	15.9	381.70
Galaxy H45	3.06	9.3	7.2	501.04
Krichauff	3.07	9.9	9.6	494.27
Camm	2.90	9.4	12.6	375.23
Machete	2.81	9.7	8.5	363.59

** Based on AWB harvest payment prices delivered Kyancutta*

(Continued on page 12)

(Continued from page 11)

Location
Kyancutta
Peter and Darren O'Brien
Central Eyre Ag Bureau

Rainfall
Average annual: 319 mm
1999 annual: 267 mm
Average GSR: 235 mm
1999 GSR: 173 mm

Paddock History
1997 Medic pasture
1998 Excalibur wheat
1999 Machete wheat

Soil
Type: Sandy loam over calcrete rubble
pH (water): 8.6
Organic carbon: 0.90%
P (Colwell): 16 mg/kg

Plot Size
50m x 6.4m

Replicates
Three

Other Factors
Moisture stress in September

What does this mean?

These trials highlight the relative importance of yield over quality. In most cases, the highest gross incomes were obtained from the higher yielding APW and ASW varieties, primarily Westonia, Camm and Krichauff. Conversely, the higher quality wheats, Kukri and Tamaroi did not compare to their higher yielding counterparts even with higher potential premiums. The major downfall with these wheats is the penalty paid for not achieving the desired quality which exacerbates the yield penalty. It should be noted that in most cases the premium quality wheats paid a substantial penalty, predominantly for low protein and in some cases, high screenings.

If intending growing wheat on wheat, it is important to consider the disease carry-over of the first wheat. Frame and Yitpi for instance are good first wheats being CCN resistant and moderately tolerant of CCN and will generally not build up high levels of rust inoculum. A good choice for second wheats include Westonia, Camm Krichauff and Worrakatta, as these are more resistant to Yellow Leaf Spot.

The worst performers in 2000 were usually the hard wheats. Machete has again proved that it should never be considered as a second wheat and generally failed with poor yields and low test weights being the most common complaint. Silverstar and Janz, while yielding well, had higher screenings. While these varieties are known to have small grain size, it seemed to be exacerbated by early sowing and the tight finish. Janz is usually a fairly solid performer and should not be thrown out on last year's results. Excalibur is susceptible to leaf rust and has to have a big question mark over it if grown in wetter areas this year. Unfortunately, Krichauff has also lost its resistance to leaf rust with the development of a new strain which puts this excellent variety under further pressure.

Check the Primary Industries Fact Sheet "Wheat Variety Sowing Guide 2001" and "Cereal Variety Disease Guide 2001" for variety attributes.

Acknowledgements
I would like to acknowledge the help and co-operation of the farmers involved, SAFCEP and the Minnipa Agricultural Centre staff for reaping some of the trials.

AGRICULTURAL BUREAU OF SOUTH AUSTRALIA EST 1888

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Wheat Breeding on EP

A.J. Rathjen and G.J. Hollamby—University of Adelaide

Major selection sites for the South Australian wheat breeding programs on Eyre Peninsula were first instigated in 1979 at Rudall, on Peter and Matthew Dunn's and John and Daryl Norris' properties, and Yeelanna (Glover family). In 1981 we expanded to Mudamuckla on Colin Martin's but following one of the periodic funding crises these plots are now located nearer to Adelaide at the Minnipa Agricultural Centre. The late Alan Glover played a major role in these initiatives. In more recent years we have had a fourth major site at Buckleboo in conjunction with Dean Williams and Graham Baldock. We are very grateful to all these co-operators and the many other Eyre Peninsula farm families and research workers who have helped us over the years.

Of course, the primary aim was to select wheat varieties particularly well adapted to Eyre Peninsula conditions. To achieve this we have typically grown 7,000-8,000 plots of about 5,000 different genotypes at each of these sites; a large proportion of which is genetic material which has not previously been selected for grain yield. So the EP program has been large and logistically challenging.

In the early years we had a separate set of seeding and spray equipment at Pt Lincoln but more recently the plots have been managed entirely from Adelaide. Generally we aim to seed with our own equipment, at the same time that the farmer co-operator is seeding. Now much of the weed control is undertaken by the farmer as part of his own routine, and the harvest is undertaken with the specially designed plot harvesters built at the Waite Institute. Fortunately we have had immensely dedicated field teams led by Jim Lewis, David Cooper, Chris Stone and Stuart Milde as the work has often involved very long hours and considerable travel.

What has been achieved?

Worrakatta, Krichauff, Excalibur, BT Schomburgk and Kukri are varieties deliberately aimed at Eyre Peninsula conditions. In fact, the cross which ultimately resulted in both Worrakatta and Krichauff was made between parental lines chosen on the basis of their performance at Rudall. In general, the whole of the program now includes a much higher proportion of boron tolerant, early maturing lines than would have been the case if selection had been limited to the Murray Mallee. We are making progress in developing premium quality varieties to suit the soil and climatic conditions. Of three new varieties queued up for release, one is specifically aimed at Upper EP.

Perhaps, as important as the release of adapted varieties, has been the increase in our understanding of Eyre Peninsula conditions. Through the repeated visits over many years we have come to an appreciation of the factors whereby Eyre Peninsula differs from other wheat growing districts in southern Australia. These differences are not explained in learned papers but can only be identified through personal experience of both the genetic variation within the breeding programs and the environmental conditions, soil and climate, of Eyre Peninsula.

In retrospect two major objectives have been particularly relevant to Eyre Peninsula.

- Boron – a well known story. While many B tolerant wheats are now available and will continue to be bred there is still a great deal more breeding required on other crops. Further we have a renewed interest in breeding even more tolerance into wheat.
- *Pratylenchus neglectus* (RLN) – resistant lines derived from an Italian variety Virest are just entering field trials. Through combinations of soil types and fertility, RLN are more important on EP than in most other areas of the wheat belts. Not surprisingly, the moderately susceptible lines such as Worrakatta, Krichauff and Excalibur have a history of selection on Eyre Peninsula.

In a number of other respects eg. Zn and Mn deficiencies, Rhizoctonia (more or less confined to Upper EP), Take-all (now fairly rare) and some specific soil types, Eyre Peninsula is differentiated from other parts of the state.

What of the future?

Over a long period of time Bob Holloway and in more recent time Sam Doudle and Alison Frischke have been of great help and stimulus. We now have work in progress on:

- Salt – being coastal, having soils of marine origin and commonly with an impervious layer fairly close to the surface, EP soils are high in sodium. Hence EP crops need to be able to tolerate relatively high levels of salinity, especially in periods of low rainfall.
- High pH subsoils – bicarbonate, carbonate and aluminium ions are toxic and at comparatively high concentrations in high pH conditions.
- Durum - The current commercial varieties of this crop are well adapted to the climatic conditions of EP but poorly suited to the soils. As the technology for selection of bread wheats is readily transferable to the durums this species has a very high priority as durums always command a price premium over APW.
- Leaf Rust - The breakdown of Lr24 has increased our vulnerability to this disease.

Funding and institutional organization

The funding by GRDC for wheat breeding has been under discussion for nearly two years with no resolution in sight. In recent times, the community at large has come to depend upon research funding from farmers far too much. Farmers, on average across Australia, profit about $20/tonne for a product worth >$200/tonne F.O.B., yet they are expected to provide an ever increasing share of the research funding as Government instrumentalities find other priorities. Clean, healthy and efficiently produced food is of benefit to the whole community and the economic returns from export income are spread widely throughout the public with multiplier effects so that the $200/tonne generates somewhere between $800 and $1400/tonne of economic activity in Australia. Wheat breeding has been a sustained contributor to public good but this can only continue, if the current turmoil ceases and there is a renewed commitment to long term support. Incidentally, congratulations to ABB Ltd and several flour milling companies for their initiative in generating markets for Krichauff!

Feed and Boron Tolerant Barley Breeding for EP in 2000

Andy Barr, Barley Breeding Unit, Waite Campus, University of Adelaide

The lines passed to SARDI for Stage 3 and 4 trials proved to be a very exciting group of material. As a result of the trial results from the SARDI and University of Adelaide (UA) experiments, we have identified nine lines (or groups of lines) which will be promoted to Stage 4 in 2001 and considered for subsequent release.

The emphasis in our feed quality program is to improve yield, disease resistance and adaptation.

Stage 1 (early generation trials) - Trials were conducted at Pinery, Maitland, Minnipa and Geranium. High levels of leaf disease were recorded at Pinery and Maitland while scald and boron were evident at Minnipa. The Geranium site was damaged by frost, which reduced the value of these experiments.
Boron tolerant lines from the following families show promise;

Keel/(Sahara/WI2723-30)//Keel
Keel/(Sahara/WI2723-30/Chebec)//Dash
Molloy/(Sahara/WI2723-30/Chebec)//Keel
WI3102//DH115/SLOOP BC3

Despite the encouraging results from these early generation trials, the boron tolerance breeding program continues to present perplexing data. On the one hand, tolerant plants appear markedly superior at Minnipa under high soil boron levels. However, the trial results are confusing

- in 1998, no yield response but a marked grain plumpness response was associated with boron tolerance genes
- in 1999, modest yield and grain size response under severe drought and boron toxicity
- in 2000, no relationship between boron symptoms and yield. Grain quality data was not available at the time of writing this report.

Hence, several reasons can be suggested. Firstly, that there are associated effects of boron tolerance genes which depress yield. Second, that there are harmful genes linked to one or more of the boron genes. Thirdly, that the boron tolerance genes enable the plants to further penetrate a "hostile" sub-soil, where it subsequently encounters very unfavourable conditions (high salt and bicarbonate; low trace elements etc).

The challenge now is to design experiments to test each of these hypotheses in order to fully exploit the potential of the boron tolerance genes.

Stage 3 and 4 (Later Generation Trials)
Two feed lines which completed Stage 4 testing in 2000 ranked "1" and "equal 2" respectively which potentially fit well in SA's feed barley industry. The outstanding lines from SARDI Stage 4 testing were:

WI3385 Waveney/Chebec//Chariot/Chebec
WI3386 Sloop Sib/Mundah//Barque

These lines also performed very well in the UA Stage 3 /4 trial series. Disease resistance is especially pleasing in WI3385 (see following table) while WI3386 is a potential replacement for Mundah.
The yield potential of this group was outstanding, with WI3385 out yielding all current feed varieties and WI3386 out yielding Mundah.

Table 1 : Disease resistance ratings of new feed type lines (shading indicates adequate resistance for SA conditions)

Name	CCN	Spot form Net blotch	Net form Net blotch	Scald	Mildew	Leaf Rust
Schooner	S	MS	MR	MS	S	S
Barque	R	R	MR-MS	S	MR	S
Keel	R	R	MR	MR	S	VS
Mundah	S	S	MR	S	S	S
WI3385	R	MR-MS	MR	R	R	MR
WI3386	R	R	MR	S	MR	MS

These lines fit into an overall strategy of developing feed barley lines to fit each of the production areas in SA.

Target zone	Varieties bred in major research projects ; SAGITF 1/99 and GRDC UA353	Existing varieties	Advance of new varieties over existing varieties
Low rainfall feed types	Keel, Barque	Galleon	Yield, scald res., hectolitre wt
Medium rainfall feed types	Barque, Keel	Galleon	Yield, scald hectolire wt.
High rainfall/high productivity feed types	WI3385	Skiff	Yield, disease resistance
Sandy soils of low fertility	WI3386	Mundah	CCN and spot form net blotch resistance
Boron toxic soils	Promising lines in Stage 1 in 2000	None well adapted	Better grain filling, ? yield increase

7

Breeding Barley for Low Rainfall

Jason Eglinton, Glenn McDonald and Andrew Barr

SA Barley Improvement Program, Department of Plant Science, Waite Campus, University of Adelaide.

Location:
1. Minnipa Agricultural Centre
2. Pt Wakefield

Rainfall
Av. Annual total
1. 330 mm
2. 275 mm
April-Oct 2000
1. 290 mm
2. 282 mm

Yield
1. 1.4 – 2.7 t/Ha
2. 2.5 – 4.9 t/Ha

Fertiliser
1. 75 kg/Ha 17:19:0 + 5% Zn
2. 100 kg/Ha 22:15:0 + 2.5% Zn

Sowing Date
1. 01/6/2000
2. 21/5/2000

Other factors
1. Boron toxicity
2. Scald and net blotch

Why do the trial?

The aim of the trials is to evaluate barley lines from the International Centre for Agricultural Research in the Dry Areas (ICARDA) to determine their potential for breeding improved barley varieties for Australian low rainfall areas.

In most Mediterranean-type, dryland cropping environments of the world, including the Middle East where it was first domesticated, barley is the crop which is best adapted to the marginal fringes of cropping. In contrast, wheat is typically the crop best adapted to marginal areas in southern Australia. Wild and primitive landrace barleys from the Middle East therefore provide an important resource to improve barley varieties for low rainfall areas in southern Australia. The current trials form part of a collaborative program with ICARDA in Syria, the world centre for barley research, with an emphasis on breeding barley with improved tolerance to drought stress in low fertility soils. The collaborative program with ICARDA commenced in 1999 and an outline of the project was presented in the 1999 EP Farming Systems Summary (p 20).

How was it done?

Replicated field trials were grown in 1999 and 2000 at Pt Wakefield and Minnipa Agricultural Centre. 156 ICARDA lines and 6 Australian varieties were evaluated in 1999 and the 50 lowest yielding lines were replaced by 50 new ICARDA selections for the 2000 trials. Assessments of early vigour, height, maturity, lodging, scald resistance, spot form net blotch resistance and boron toxicity tolerance were made and grain yield, screenings and thousand-grain weight were measured.

What happened?

The 1999 season was characterised by severe drought stress, with grain yield ranging from 0.2 – 1.0 t/ha at both sites. The trials at Pt Wakefield experienced cyclical drought stress first evident at late tillering, while the Minnipa trials experienced a more typical terminal drought stress. Post harvest analysis identified 10 ICARDA lines with grain yield at least as high as the best Australian varieties, and these lines did not suffer from poor grain size, which is often associated with material derived from wild and landrace barleys. Figure 1 illustrates the grain yield of an elite ICARDA line at Minnipa Agricultural Centre in 1999 in comparison to Barque, Keel and Schooner.

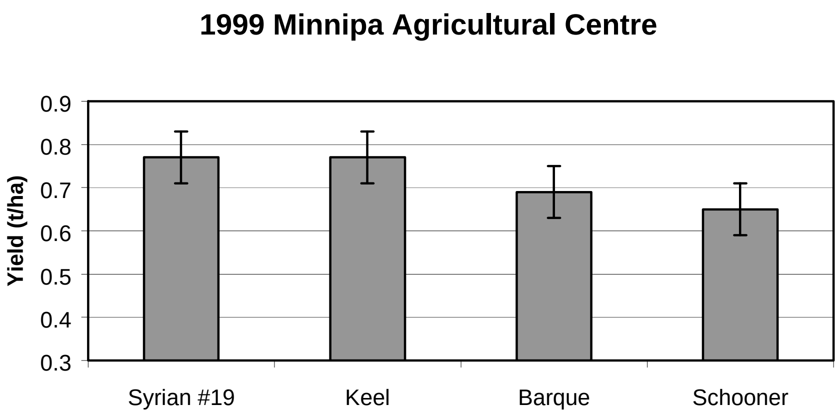

Figure 1: Grain yield (t/ha) of an elite ICARDA line in comparison to Keel, Barque, and Schooner in trials at the Minnipa Research Centre in 1999. Error bars indicate the L.S.D.

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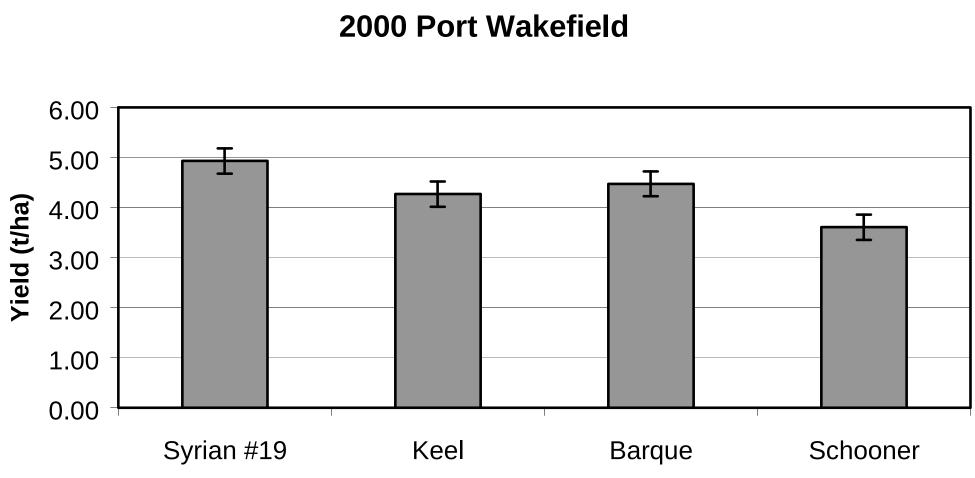

Figure 2: Grain yield (t/ha) of an elite ICARDA line in comparison to Keel, Barque, and Schooner in trials at Pt Wakefield in 2000. Error bars indicate the L.S.D.

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The 2000 season provided very good early season conditions at Minnipa Agricultural Centre. However, yield was limited by a dry period during flowering and early grain filling (Sep 10-Oct 6), with grain yield ranging from 1.4 – 2.7 t/ha. The top 10 ICARDA lines, including the line Syrian #19 shown in figures 1 and 2, were not significantly different to the highest yielding Australian varieties Barque and Keel. A total rainfall of 282 mm was recorded at the Pt Wakefield trial site, but this was more evenly distributed across the growing season, resulting in grain yield of 2.5 – 4.95 t/ha. Analysis across the two trial sites in 2000 identified 20 ICARDA lines with grain yield at least as high as the best Australian varieties. Figure 2 illustrates the grain yield of an elite ICARDA line at Pt Wakefield in 2000 compared to Barque, Keel and Schooner. In addition to testing maximum yield potential, the 2000 Pt Wakefield trials also allowed the identification of a number of ICARDA lines with useful levels of resistance to scald and the spot form of net blotch.

What does this mean?

A significant number of ICARDA lines performed at least as well as current varieties in each of the trials. However, the most outstanding result of the trials to date is the performance of a small number of ICARDA lines that have produced grain yield at least as high as the best Australian feed varieties analysed across the two contrasting seasons. This is very significant given that imported barley lines are not normally comparable to Australian varieties, particularly under lower rainfall conditions. These lines exhibit a very different genetic background to current Australian varieties and represent significant research and breeding opportunities.

Additional trials are planned for the 2001 season to further evaluate these lines, and to test additional barley lines selected from the ICARDA breeding program. The most promising ICARDA lines have been promoted into Stage 3 trials of the SA Barley Improvement Program for evaluation in a wide range of environments in 2001. These lines will also be used in crossing with elite Australian lines to combine the key characteristics of both, in order to develop new barley varieties with improved yield and yield stability for southern Australia.

7

Improving the Growth and Yield of Barley on Sandy Soils of Low Fertility

Nigel Long[1], Andrew Barr[1], Steve Jefferies[1] and Bob Holloway[2]
[1]SA Barley Improvement Program, Waite Campus, University of Adelaide
[2]SARDI, Minnipa Agricultural Centre

Location
Variety trial-Minnipa, Lowbank, Cooke Plains
Seed size trial-Tuckey, Geranium
Population trial-Minnipa, Lowbank, Tuckey
Varieties
Mundah, Yagan, Forrest, O'Connor, Keel, Barque, Sloop, Clipper, Galleon
Sowing date
Minnipa-2/6/2000,6/6/2000
Lowbank-2/6/2000
Cooke Plains-30/5/2000
Tuckey-25/5/2000
Geranium-14/6/2000
Sowing density
145 plants/m^2
Fertilizer
75 kg/ha 17:19+5% zinc (EP)
89 kg/ha 9:17+5% zinc (Lowbank)
76.4 kg/ha 17:19+5% zinc (Cooke Plains)
Plot size
16m^2 (SARDI),
4m^2 (University)

Why do the trial?

The aim of this project is to improve the selection of barley varieties for sandy soils of low fertility by:
1. identifying traits to improve growth and yield on sandy soils,
2. characterising and mapping genes that control these traits, and
3. developing appropriate selection strategies for sandy soils.

South Australia has a broad range of soil types that are dominated by sand and calcium carbonate. These soils are naturally low in fertility and in terms of cereal production, are characterised by a high incidence of root disease, low water retaining capacity, are subject to water repellency and are prone to leaching and erosion. These factors, along with uneven seeding depth, result in poor establishment and plant growth, reducing the yield potential of these soil types and making the growing of barley unreliable.

WA varieties (eg Mundah) have been shown to be superior to SA bred varieties (eg Keel and Chebec) on sand, yet they do not have the disease resistance required for growing barley in SA. With approximately 30% of all barley being grown on sandy soils, the ability to grow and yield well on these soil types is an important characteristic to be selected for in the SA breeding program.
This summary will discuss results from trials conducted in 2000 and follows on from an article in Eyre Peninsula Farming Systems 1999 Summary (page 18).

How was it done?

A variety comparison Trial (3 sites, 9 varieties) and a seed size experiment (2 sites, Mundah only) were set up in 2000 to identify traits conferring improved growth and yield on sandy soils. Particular emphasis was placed on identifying factors that were likely to increase early vigour and to assess whether this contributed to improved grain yield on sandy soils.

The Mundah x Keel population, consisting of 50 lines generated from this cross and including the two parents, was sown at 3 sites in 2000. Mundah is the superior parent, showing improved performance on sandy soils compared to Keel. The progeny of these crosses should show variability for sand performance (plant growth and grain yield) with those individuals displaying high grain yields potentially carrying genes originating from Mundah. The latest genetic technology is being used to identify the gene(s) linked to improved grain yield on sandy soils.

What happened?

Variety Trials
Grain Yield—Ultimately grain yield is the primary determinant of the performance of a variety under any stress condition. On sandy soils of low fertility where there is a host of stresses to which a plant is exposed, grain yield will highlight those varieties that have the characteristics important to improved 'adaptability' on sand.

Mundah and Yagan (parent of Mundah) were the highest yielding of the nine varieties tested, including sites at Lowbank and Minnipa (Table 1). Varieties considered better suited to sandy soil, such as Mundah, Yagan and Barque, ranked lower at Cooke Plains than either Lowbank or Minnipa.

The 'poorly adapted' varieties (Galleon, Clipper) were the highest yielding at Cooke Plains, but did not perform well at the other two sites, which was expected for these varieties on sandy soils. However statistics for Cooke Plains (Table 1) suggest that the yield differences were not significant ($P<0.05$). Only Forrest and Barque were significantly lower than Galleon and Clipper. The performance of Forrest, a variety previously recommended for sandy soils, was to say the least a surprise. Forrest yielded poorly at both Cooke Plains and Lowbank, and ranked moderately at Minnipa.

Keel, considered moderately poor on sandy soils, did rank moderately at Minnipa and Lowbank, but yielded better than Mundah, Yagan and Barque at Cooke Plains. Cooke Plains was affected by frost and powdery mildew and this may explain the contrasting results at this site, particularly for Forrest, which is highly susceptible to mildew. The extent of frost damage has not been determined as yet.

(Continued on page 18)

Table 1:Grain yield data and rankings for 9 barley cultivars in field trials in 2000.

VARIETY	COOKE PLAINS	RANK	LOWBANK	RANK	MINNIPA	RANK	MEAN	RANK
Mundah	1.51	7	1.58	1	1.69	1	1.59	1
Yagan	1.56	5	1.48	2	1.53	2	1.52	2
Barque	1.36	8	1.38	3	1.27	6	1.34	6
Sloop	1.58	4	1.32	4	1.10	8	1.33	7
Keel	1.64	2	1.27	5	1.39	4	1.43	3
O'Connor	1.53	6	1.27	6	1.48	3	1.43	3
Clipper	1.69	1	1.23	7	1.12	7	1.35	5
Forrest	1.30	9	1.18	8	1.37	5	1.28	8
Galleon	1.62	3	1.17	9	0.91	9	1.23	9

Table 2: Analytical and agronomic data for the Mundah seed size trial at Geranium, 2000.

Seed Size (mm)	Seed Phosphorus content (µg/grain)	Seed Zinc content (µg/grain)	Seed Manganese content (µg/grain)	Coleoptile length (cm)	Establishment (plants/m^2)	Early Vigour (g/m^2)	Grain Yield (t/ha)
<2.2	7.68	0.05	0.06	65.36	105.6	50.4	2.14
2.2-2.5	9.68	0.07	0.06	72.75	136.3	51.6	2.96
2.5-2.8	11.93	0.09	0.08	78.92	154.0	68.4	3.68
>2.8	12.72	0.09	0.09	79.45	172.0	78.2	3.62

(Continued from page 17)

Early Vigour

Early vigour, in terms of dry matter production (DMP) and leaf area development (LAI - measure of the rate of early growth), is one of the features of plant growth that we are focusing on as a characteristic that may be important to plant 'adaptation' and grain yield on sandy soils. Mundah and Yagan both showed good early dry matter production and LAI. At Lowbank improved DMP was correlated to a high LAI (Figure 1),. The high LAI of Mundah and Yagan seems to have provided a clear advantage over the other varieties in improving early vigour. This trend was less evident at Cooke Plains, but again these results were significantly influenced by powdery mildew and frost.

It was found that good early vigour (DMP) of Mundah and Yagan contributed, to some extent, to their superior grain yields at Lowbank, but this trend was less evident at Minnipa, with considerable variability in the relationship between grain yield and early vigour. At Lowbank a high LAI of Mundah and Yagan appeared to be of some importance to grain yield. At Cooke Plains, Mundah and Yagan's grain yield response to increased LAI was less pronounced, possibly due to frost and powdery mildew.

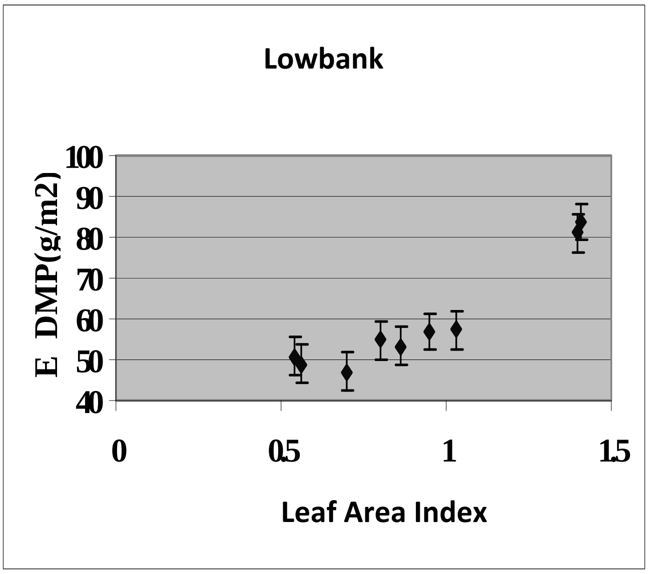

Figure 1: Relationship between Leaf Area Index and Early Vigour (E_DMP = early dry matter production) at Lowbank in 2000 for the 9 varieties tested.

Mundah seed size trial

Seed size is determined by a complex interplay between genetic effects, which sets potential and, also influences actual grain size (via disease resistance, flowering type, lodging resistance), and environmental effects (rainfall, temperature, soil evaporation, soil fertility). One method to estimate the effect of seed size on growth and grain yield on sand, is to screen samples into different size fractions. Table 2 shows data from the seed size trial at Geranium. Major differences in establishment, early vigour and grain yield were apparent with seed size.

The improvement in growth and yield is potentially related to the enhanced seed nutrition and longer coleoptile length in larger seed. Seed nutrition and coleoptile length is critical because of the low soil fertility and the variability of seeding depth commonly associated with cropping on sandy soils.

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Table 3: Key strategies for improving the growth and yield of barley on sandy soils.

Attribute	Genetic	Management
Large Seed size	·Large potential (reduced number of florets per head) ·Defend the potential-lodging resistance -disease resistance	·Screen seed samples heavily ·Apply fungicide to crops infected with leaf disease ·Ensure high nutrient concentration on seed crops ·Choose seed from plumpest crop
High nutrient concentration in seed	·Trace element efficient varieties	·Increase rates of macro- and micro-nutrients on seed crops ·Late application of nutrients
Increase early vigour and crop establishment	·Choose high genetic potential ·Long coleoptile	·Sow shallow ·High nutrient rates at seeding

(Continued from page 18)

What does this mean?

Results from the variety field trials in 2000 has provided a picture of some of the characteristics that may be related to the improved performance of some barley varieties on sandy soils of low fertility. Improvements in grain yield on sandy soils seem to be determined by factors such as improvements in establishment and early vigour (dry matter production and leaf area development). In addition to genetic differences, early vigour may be related to seed size, where factors such as longer coleoptile length and higher seed nutrient content are likely to assist in establishment and early plant growth. The varieties that showed good growth and grain yield on sand (Mundah and Yagan) also exhibited an upright growth habit and were earlier flowering, while those that were poorly adapted had a more prostrate habit (eg. Galleon). Currently a controlled environment experiment is underway to observe genetic differences in root development, as well as canopy development. Intuitively, root development (depth) should be a crucial component of improved performance because the enhanced accessibility and availability of moisture and nutrients is absolutely vital for crop productivity on sandy soils. Further to this, the potential for reallocation of carbohydrates from the stem to the developing grain following flowering will be assessed to determine whether a characteristic such as this is associated with improved growth and yield on sandy soils.

For further information contact Nigel Long, SA Barley Improvement Program, Waite Campus.

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Comparing Durum and Bread Wheats

By Nick Booth, PIRSA Rural Solutions, Cleve

Why do the trial?

Following on from some trials done in 1999, durum wheat has shown potential to be a solid contributor to farmers on Eyre Peninsula. Several farmer trials in 1999 demonstrated that the minimum quality could be achieved around the Cummins/Yeelanna area, although this was a low rainfall year. The question still needed to be asked if durum could still make the grade in a more 'normal' year.

The other question that needed to be answered was if durum could stack up financially against the bread wheats in the lower rainfall areas of Upper and Eastern Eyre Peninsula. Durum tends to yield 10-15% below most bread wheats. With the extra cost associated with freight, there is some concern that other wheats might perform better financially in the lower rainfall areas.

How was it done?

The trial involved 20-30 growers across Eyre Peninsula, growing durum and providing all the inputs necessary to achieve a target yield and quality.

Areas of durum were sown next to bread wheats in the same paddock or on ground with similar history.

What happened?

Table 1: A selection of results from different districts

District	Variety	Pay Grade	Yield (t/ha)	Protein (%)
Kimba	Tamaroi Janz	DR2 AH	2.7 2.7	11.7 11.0
Cleve	Gunderoi Yitpi	DR1 AH	2.0 2.4	13.1 12.1
Yeelanna	Gunderoi	DR2	3.87	12.3
Cummins	Tamaroi Krichauff	DR2 ASW	3.3 4.7	11.7 10.0
Kimba	Tamaroi Krichauff	DR1 ASW	2.05 2.47	13.9 12.4
Rudall	Gunderoi Camm	DR2 APW	2.72 3.75	11.8 9.8

What does it mean?

The perennial problem of smaller industries in an export-only market is evident again. Without the local ports able to guarantee a destination due to irregular or uncertain supply, durum has to be freighted around to Wallaroo or Adelaide for sale. At a cost of up to $40/tonne, this is making the proposition fairly tight unless price improves dramatically.

Significantly, several farmers around the higher rainfall areas have decided to drop out of durum production, primarily due to the freight cost and the uncertainty of having to achieve 13% protein. The alternative hard wheats are considerably more attractive due to higher yields, lower protein requirements and invariably, higher returns. With these farmers dropping out of production in the higher yielding areas, it will make the critical mass of approximately 6,000 exportable tonnes a distant prospect.

For farmers on Upper Eyre Peninsula, I think that durum remains a firm financial proposition if the freight issue can be resolved. While yields are down compared to most bread wheats, the additional price for a quality product can offset the yield difference. The quality achieved around the Cleve and Kimba areas is exceptional and for the time being, growers in this area can still tap into AusBulk's Kimba silos.

Generally speaking however, there is no substitute for yield. Most of the growers who participated in this trial, said that the durum had been grown on their best ground and usually following a legume break crop. Given the preferential treatment, how would any other wheat perform?

Durum remains a risky commodity, with large fluctuations in world price and significant penalties if quality is not met. Most of the growers I spoke to are persisting with durum but no more than 10% of their total wheat production.

PIRSA Rural Solutions

Prime Hard Quality Wheat on Upper Eyre Peninsula

Hugh Reimers[1], Miyan Shahajahan[1], Mark Bennie[2] and Bob Holloway[2]

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Why do the trial?

To develop an agronomic management package for the production of Prime Hard quality wheat on upper Eyre Peninsula.

The production of Prime Hard quality wheat is currently restricted to N.S.W and Queensland growers. Historically, wheat growers on Upper Eyre peninsula have demonstrated an ability to deliver grain of high protein, but have not been able to deliver to a Prime Hard segregation as it was thought that such grain would not meet the stringent quality standards required. In 1995, a five year research program, supported by the GRDC, was commenced to determine whether Prime Hard quality wheat could be grown in South Australia and to determine the agronomic management required to meet Prime Hard standards.

How was it done?

Variety trials were conducted at 8 sites (Kalanbi, Kimba, Lock, Minnipa, Mitchelville, Nunjikompita, Penong and Streaky bay) in order to compare the performance of existing Prime Hard wheats with high quality locally bred wheat varieties and breeders lines.
Management trials were conducted at Minnipa Agricultural Centre to determine the agronomic management required to consistently produce grain of Prime Hard quality.

Each year at Minnipa, a trial was sown to compare four potential Prime Hard quality varieties, at six rates of nitrogen following three different paddock rotations. The rotations were chemical fallow commenced in the Spring, peas grown for grain and oats grown for grain.

What happened?

The variety trial results indicated that the sites at Lock and Mitchelville were not reliable as consistent producers of Prime Hard quality protein levels. The other six sites consistently achieved the desired protein levels and so the results for Kimba are presented as representative of the 6 Eyre Peninsula sites where Prime quality, high protein wheat, could be produced regularly. The data in Table 1, demonstrates the degree of yield variation typical of the upper Eyre Peninsula and also illustrates the high levels of protein achievable. Excessive levels of protein (>16%) have been found to be undesirable in Prime Hard, so nitrogen management practices will need to be carefully managed.

The results for the management trials conducted at Minnipa are shown in Tables 2, & 3 and indicate the highest yields with adequate protein levels followed chemical fallow pre-treatment. Moisture data collected at the time of seeding consistently demonstrated a higher level of subsoil moisture under the chemical fallow rotation compared to the cropping rotations. There was no significant yield response to nitrogen treatments and so only low rates of nitrogen could be recommended in order to maintain adequate protein levels and yet avoid haying off with excessive protein levels and inadequate grain size. Split applications of nitrogen were ineffective in these dry environments and so application at seeding is recommended.

What does this mean?

The following management practices will increase the probability of achieving better yields of larger grains within the desired protein range of 13-16%. All other practices which contribute to the production of high quality grain should be maintained along with these recommendations. Particular attention should be taken to the application of trace elements such as zinc. Also, as many producers are currently using DAP as their phosphorus source, care must be taken not to exceed the recommended nitrogen rate and so increase the probability of increased screenings and excessive levels of protein.

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Table 1. Prime Hard quality variety trials mean site yield (t/ha) and protein % (Kimba)

	1995		1996		1997		1998		1999	
	Yield (t/ha)	Protein (%)	Yield (t/ha)	Protein (%)	Yield (t/ha)	Protein(%)	Yield (t/ha)	Protein (%)	Yield (t/ha)	Protein (%)
Chara	-	-	-	-	1.52	14.4	2.1	15.0	0.63	16.0
Janz	0.98	14.7	1.09	14.2	1.77	13.4	2.2	15.1	0.71	15.8
Kukri	0.91	15.5	1.04	14.1	1.64	14.5	1.88	15.7	0.69	16.7
Molineux	0.91	15.6	1.11	14.6	1.73	14.3	1.85	16.0	0.71	15.9
Sunco	0.85	15.7	0.94	14.5	1.59	14.1	1.88	15.0	0.81	16.1
Sunstar	0.54	15.6	1.01	14.4	1.48	15.0	-	-	-	-
Worrakatta	-	-	-	-	1.67	12.8	2.26	13.8	0.80	15.2

Note: Worrakatta is ASW quality

Table 2. Mean yield t/ha and protein (%) of management trials at Minnipa 1996-1999

** Note In 1996 vetch was used as a pre-treatment and Suneca was used as a Prime Hard quality variety*

Rotation	Peas*		Oats		Chem. fallow	
	Yield (t/ha)	Protein (%)	Yield (t/ha)	Protein (%)	Yield (t/ha)	Protein (%)
1996	0.88	14.0	0.91	14.3	1.02	15.2
1997	1.46	13.4	1.18	12.8	1.76	12.7
1998	1.70	15.2	1.65	14.7	1.79	14.7
1999	0.95	15.8	0.49	15.9	1.31	15.0

Variety	Molineux		Sunstar*		Janz		Kukri	
	Yield (t/ha)	Protein (%)	Yield (t/ha)	Protein (%)	Yield (t/ha)	Protein (%)	Yield (t/ha)	Protein (%)
1996	0.78	14.9	0.83	14.7	1.06	14.5	1.07	14.8
1997	1.52	13.4	1.40	12.9	1.53	12.4	1.40	13.1
1998	1.44	15.2	1.65	15.2	1.95	14.5	1.81	15.0
1999	0.93	15.7	0.78	15.5	0.99	15.0	0.97	15.7

Table 3: Mean yield t/ha and protein (%) of management trials at Minnipa 1996-1999

N treat	0		7.5kg		15kg		15/15T		30kg		45kg	
	Yield (t/ha)	Protein (%)	Yield (t/ha)	Protein (%)	Yield (t/ha)	Protein (%)	Yield (t/ha)	Protein (%)	Yield (t/ha)	Protein (%)	Yield (t/ha)	Protein (%)
1996	0.90	13.9	-	-	0.96	14.3	0.92	15.0	0.95	14.7	0.96	14.8
1997	1.44	12.5	-	-	1.48	12.8	1.46	13.2	1.47	13.1	1.46	13.1
1998	1.72	14.6	1.71	14.9	1.71	15.0	1.71	15.0	1.73	14.9	1.71	15.0
1999	0.91	15.5	0.93	15.6	0.92	15.5	0.92	15.6	0.91	15.5	0.91	15.7

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For Upper Eyre Peninsula:

- Sow after a chemical fallow begun in the previous Spring.
- Use varieties Janz or Kukri which have desired quality and high protein.
- Sow in early May if possible.
- Sow at a seed density of 200 seeds per square metre (~ 140-160 plants/sq metre)
- Seed with no more than 7.5 kg/ha N.

Adherence to these recommendations should increase the probability of achieving the quality standards required. Where high screenings have been a problem with Janz, the larger seeded early variety Kukri may assist. The AWB would prefer delivery of more than one variety to this segregation if a further southern Prime Hard class is to be created in the future. As the yield of these Prime Hard quality varieties is approximately 10% below that of the current highest yielding Australian Hard variety (Yitpi) received in South Australia, growers will need to be paid a premium for the high quality grain they produce.

Acknowledgements

The authors would like to acknowledge assistance provided by Gill Hollamby, Glen McDonald, and Tony Rathjen (University of Adelaide), Rob Wheeler of the crop evaluation unit of SARDI and Leigh Davis and Shane Doudle of the Minnipa Agricultural Centre.

Particular note needs to be taken of the large financial input of the GRDC in supporting this five year research project.

Managing Climate Risks in Cropping in Low Rainfall districts

Jim Egan & Melissa Truscott, SARDI

Why do the trial?

The decision support trial in the 2000 growing season aimed to test the value of climate information to grain growers in low rainfall districts of SA. This provides them with the best available information on seasonal conditions and forecasts, the likely effects of these on district crop yields and monitoring how they used and valued such information.

One of the many difficulties that farmers have to contend with is the variability and uncertainty of seasonal conditions from one year to the next. In recent years there has been a number of developments that provide the opportunity for farmers to improve their understanding of this climate variability and to better manage its effects on production. These developments include computer programs to allow ready access to long-term rainfall and other climate records, computer models to predict grain yields under a range of climatic and management conditions and improved long-range climate forecasting techniques.

With funding from the GRDC, our research is adapting and testing these tools under SA conditions and assessing how farmers can access and use them to make better informed crop management decisions. This includes an assessment of how their management responses may impact on long-term farm profitability.

We presented some of the information provided in this trial in the Eyre Peninsula Farming Systems 1999 Summary, pages 21-23.

How was it done?

Three low rainfall cropping groups were formed in the Upper Eyre Peninsula, Upper North and Murray Mallee regions of SA, with approximately 15 farmers in each. Presowing workshops were conducted with each group in April, to discuss the climate information, tools and services available, current and forecast seasonal conditions and the farmers' crop management plans for 2000. Trial participants were issued with information kits containing trial details and a series of district yield probability charts, showing effects of early season (April-May) rainfall, March sea surface temperature (SST) patterns and April-May Southern Oscillation Index (SOI) phases on likely district yields.

Updates on district seasonal conditions and forecasts, and the implications for likely district yields, were faxed or e-mailed to trial participants at regular intervals of 2-3 weeks during seeding (to early July) and about monthly from July to late September. Information for these updates was collated or generated from a number of sources, including:

- Bureau of Meteorology Seasonal Climate Outlook and short-term forecasts, and seasonal rainfall recordings, via the "SILO" website;
- Queensland Department of Primary Industries' Australian Rainman computer program and "Long Paddock" website;
- Other forecast information from a range of websites;
- Analysis of predicted district wheat yield data from the STIN (stress index) model of David Stephens (Agriculture WA);
- Stored soil water estimates for trial participants' farms using the PYCAL (Potential Yield Calculator) program of David Tennant (Agriculture WA).

Participants kept a log of seasonal conditions and management decisions on their properties during the trial period. A survey was conducted at the end of seeding to see how the climate information provided was utilised by participants. Results of this survey, climate information needs and management responses were then discussed with the farmers at workshops in each region in August.

A further (post-harvest) survey of farmers' wheat yield, protein and screenings content was conducted in January 2001, but results of this are not yet available.

What happened?

Farmers in the trial groups are using a wide range of information sources and tools to assess forecast seasonal conditions on their farms. They are using this information to support crop and farm management decisions at several levels:

- Strategic, e.g. how to make best use of farm resources?
- Tactical, e.g. what is the best way to manage the conditions we are experiencing this season and the likely forecasts?
- Operational, e.g. what should they do next and how?

The climate information delivered to farmers in these trials was generally rated highly for understanding, but only about half of the farmers indicated it to be useful to their decision-making in this season. The most useful piece of information for this year's decisions was that on seasonal conditions to the end of April and what this means for likely district yields. Sixty percent of farmers rated this as useful. In general, the later the information was provided during seeding, the less useful it rated for seeding decisions.

The 2000 season opened well in April for most trial participants, with the added bonus (they considered) of useful amounts of stored soil moisture. Their own experience, backed up by analysis of farmers' own records, trial data, and actual and simulated district yields, have demonstrated that good early seasonal conditions are a strong indicator of above average yield expectations in low rainfall districts. Faced with such strong indications of good yield potential in 2000, most farmers did not require additional climate and yield probability

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information to assist their cropping decisions.

Another factor exerting a strong influence on their cropping decisions in 2000, particularly in the Upper North, was the immediate threat of locusts attacking emerging crops, and the prospect of further attacks in spring.

All climate information sources scored more highly for potential use and value in another season. Farmers expected such information to be especially useful in a poorer season, such as a late break, when their major management changes are made. In such a season, if the forecast indices point to a higher likelihood of future seasonal conditions continuing below average, farmers are more likely to make downward adjustments to crop inputs and management.

A number of management responses to the seasonal conditions were adopted by trial participants in 2000, including increasing crop area where early conditions were most favourable, changing crop types and varieties and increasing fertiliser rates.

What does this mean?

The decision support trial in 2000 highlighted the importance of farmers monitoring actual seasonal conditions on their own farms and responding to this information. In low rainfall districts, early season (April-May) rainfall is a major indicator of likely crop yields. Table 1 shows how the probability of district wheat yields being in the bottom third (below average) or top third (above average) responds to total April-May rainfall at a number of SA low and medium rainfall locations included in the trial. A dry start (less than 40 mm) increases the risk of below average yields (50-60% chance of being in lowest third) and a much reduced (10-20%) chance of above average yields. A wetter start to the season (more than 80 mm in April-May) increases the chance of above average yields to 50-80% and the risk of below average yields to only 0-20%, depending on location.

Farmers need to be prepared to make the most of any early seeding opportunities. But if dry conditions prevail during April, May and into June, farmers need to reassess their

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Table 1: Probabilities of district wheat yields being below or above average, depending on total April-May rainfall, for a number of SA low-medium rainfall locations (District yields predicted from STIN yield model, D. Stephens, Agriculture WA).

Rainfall Station Location	If total April-May rainfall is:			
	Less than 40 mm		More than 80 mm	
	Chance of district yields being:			
	Below Average (lowest third)	Above Average (highest third)	Below Average (lowest third)	Above Average (highest third)
EYRE PENINSULA				
Ceduna	58%	12%	13%	67%
Cleve	60%	16%	12% (> 70 mm)	52% (> 70 mm)
Kimba	70% (< 30 mm)	12% (< 30 mm)	6%	65%
Kyancutta	42%	13%	0%	71%
Lock	46%	18%	19%	50%
Minnipa	50%	19%	6%	59%
Nundroo	55%	14%	4%	57%
Penong	59%	4%	8%	69%
Streaky Bay	50%	8%	13%	61%
Wirrulla	57%	6%	8%	75%
UPPER NORTH				
Black Rock	61% (< 30 mm)	10% (< 30 mm)	12% (> 50 mm)	57% (> 50 mm)
Hammond	57%	14%	0%	83%
Quorn	54%	15%	8%	50%
Terowie	49%	13%	0%	79%
MURRAY MALLEE				
Copeville	53%	25%	10%	70%
Lameroo	52%	24%	8%	47%
Milang	62%	19%	17%	48%
Paruna	50%	16%	0%	75%
Tailem Bend	60%	20%	10%	45%
Waikerie	46%	20%	5% (> 60 mm)	63% (> 60 mm)

(Continued from page 24)

cropping programs in the light of the higher risk of poor yields and reduced chance of good yields. At this stage, the forecast indices such as the SOI and SST patterns can also give some indication of likely winter and spring rainfall, which can be factored into revised crop management plans.

Several computer programs currently being developed by Agriculture WA will improve our ability to access and integrate current and forecast seasonal condition information, and translate this into farm-specific yield predictions for the current season. One of these programs is the self-calibrating PC version of STIN, which we will test in decision support trials with farmers in medium-high rainfall cropping districts of SA in 2001.

We will also be exploring and developing options for on-going delivery of this climate and yield risk information to farmers, including provision of:

- District level information, able to be accessed directly by users via the Internet or poll-fax services;
- Farm-specific information, incorporating a farmer's own data and processed via computer programs, and accessed or delivered by fax-back or e-mail services.

Climate Risk Management Workshops

Much of the information from this and our earlier climate risk management decision support trials has been incorporated into Climate Risk Management training workshops. If you would like to learn more about the climate influences such as the SOI and SST on your local weather patterns, then a Climate Risk Management Workshop is for you. These workshops will shed some light on the climate influences at the local level and how you can use them to assist your management decisions.

If you would like to improve your understanding of the information on a weather map, or how to better manage climate risks such as frost, drought, waterlogging or late starts in your region, then these workshops will help. By attending you will see the long term variability and patterns in rainfall and temperature for your region, and develop strategies to manage this variability in order to maximise your profits and minimise your losses.

The Climate Risk Management workshops are a half to one full day interactive program. They are subsidised by FarmBis. For more information, contact Melissa Truscott at SARDI Waite Campus, on 08 8303 9639.

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SARDI

SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Section Two

Section Editor: Brendan Frischke
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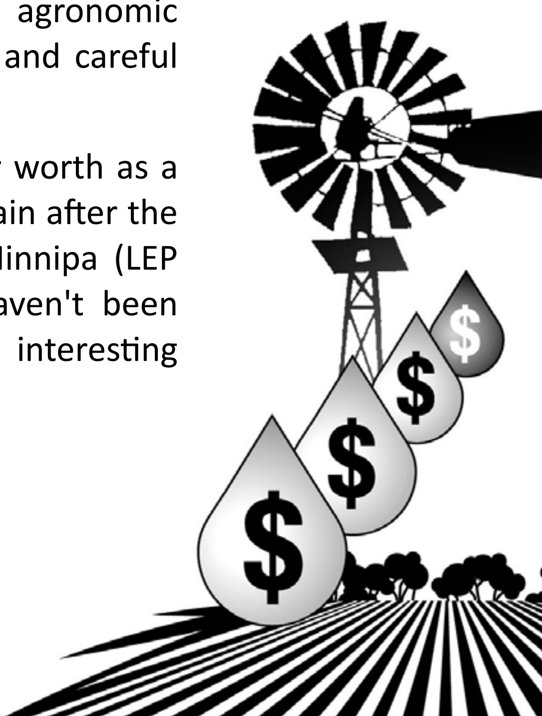
Break Crops

2000 was a very good season for break crops on Upper Eyre Peninsula. Most areas had a good early opening and follow up rains, which enabled crops to establish and cover the ground quickly.

Many challenges were presented to farmers including aphid attack on canola crops during flowering. Spring rains and mild weather created an environment favourable for black-spot (*Ascochyta*) infection in peas, and rust and chocolate spot (*Botrytis*) infections in some vetch and faba bean crops.

Despite these difficulties, adequate seasonal rains allowed canola and pea crops to perform well and pleasing yields were recorded. This highlights the importance of having sound agronomic practices, awareness of threats (insects and disease) and careful variety selection.

Summer crops were grown late in 2000 to asses their worth as a break crop. They had a good start but received little rain after the new year and didn't perform as well as hoped at Minnipa (LEP summer crops look more promising). The crops haven't been harvested at the time of printing but you can find interesting information about sorghum at MAC on pages 63—64.



AusBulk

Peas on Upper EP in 2000

Larn McMurray, South Australian Field Crop Evaluation Program, SARDI (Waite) and Brendan Frischke, SARDI, Minnipa Ag Centre

Locations
1) Minnipa Ag Centre
2) Michael Weiss, Rudall
3) Mick & Geoff Scholz, Wudinna

Rainfall (mm)
Av. Annual total:
1) 326, 2) 339, 3)327

Av. Growing season:
1) 241, 2) 247, 3) 241

2000 Annual total:
1) 390, 2) 409, 3) 349

2000 Growing season:
1) 299, 2) 301, 3) 287

Soil
1) Sandy loam, pH 8.4
2) Sandy loam, pH 6.6
3) Sandy loam, pH 8.5

Plot size
1.48 m x 10m
4 Replicates

Other factors
1) Rudall - good season.

2) Wudinna - high levels of black spot.

3) Minnipa - heat/moisture stress late flowering.

Why do the trial?

To improve the profitability and sustainability of pea crops grown in the low rainfall areas of Eyre Peninsula (<350mm).

Good rotations are essential for higher yields, increased water use efficiency and sustainable farming practices. Options for break crops in rotations for low rainfall areas are limited and often unreliable. Over a number of years of trials comparing a range of different pulse crops in low rainfall areas, peas have consistently been the highest yielding and most reliable pulse crop option. This report looks at the most relevant outcomes from the work in 2000 and provides an interpretation of the cumulative trial work over the last 2 years.

This article follows on from last year's article – Pulses for Low Rainfall Areas – a reality check (p26 - 30).

How was it done?

Trial details - Pea agronomy trials were conducted at three sites. Minnipa Agricultural Centre, Wudinna and Rudall.

The trial at Minnipa had two seeding times (May 18 & May 31) with two varieties (Dundale & Parafield) sown at four targeted plant densities (20, 40, 60 & 80 plants/m^2).
Wudinna had three varieties (Alma, Dundale & Parafield) and two seeding times (May 4 & May 17).
At Rudall, four varieties (Santi, Excell and a breeding line (all semi-leafless) and Parafield (a conventional type)) were sown at five targeted plant densities (20, 40, 60, 80 & 100plants/m^2). The trial was sown on May 8.

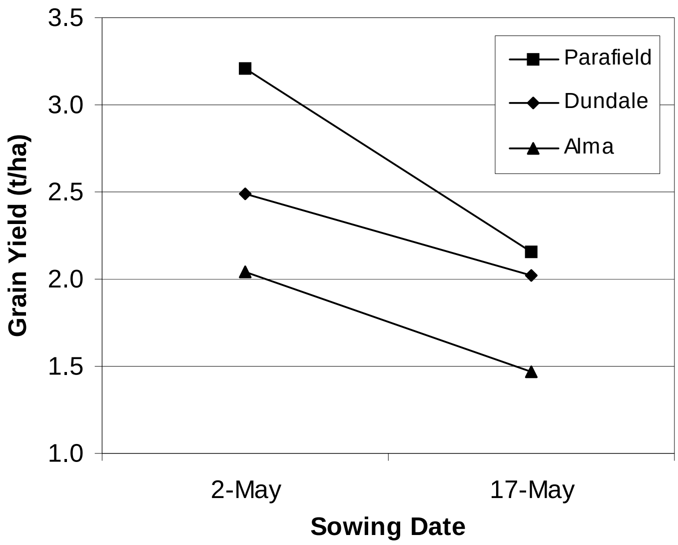


Figure 1: Effect of time of sowing on grain yield of pea varieties at Wudinna, 2000.

Trial treatments - Seedbed preparation involved a single cultivation prior to seeding at Wudinna, while trials were sown directly into standing stubble at Minnipa and Rudall. All trials were sown with narrow points and 80 kg/ha of 0:20:0 with 5% Zinc.
Trials were sprayed with a pre-seeding knockdown (Round -up CT XTRA® 800 ml/ha or Spray-Seed® 1L/ha), a grass selective herbicide (Targa® 250 ml/ha or Shogun® 450 ml/ ha) and insecticide (Karate EC® 180 ml/ha) for Heliothis.
Measurements- Emergence, plant vigour, date of flowering, date of maturity, lodging, shattering losses and yield.

What happened?

Time of sowing
Grain yield in time of sowing trials at Minnipa and Wudinna was reduced by 14% and 37% respectively when sowing was delayed by 13-15 days after the break in season (Figure. 1 & 2).
Dry matter production was also reduced by 24% at Minnipa

(Continued on page 29)

(Continued from page 28)

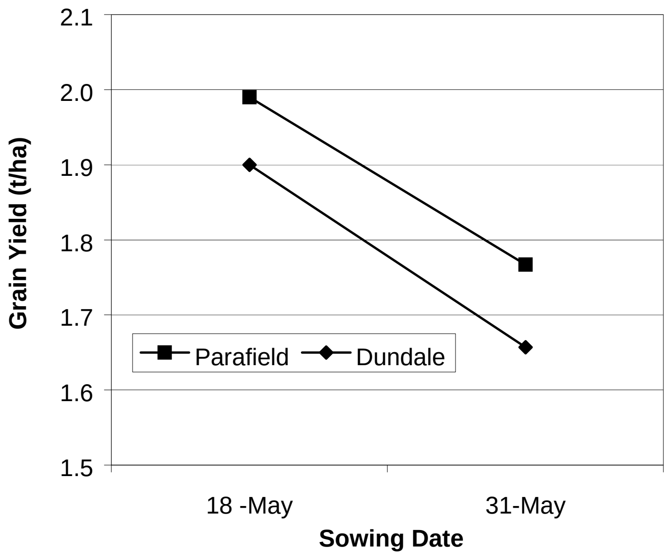


Figure 2: Effect of time of sowing on grain yield of pea varieties at Minnipa, 2000

and 48% at Wudinna by this delay in sowing. Yield losses were due to the later sown peas flowering during higher periods of stress, caused both by increased temperature and lower soil water and also due to lower pod production. Yields at Minnipa were lower than at Wudinna, attributed to the later start to the season and later sowing dates at this site.

At Wudinna, Ascochyta (black spot) levels were high in the trial. Disease loading was significantly greater on plants in the early time of sowing, with infection reaching the top of the plant and covering all pods. However, yield losses due to disease infection did not appear to be severe, and the yield penalty for later sowing far out-weighed any loss caused by higher disease levels on the plant. The lack of rains from early September onwards, even though conditions were favourable for plant growth, restricted further spread of disease and also reduced the yield of later maturing varieties and later sown plots.

Seeding rates

Plant density comparisons at Minnipa and Tuckey indicated that the optimum density for conventional tall peas like Parafield, Alma and Dundale is around 40-45 plants/m^2 (85 -95 kg/ha). Delaying sowing at Minnipa by 13 days had no significant effect at this optimum rate. These results validated similar findings from 1999. Semi-leafless lines like the short variety Santi and the medium tall variety Excell were evaluated in density trials at Rudall. Results suggested higher plant densities (60-70 plants/m^2) of these shorter semi-leafless lines are required to maximise yields. These results are similar to findings in the Mid North of the state.

Varieties

Parafield continues to be the highest yielding variety on Upper Eyre Peninsula over 5 years of evaluation in numerous agronomic and variety trials. Generally Parafield is 5-15% higher yielding than Alma and Dundale. Long term (1992-2000) yield results of Parafield from SAFCEP variety trials at Lock and Minnipa show yield increases over Alma of 26% and 19% respectively. Parafield is the best option of currently available varieties for the low rainfall areas of Eyre Peninsula.

Downy mildew affected a number of commercial pea crops on Upper EP last year. Generally downy mildew only affects seedling crops. However last year in a number of cases the disease continued into spring. Parafield, like Alma and Dundale, is susceptible to downy mildew and management practices are the only way of controlling the disease in these varieties. If paddocks have had a history of peas, especially if downy mildew has been detected before, growers are advised to treat their seed with Apron®.

SA pea breeding trials have been at Minnipa for the last 3 years now, with earlier generation material being included last year. This increased breeding effort will continue in 2001 with the aim of identifying better adapted material for the low rainfall areas. Apart from yield, lines are evaluated for disease resistance, standing ability, maturity and shattering resistance.

What does this mean?

- Peas performed well in low rainfall areas in 2000 and generally produced high dry matter levels and long vine lengths enabling easier harvest than the previous year. In low rainfall areas Parafield continues to be the highest yielding and best adapted variety. However Parafield is very similar to Dundale and Alma in its growth habit and disease resistance. At this stage farm management is the only way to handle limitations such as black spot and downy mildew susceptibility, harvest problems and erosion risk.
- Time of sowing trials over two years at Wudinna and Minnipa have shown that in all cases sowing on the break has resulted in higher yields than delaying sowing. This yield increase has now occurred in below and above average rainfall years, and also in years where late season rainfall has and has not occurred.
- Black spot levels were high with the early time of sowing at Wudinna. However, yield loss was greater from delayed sowing than from disease. No information is known on existing spore levels in the paddock and growers are still advised to take disease management precautions when sowing peas especially into paddocks with previous black spot epidemics. However the critical limiting factor over two years of work has been delayed sowing, and in all cases earlier sowing has maximised yields.
- Agronomy trials in the low rainfall areas need to continue to validate results over variable seasons and maximise the growth and profitability of peas.
- Selection efforts on breeding material needs to continue in lower rainfall areas to increase local adaptation, yield and disease resistance.

GRDC Grains Research & Development Corporation

(Continued on page 30)

wledgements
ledge the efforts of agricultural
and Lisa Bennie, who are
nd recording trial measurements
se trials were designed by Colin
ed in 1998 under his guidance.
We also acknowledge the cooperators (listed in boxed section) for allowing access to their properties to conduct trials. This research is made possible by the Grains

Improving Lupin Yields on the Lower Eyre Peninsula

Tim Richardson (Pt Lincoln) & Larn McMurray (Waite)

Location:
Ungarra / Wanilla
Terry Young / David & Graham Giddings
Rainfall
Av. Annual total: 418 mm / 450 mm
Av. GSR: 308 mm / 330 mm
Yield
Potential: 2.67t/ha / 3.12t/ha
Soil
Ungarra: deeper duplex soil 30-40 cm non wetting sand over clay, pH (H_2O) 6.4.
Wanilla: shallow duplex soil, 10-20 cm sand over clay, pH (H_2O) 6.0.
Diseases
CMV, rhizoctonia, brown leaf spot, phomopsis
Plot size
10m x 1.8m, 4 reps
Other factors
premature wilt

Why do the trial?

Aim: To increase yields of narrow-leafed lupins in medium and high rainfall environments of the Lower Eyre Peninsula (LEP).

Lupins are an important break crop and make up approximately 50% of the pulse crops grown on LEP. A significant increase in lupin prices over the last 6 months is likely to see this area increase in the coming season. Lupins are often the only profitable and sustainable pulse option in the rotation due to the nature of the soil in this area, but low and variable yields are major concerns to growers. A number of agronomic problems have limited lupin yields including excessive vegetative growth, premature wilt and poorly adapted varieties. This SAGITF funded project started in 1998 to define the extent of root diseases and overcome agronomic problems limiting lupin yields on the LEP. It complements the GRDC funded SAFCEP lupin variety evaluation on the LEP and across SA. The results presented below are a preliminary summary from the last 3 years of trials.

How was it done?

- *Treatments:*
  - 8 varieties: Belara, Kalya, Merrit, Tallerack, Tanjil, Warrah, Wonga & Jindalee (WL318)
  - 3 times of sowing: Time of Sowing 1(TOS 1) = sown on the opening break, TOS 2 = sown 2-3 weeks after the break & TOS 3 = sown 5-6 weeks after the break
  - 3 targeted seeding rates (25, 45 & 65 plants/m^2) plus 85 plants/m^2 in 2000.
- *Fertiliser and herbicides:* current district practice
- *Measurements* – Grain yield, harvest index, pod and plant physiological measurements, premature wilting, visual disease assessment (leaf & roots) and pathogen isolation were recorded.
- *Deep ripping trial* - (Paraplow® used to deep rip 40 cm)
  -*Control* - Kalya & Wonga sown @ 50 plants/m^2 + 90 kg/ha MAP.
  -*Deep rip* - March 18 + 90 kg/ha MAP liquid fertilisers + 1 kg/ha Cu + 5 kg/ha Zn + 6 kg/ha Mn on June 14 with the seed
  -*Deep rip + liquid fertiliser* - March 18 plus 77 kg/ha of TechGrade MAP +1kg/ha Cu + 5 kg/ha Zn + 6 kg/ha Mn on June 14 with the seed
  -*Deep rip + nutrients* - 77 kg/ha of TechGrade MAP +1 kg/ha Cu + 5 kg/ha Zn + 6 kg/ha Mn on March 18

All treatments were sown with both Wonga and Kalya to observe varietal differences to soil amelioration

What happened?

1. Root diseases and premature wilt

Significant premature wilt was observed in the lupin trials over the 3 years 1998-2000, even in the absence of any root rot pathogens. Investigation into lupin plant root patterns in 1998 suggested that the main factors leading to premature wilt on LEP duplex soils were the inability of some varieties to penetrate the clay subsoil, and transient water-logging at the sand - clay interface. Varieties Wonga and Jindalee were found to have resistance, attributed to the ability of their primary tap root to penetrate further into clay subsoil than more susceptible varieties like Kalya. These findings suggested that root rots are playing a lesser primary role in premature wilt on the LEP duplex soils. Work in southern NSW has shown that a species of *Phytopthora* causes their "lupin sudden death", but this is yet to be isolated in our situations in SA.

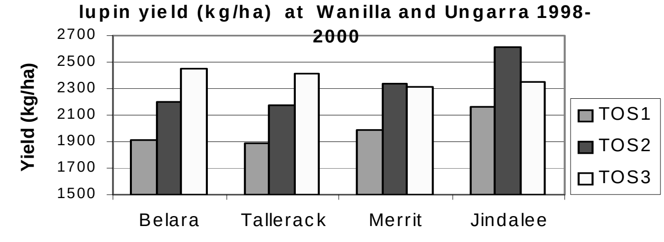
2. Varieties

The newly released Jindalee was the highest yielding variety at both Ungarra and Wanilla over the range of sowing times over 3 years. Overall, Jindalee was 9% higher yielding than Merrit when sown on the break, 14% higher when sown 2-3weeks after, and 2% when sown late June-July (Fig. 1). Early sowing maximised yields of Jindalee at Wanilla, while delaying sowing until 2-3 weeks after the opening rains maximised yields at Ungarra. Belara is an early flowering variety which yielded 11% higher than Merrit at the late time of sowing.

3. Time of Sowing

Early sowing of lupins in the Wanilla trials often led to

Fig. 1 Effect of variety and time of sowing on lupin yield (kg/ha) at Wanilla and Ungarra 1998-2000



excessive vegetative growth, poor pod set and a reduction in yield. However delayed sowing also led to low yields in years when flowering occurred in periods of high heat stress, leading to flower abortion. In favourable years for plant growth, Merrit and Warrah were found to produce similar yields when sown early (mid May) or later (July).

(Continued on page 31)

Table 1: Effect of time of sowing on lupin yields (kg/ha) averaged over varieties and seeding rates.

Time of Sowing	Wanilla			Ungarra		
	1998	1999	2000	1998	1999	2000
TOS 1	-	2283	1835	1374	1683	2422
TOS 2	1782	1452	2126	1534	2024	2633
TOS 3	1833	1563	2338	1290	1949	2761

(Continued from page 30)

This did not occur with Jindalee which requires vernalisation (a cold period before flowering). Jindalee pods profusely on the main stem, so it produces greater yield over other varieties when sown early. The Jindalee plant type appears more suited to these areas than traditional varieties like Merrit.

At Ungarra on a non-wetting sand, maximum yields were achieved when sowing was delayed 2-3 weeks after the break of season. Poor emergence was often the problem with sowing on the break. Results from both sites suggested that to maximise yields when sown late (late June, July), high seeding rates of varieties Belara (early flowering) and Tallerack (restricted branching type) were required.

4. Seeding rate

Over the 3 year period the achieved plant densities were generally below the targeted rates at both locations, especially in the earlier times of sowing. At Ungarra this was attributed to the non-wetting nature of the sand and early pest damage reducing plant establishment. Achieving target plant densities is essential to maximise lupin yields and increased seeding rates may be required if farmers are consistently getting plant densities significantly lower than targeted rates. However with the use of press wheels and a good break to the season, achieved plant densities were much closer to the target rate in 2000. Plant establishment was more successful at Wanilla, but a similar trend existed with reduced plant density at earlier sowings.

Over all trials in the 3 year period, lupin yields were increased by increasing targeted plant densities from 45 to 65 plants/m^2 (85 to 120 kg/ha) (Fig. 2). However it should be noted that over the 3 year period foliar disease levels were quite low. On average the actual plant density when targeting 65 plants/m^2 was around 55 plants/m^2 and the achieved yield increases were always greater at later times of sowing. Seeding rate results from 2000 indicated that rates of up to 85 plants/m^2 maximised yields of late sowings of varieties like Belara and Tallerack.

5. Subsoil limitations

Fig. 2 Effect of seeding rate on lupin yields Ungarra and Wanilla 1998-2000

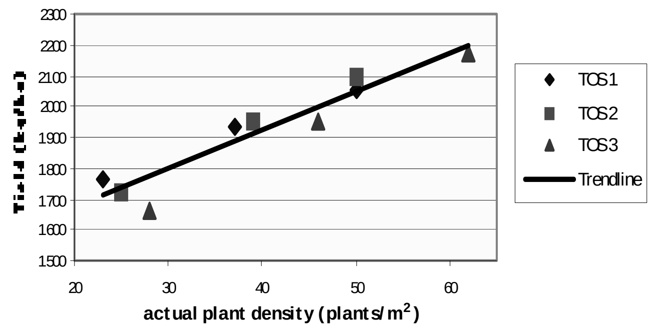


Table 2: Effect of ripping and nutrient treatments on lupin yield (kg/ha) at Ungarra in 2000

Treatment	Yield (kg/ha)	% Control	Dry Matter wt (g/m²) 26/9/00	% Control
Deep rip + liquid fertiliser	2721	110	417	137
Deep rip + nutrients	2698	109	394	129
Deep rip	2585	104	314	103
Control	2482	100	305	100
liquid fertiliser	2191	88	258	84

The benefit of deep ripping was demonstrated at Ungarra on a shallow sodic subsoil last year. Treatments trialed included deep ripping up to 40 cm using a para-plow and the placement of nutrients at depth. There was an increase in both dry matter production and grain yield from the deep ripping. Deep-ripping alone increased grain yield by 4 %, but the advantage increased to 10 % when combined with liquid nutrient applications, (Table 2).

What does this mean?

- Sowing lupins too early on LEP can reduce yields compared to delaying sowing 2-3 weeks after the break.
- Excessive vegetative growth and poor early pod set can occur, along with establishment problems on non-wetting sands.
- Variety choice is important, with Jindalee more responsive to early sowing and Belara to late sowing.
- Seeding rates need to target 65 plants/m^2, with establishment rates around 55 plants/m^2 to maximise yields, especially at late times of sowing.
- 2000 seeding rate data suggests that further yield increases may be obtained from increasing seeding rates to 85 plants/m^2, with some varieties under certain conditions. However due to the limited number of observations and seasonal variability, further research is required before optimum seeding rates can be determined.
- Consideration needs to be given to the increased risk of foliar disease associated with a denser lupin stand (during this trial disease levels were quite low).
- High seeding rates are especially critical for maximum yields with late sowing.
- The major cause of premature wilt is thought to be transient waterlogging at the sand-clay interface and the inability of some varieties to penetrate the clay subsoil. By selecting varieties with better premature wilt resistance (Wonga and Jindalee) potential yield losses in high rainfall years can be reduced.
- Jindalee will offer yield advantages over Merrit and it appears that early sowing will maximise yield .
- Preliminary work with deep-ripping to break up the sand -clay interface and the addition of nutrients at depth at Ungarra looks promising for improved plant growth and yields, but more detailed work is required.

Acknowledgments

The research reported in this article was funded by the SA Grains Industry Trust Fund (SAGITF). This support and that of cooperators David and Graham Giddings (Wanilla) and Terry Young (Ungarra), is gratefully acknowledged.

Triticale: Benefits in a Cereal Based System

Chris McDonough, PIRSA Rural Solutions Field Crops Consultant, Loxton

Why grow triticale?

- Triticale has excellent resistance to many leaf and root diseases.
- Many farmers who have intensified cereals in their rotations have found that where wheat yields were declining, the introduction of triticale into the rotation has helped restore wheat yields.
- Tahara has excellent resistance to Stem, Stripe and Leaf Rusts, *Septoria tritici,* Bunt and Flag Smut. It is resistant and tolerant to CCN, and is resistant to and moderately tolerant of *Pratylenchus neglectus.*

Where can it fit into rotation?

- After a number of cereals, where a build up of various root and leaf diseases is a concern.
- On poorer sandy soils triticale can be grown before or after lupins or pastures.
- After wheat where a Chlorsulphuron® or triasulphuron herbicide has been used and barley or other sensitive crop damage is a concern.
- Triticale can build up Take-all in a rotation, so a Take-all break may still be necessary prior to growing another wheat crop.
- It is also moderately susceptible to Crown Rot, so should not be used where this disease is significant.
- Some farmers have had problems with triticale contamination in wheat crops immediately following. In these cases some farmers have made sure that triticale residues are well grazed to remove seed, and have slashed or rolled stubbles to allow remaining triticale heads to break down in the soil and seeds to better germinate on opening rains.

Benefits of Triticale in Rotations

Many farmers' reports have indicated that triticale in a rotation can help improve yields of wheat, barley and oats. Avon farmer Robin Manley runs a continual cropping program which includes triticale. Results have clearly indicated that the highest yielding wheat paddocks always followed a history of triticale. Wheat yields became progressively lower as the number of seasons increased since the last triticale crop was sown. David Roget of the CSIRO has taken an interest and some field trials have commenced to establish what factors are causing this affect. Although resistance to *Pratylenchus* may be the key, results so far suggests there is more to the story.

SARDI trials in 1996-97 at Minnipa and Condada showed that Tahara triticale sown into plots of high *Pratylenchus*, gave a similar response to the nematicide treatments. It led to yield increases in following crops of 11% and 22% respectively at each site when compared to crops following Machete wheat (susceptible). There was a 90% reduction in the level of *P. neglectus* and 95% reduction in *P. thornei* after Tahara.

Basic Agronomy

- Triticale is well adapted to a broad range of conditions, including low fertility sands, shallow soils, sodic soils and very low or very high pH.
- Keep seeding rates up, with 95-120kg/ha recommended for 250-450mm annual average rainfall.
- Optimal sowing time generally is similar to wheat, as is weed control and nutrition requirements.
- Triticale holds its seed well for those wishing to delay its harvest.
- The stiff straw takes longer to break down, maintaining excellent cover for lighter soils.

Tahara triticale is still the main option for most areas, although Tickit should replace it when it becomes widely available in the next few years. Treat has higher test weight than Tahara, but lacks CCN resistance. In higher rainfall districts where waterlogging is an issue, then Abacus and Muir should be considered.

Marketing issues for EP

Although it is very early in the season Ausbulk has indicated that triticale will most likely be received at Wudinna, Thevenard, Cowell and Rudall. Pt Lincoln may receive triticale if a marketing body intends to export. This will depend on the area sown and the season outlook for 2001.

Further Information

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PIRSA
Rural Solutions

Faba Beans on Upper EP

Dr Jeff Paull, University of Adelaide, Waite Campus and
Brendan Frischke, SARDI, Minnipa Ag Centre

Why do the trial?

To improve the profitability of faba beans in low rainfall areas (<350mm) of Eyre Peninsula. Faba beans have been identified as a possible alternative to peas as a break crop because of their plant structure which may be suited to low rainfall areas. These trials aim to identify and demonstrate good agronomic practice using the best current varieties to maximise yield and profit.

This article follows on from last year's article – "Pulses for Low Rainfall Areas – a reality check" (p26-30).

How was it done?

Trial details - Faba bean trials were sown at Minnipa Ag Centre and Wudinna; trials at both locations contained identical treatments. Two varieties (Fiesta & Fiord) were sown at four targeted plant densities (8, 16, 32 & 40 plants/ m^2). Both trials had two seeding dates—Wudinna on May 2 and May 17 & Minnipa on May 30 and June 6 (because of a later break to the season) .

Trial treatments - Seedbed preparation involved a single cultivation prior to seeding at Wudinna, while trials were sown directly into standing stubble at Minnipa. All trials were sown with narrow points and 80 kg/ha of 0:20:0 with 5% Zinc. Trials were sprayed with a pre-seeding knockdown (Round-up CT XTRA® 800 ml/ha or Spray-Seed® 1L/ha), a grass selective herbicide (Targa® 250 ml/ha or Shogun® 450 ml/ha) and insecticide for heliothis (Karate EC® 180 ml/ha) and aphids (Dimethoate® 300 ml/ha). Trials were sprayed with a fungicide (Bravo® 1.4 l/ha) for ascochyta blight and chocolate spot several times to ensure disease did not affect yield or growth.

Measurements- Emergence, dry matter production, date of flowering, date of maturity, lodging, shattering losses and yield.

What happened?

These trials have demonstrated that in the more favourable seasons, such as 1998 and 2000, faba beans can be grown successfully on Upper Eyre Peninsula. The maximum yields at both sites exceeded 1 t/ha in 1998 while in 2000 over 2t/ha was produced at Wudinna and 1.4 t/ha at Minnipa. In addition, these trials investigated several of the key management strategies to maximise yields of faba beans and confirmed the importance of early sowing and maintaining an adequate seeding rate.

The maximum yield for both varieties in all trials was obtained at the earlier time of sowing. Early sowing generally resulted in a yield improvement in the order of 0.2 – 0.5 t/ha, with the exception of the severe drought at Minnipa in 1999 when yields of all treatments were extremely low.

Both varieties responded to increased seeding rates, and in several trials the yields were still increasing at the highest rates. The maximum yields were generally achieved with a plant density of greater than 30 plants/m^2. Faba beans have large seeds and to achieve a density of 30 plants/m2 requires sowing approximately 130-140kg/ha for Fiord and 180-190 kg/ha for Fiesta, although the exact rate will depend on seed size.

The relative yields of Fiord and Fiesta were inconsistent between sites and seasons, with Fiord producing higher yields at Wudinna in 1998 and 2000, while Fiesta produced higher yields at Wudinna in 1999 and at Minnipa in all seasons. When selecting a variety other factors to consider include disease resistance, plant type and quality. Fiesta has better disease resistance than Fiord so while it is necessary to budget for the use of fungicides for both varieties, better control should be achieved with Fiesta. Fiesta is more vigorous than Fiord and pods are higher off the ground and this should assist harvesting, particularly in the poorer seasons when plants are shorter and many of the lowest pods are missed at harvest.

Location:
1) Minnipa Ag Centre
2) Wudinna - Mick, Geoff & Nigel Scholz

Rainfall (mm)
Av. Annual total:
1) 326 2) 327
Av. Growing season:
1) 241 2) 241
2000 Annual total:
1) 390 2) 349
2000 Growing season:
1) 299 2) 287

Plot size
1.48 m x 10 m
4 Replicates

Other factors
Heat & moisture stress during pod fill

What does this mean?

Faba beans can be grown successfully on Upper Eyre Peninsula, provided they are sown early and a high plant density is achieved. These results are consistent with trials conducted in the more established faba bean growing regions of South Australia and also at low rainfall sites in Western Australia.

Early sowing and high plant densities result in maximum yield potential, but also increase the risk of fungal diseases such as ascochyta blight and chocolate spot. Both diseases can be controlled by an integrated approach including choice of variety, sowing clean seed, management of residue of previous crops, early fungicide application 6-8 weeks after sowing prior to the diseases becoming established in the crop and just before flowering. Several fungicide applications may be required depending on seasonal conditions.

Faba beans should probably be considered as an opportunity crop for regions such as Upper Eyre Peninsula, only to be grown in seasons with an early break.

Acknowledgments

We would like to acknowledge the efforts of agricultural officers Wendy Payne and Lisa Bennie, who are responsible for managing and recording trial measurements throughout the year. These trials were designed by Colin Edmondson and commenced in 1998 under his guidance. We also acknowledge the cooperators (listed in boxed section) for allowing access to their properties to conduct trials. This research is made possible by the Grains Research and Development Corporation (GRDC).

Vetch Variety Update on Upper Eyre Peninsula

Larn McMurray, South Australian Field Crop Evaluation Program, SARDI (Waite) and Brendan Frischke, SARDI, Minnipa Ag Centre

Location:
1) Michael Weiss, Rudall
2) Mick & Geoff Scholz, Wudinna

Rainfall (mm)
Av. Annual total:
1) 339, 2) 327
Av. Growing season:
1) 247, 2) 241
2000 annual total:
1) 409, 2) 349
2000 growing season:
1) 301, 2) 287

Soil
1) Sandy Loam, pH 6.6
2) Sandy Loam, pH 8.5

Plot size
1.48 m x 10m
4 Replicates

Why do the trial?

To identify and demonstrate the suitability of vetch varieties for grain and dry matter production in low rainfall areas (<350mm) of Eyre Peninsula.

Vetch is being used as a pasture alternative to medic on the UEP, especially in areas where medic seed reserves are low. Vetch in these cases is generally sown early and then grazed or sprayed out in spring. Varieties with high dry matter production are required, although grain yield is an issue when retaining seed for the following year. The results reported below are from trials testing the suitability of several current varieties at different locations and different times of sowing. This article follows on from last year's article – "Pulses for Low Rainfall Areas – a reality check" (p26-30).

How was it done?

Vetch trails were sown at Wudinna and Rudall in 2000. Four varieties (Blanchefleur, Languedoc, Cummins and Morava) were sown at each site. The Wudinna trial had two seeding dates (May 4 & May 17) and Rudall had one time of seeding (May 8).

Trial treatments - Seedbed preparation involved a single cultivation prior to seeding at Wudinna, while trials were sown directly into standing stubble at Rudall. All trials were sown with narrow points @ 80 kg/ha of 0:20:0 with 5% zinc. Trials were sprayed with pre-seeding knockdown (Round-up CT XTRA® 800 ml/ha or Spray-Seed® 1L/ha), a grass selective herbicide(Targa® 250 ml/ha or Shogun® 450 ml/ha) and insecticide for heliothis (Karate EC® 180 ml/ha) and aphids (Dimethoate® 300 ml/ha).

Measurements- Emergence, plant vigour, dry matter production, date of flowering, date of maturity, lodging, shattering losses and yield.

What happened?

The break in season was early and conditions were ideal for good establishment and early growth at both sites. A combination of lush growth, above average rainfall and warm temperatures during spring enabled diseases to thrive later in the year, particularly at Rudall. Crops were infected by chocolate spot (*Botrytis fabae*) and rust. Chocolate spot infection at Rudall was related to maturity, with earlier maturing varieties like Languedoc less affected than later maturing varieties like Blanchefleur and Morava.

In 2000, dry matter and grain yields were severely affected by disease infection at Rudall. A number of trials over the last two years comparing dry matter production indicate that Morava generally produces more dry matter than Languedoc, Cummins and Blanchefleur on the upper EP. This result is similar to findings in other areas of the State.

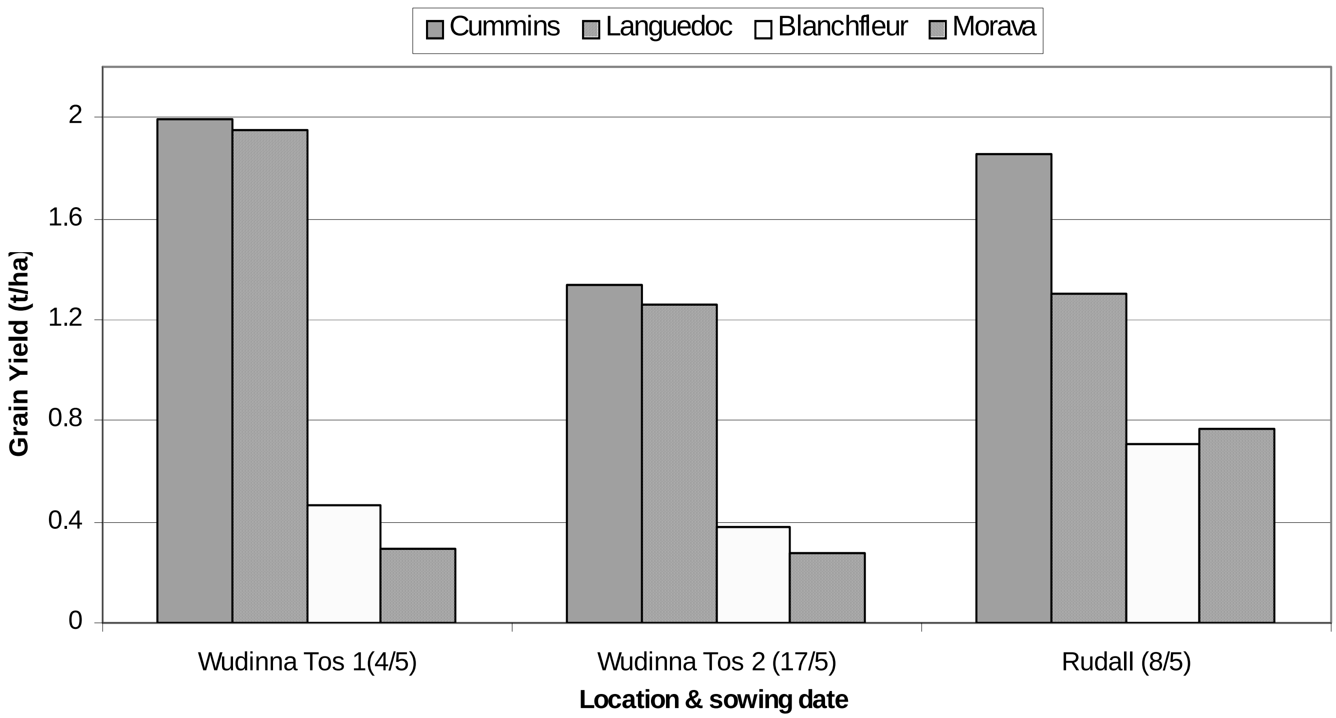
When grain yield was compared from the two seeding dates at Wudinna, the early time of sowing maximised yields in Languedoc and Cummins (Fig 1). These results are similar to findings from experiments with peas and beans. However different seeding dates had no effect on the late maturing lines of Blanchefleur and Morava. Both Morava and Blanchefleur mature too late to be consistently viable grain options in the low rainfall areas of UEP. Languedoc and Cummins were clearly the highest yielding varieties at Wudinna (both times of sowing) and at Rudall (Fig.1).
These results are similar to previous years' on UEP where early maturing varieties have yielded higher than later maturing lines. Generally, this has been due to early maturing varieties setting pods before high temperatures and moisture stress occur. However in 2000, the yield loss was also influenced by the arrival of disease in spring. Interestingly in the SAFCEP Stage 4 trial at Minnipa, Morava was 7% higher yielding than Languedoc, 20% higher yielding than Cummins and 22% higher than Blanchefleur. Disease levels in this trial were low, with only very low levels of Ascochyta detected and finishing conditions generally fairly favourable.

What does this mean?

- The choice of variety needs to be based on intended use, whether for grain or dry matter production.
- Morava, then Blanchefleur are the varieties most suited to dry matter production. Morava is the only rust resistant line and recommended for areas prone to this disease.
- Seed retention can be an issue in Morava due to its late maturity generally resulting in low yields.
- For grain production the higher yielding varieties generally are Languedoc and Cummins, although Morava performed well at Minnipa in 2000. Early maturing varieties, Languedoc in particular, can be difficult to harvest under low rainfall conditions due to short vine lengths.
- Botrytis infected a number of vetch crops last year reducing both dry matter production and grain yield. All varieties have similar susceptibility.

(Continued on page 35)

Figure 1: Grain yield of vetch varieties at Wudinna and Rudall, 2000.



(Continued from page 34)

- Further agronomic trials are required over a number of seasons to understand the best practice for maximising vetch dry matter production.
- Next year specifically selected early flowering lines from the SARDI vetch breeding program will be evaluated at Minnipa for both grain yield and herbage production in an attempt to find material with improved local adaptation.

Acknowledgments

We would like to acknowledge the efforts of agricultural officers Wendy Payne and Lisa Bennie, who are responsible for managing and recording trial measurements through-out the year. These trials were designed by Colin Edmondson and commenced in 1998 under his guidance. We also acknowledge the co-operators (listed in boxed section) for allowing access to their properties to conduct trials. This research is made possible by the Grains Research and Development Corporation (GRDC).

GRDC
Grains Research & Development Corporation

Canola Varieties on Eyre Peninsula

Brendan Frischke, SARDI, Minnipa Agricultural Centre

What Canola variety?

Many new varieties of canola are being released each year with more than thirty varieties being marketed in 2001. The following steps will help identify what variety is suitable for your needs.

Selecting a variety:

- Match maturity of cultivar to rainfall and growing season length (ie. early or mid season)
- Determine weed spectrum to make a decision on conventional compared with triazine tolerant (TT) or Imidazolonone Tolerant (IT) lines
- Determine the level of blackleg resistance required - a high level of resistance is preferred in mid to long season areas
- Consider the economics of different packages (eg. Clearfield system using IT canola)

Try new varieties in conjunction with proven varieties on smaller areas.

This year several new varieties are being marketed on Eyre Peninsula. Table 1 shows how conventional and IT varieties performed in 2000, and long term. Table 2 shows TT variety yield performance. Varieties with '*new*' after their name have been released for this season; these varieties and other recent releases have only a few years of yield data. More information about varieties, such as black leg resistance, early vigour, oil and maturity is available from Minnipa Agricultural Centre.

Table 1: Canola variety yield performance 2000 and long term (1994-2000) (expressed as a % of Oscar yield).

Variety	2000				1994 - 2000			
	Minnipa	Yeelanna	Bosanquet	Mt Hope	Minnipa	Yeelanna	Bosanquet	Mt Hope
Conventional								
Oscar	100	100	100	100	100	100	100	100
Georgie	115	98	107	120	109	102	104	105
Monty	172	72	94	94	110	94	96	98
Mystic	121	93	115	105	105	99	104	99
Ag-Outback *new*	149	121	105		130	107	109	
Emblem	122	113	108	120	124	108	105	109
Rainbow	94	111	101	119	99	102	102	103
Charlton	67	82	102	95	84	90	99	99
Dunkeld	78	88	91	100	84	92	91	98
Hyola 60 *new*	42	124	103	118		111	113	112
Pioneer 46C03	56	103	107	107	82	96	99	100
Clearfield System								
Surpass402CL *new*	102	122	83		96	101	95	
Surpass603CL *new*	67	109	93	110	108	104	105	106
Pioneer 44C71	145	94	94		102	93	96	
Pioneer 46C72	84	66	84	89	77	90	90	91
Oscar yield kg/ha	*491*	*1955*	*1456*	*1343*				
Date sown	5/6	16/5	10/5	17/5				
Soil type	Scl/sl	Ls/s	Ls/s	Sl/cs				
A-O rain	299	391		493				
PH	8.4	5.9	7.8	6.7				
Stress Factors	dl, ht, sh, wd	wa, bl, dl	E, w, dl, wd, bl	Wa, ap, bl, e, w, id, dl				

Abbreviations:

Soil type: topsoil / subsoil, s = sand, c = clay, l = loam, h = heavy, m = medium, li = light, f = fine, k = coarse
Site stress factors: de = moisture stress pre-flowering, dl = moisture stress post-flowering, w = weeds, lo = lodging
sh = shattering, pe = poor establishment, s = sulphur deficiency, ap = aphids, hd = herbicide damage, bl = blackleg,
id = insect damage, mt = manganese toxicity

Table 2: Triazine tolerant canola variety yield performance 2000 and long term (1994-2000) (expressed as a % of Pinnacle yield)

Variety	2000				1994 - 2000			
	Minnipa	Bosanquet	Ungarra	Tuckey	Minnipa	Bosanquet	Ungarra	Tuckey
TI 1 Pinnacle	100	100	100	100	100	100	100	100
Drum	54	90	83	86	58	85	90	88
Karoo	111	105	62	102	102	91	96	104
Clancy	78	101	102	88	83	92	99	95
Surpass 300TT *new*	53	93	67	87	51	81	80	86
Surpass 600TT	79	117	96	94	85	97	101	96
ATR-Grace *new*	104	132	112	101	101	105	105	103
ATR-Hyden *new*	79	130	110	112	88	104	104	108
Pinnacle yield	*448*	*1035*	*950*	*1382*				
Date sown	1/6	10/10	1/6	4/5				
Soil type	Scl/sl	S/mc	Ls/s	S/sc				
A-O rain	299		369					
pH	8.4	6.6	6.4	8.3				
Stress factors	pe, dl, ht, sh, wd, id	pe, w, bl, dl	Bl,ld,dl	Sh,dl				

Abbreviations:

Soil type: topsoil / subsoil, s = sand, c = clay, l = loam, h = heavy, m = medium, li = light, f = fine, k = coarse
Site stress factors: de = moisture stress pre-flowering, dl = moisture stress post-flowering, w = weeds, lo = lodging
sh = shattering, pe = poor establishment, s = sulphur deficiency, ap = aphids, hd = herbicide damage, bl = blackleg,
id = insect damage, mt = manganese toxicity

(Continued from page 36)

Canola Quality Mustard Update

Canola quality mustard has the potential to provide growers in low rainfall environments with an alternative species for oilseed production. Advantages of mustards are that they are more drought tolerant, have better early vigour, are blackleg resistant, can be direct headed more reliably than canola and have out-yielded canola in low rainfall environments. Significant progress has been made in the past 3 - 4 years in the development of canola quality mustard for low rainfall environments. Early flowering, high yielding, Australian lines with good agronomic characteristics have been developed and have been crossed with a source of high oleic acid from Canada. The progeny from these crosses is expected to produce the first canola quality Mustard for commercialisation within 3 years. The release of canola quality mustard will offer farmers better opportunities to sustain reliable high quality production into the future, especially in the low rainfall environments.

Acknowledgments

Data is sourced from South Australian Field Crop Evaluation Program.
Trent Potter, Senior Research Officer, Field Crop Evaluation, SARDI
Wayne Burton, Victorian Institute of Dry land Agriculture, Horsham
Ingrid Kennerley, Former researcher at Minnipa.
This Project is funded by the South Australian Grains Industry Trust Fund (SAGITF).

Growing Canola on Upper Eyre Peninsula

Brendan Frischke, SARDI, Minnipa Agricultural Centre

Location
1) Minnipa Ag Centre
2) Jason & Julie Burton, Tuckey
3) Mick & Geoff Scholz, Wudinna

Rainfall (mm)
Av. Annual total:
1) 326, 2) 335, 3) 327
Av. Growing season:
1) 241, 2) 250, 3) 241
2000 annual total:
1) 390, 2) 378, 3) 349
2000 growing season:
1) 299, 2) 288, 3) 287

Soil
1) Sandy loam, pH 8.4
2) Sandy clay loam, pH 8.3
3) Sandy Loam, pH 8.5

Plot size
1.48 m x 10m
4 Replicates

Other factors
Tuckey had a good season.
Wudinna was good although a harsh finish.
Minnipa suffered from heat/moisture stress during flowering due to late start.
Shattering caused approximately 20% yield reduction.

Why do the trial?

To improve the profitability of oilseed crops in low rainfall areas (<400 mm) of Eyre Peninsula.

Canola has become an established opportunity crop in low rainfall areas of Eyre Peninsula with the area sown steadily increasing. These trials look at issues affecting the production of canola in the low rainfall areas of Eyre Peninsula. Trials need to continue over a number of years to gain reliable information.
This article follows on from last year's article – “Canola on Upper Eyre Peninsula in 1999” (p31-32).

How was it done?

Canola agronomy trials were established at three sites in 2000; Minnipa Agricultural Centre, Tuckey and Wudinna. Plant density trials were sown at Tuckey (Karoo) and Minnipa (Monty) using sowing rates from 1kg/ha to 8 kg/ha. A time of sowing trial at Wudinna consisted of two varieties (Karoo and Hylite) sown at varying plant densities and three sowing dates. The first sowing date was May 2nd, the second sowing on May 17 and the final sowing on June 7. Both varieties are early maturing but Hylite is about 10 days earlier than Karoo. The time of sowing trial at Minnipa consisted of ten varieties of varying maturity, conventional and triazine tolerant (TT). Minnipa had a later break than Wudinna, with the first sowing date on May 17 in very dry conditions. The second sowing was on May 31 following good rains, and the third sowing was on June 7.
Trial treatments - All trials were sown using knife points with 70 kg/ha of DAP 5% zinc with the seed and 50 kg/ha deep banded. Sowing followed a knockdown herbicide of Roundup CT® (800 mL/ha) or Spray-Seed® (1L/ha) mixed with Treflan® (1L/ha). Triazine tolerant canola had Simazine 500® (1.5 L/ha) applied immediately following sowing. Trials were sprayed with a grass herbicide and insecticides for aphids and heliothis.

Measurements - Emergence, plant vigour, flowering dates, lodging, shattering losses, yield and oil content were recorded.

What happened?

Plant density trials.
Trials on Upper Eyre Peninsula have consistently shown that canola is very capable of compensating for low plant densities. Trials comparing plant density in 2000 showed no significant yield difference between various plant densities when plots were free of weed competition. When weeds (other *Brassica species*) were present at low levels, the lower plant densities from seeding rates below 3 kg/ha yielded less. Figure 1 shows a typical yield response to sowing rate when low weed populations were recorded. This result is consistent with findings from previous trial work.

The highest plant densities had 10-15% lower plant height compared to the lowest plant densities. The lowest plant density crops were more likely to lodge because of the extra height and less plants. No difference was found in flowering patterns in 2000, however lower densities have flowered slightly longer in the past and may benefit from late rains. Oil content from last year’s trials has not yet been tested, but no difference has been found in previous trials on Eyre Peninsula and other low rainfall areas.

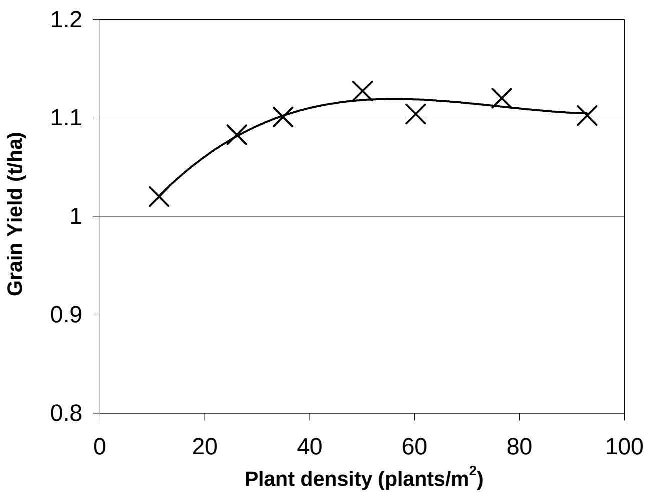


Figure 1: Yield response to plant density at Wudinna, 2000. Low levels of Brassica weeds were recorded.

Time of sowing trials
Time of sowing trials at Minnipa and Wudinna showed that sowing early increased yield. Figure 2 shows grain yields at Wudinna. After the first time of sowing yields decreased at a rate of 100 kg/ha/week for Hylite and 120 kg/ha/week for Karoo.

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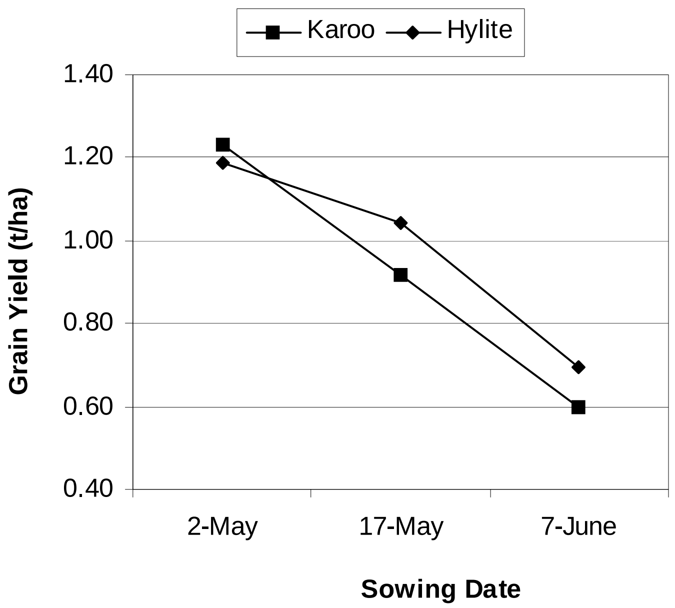

Figure 2: Effect of time of sowing on canola grain yield at Wudinna, 2000

Table 1: Grain yields from the first time of sowing and the yield reduction of each variety due to delayed sowing at Minnipa, 2000.

Variety	Yield from First sowing on 17/5 (kg/ha)	Yield Reduction due to delayed sowing (kg/ha/week)
Monty	690	65
Mystic	620	120
Oscar	590	115
Georgie	580	100
Emblem	540	85
Karoo (tt)	560	60
Hylite (tt)	520	40
Pinnacle (tt)	460	75
Drum (tt)	280	35
Bugle (tt)	240	35

(Continued from page 38)

Because Hylite is earlier maturing than Karoo, yield reduction was not as severe when sowing was delayed. The first sowing at Minnipa was two weeks after Wudinna, conditions were very dry and emergence was slow. The second sowing was in better conditions and emerged quicker. All varieties yielded highest in the first time of seeding, Yields were reduced as sowing was delayed, but at different rates, (Table 1). Conventional varieties out-yielded most TT varieties in the early time of seeding, Karoo and Hylite yielded the same as the lower yielding conventional varieties. In successive sowings, on average there was no difference between conventional and TT varieties. However the individual varieties did perform better than others in later sowings (as shown by lower yield reductions due to delayed sowing in table 1). They were Monty, Karoo (TT) and Hylite (TT).

What does this mean?

- Current recommended sowing rates of 3-5 kg/ha are appropriate for low rainfall areas. In ideal conditions 3 kg/ha is adequate, but if emergence might be reduced (*ie. rapidly drying soils*) and good weed competition is required, the higher rate should be used.
- Canola is an opportunity crop and should be grown as early as possible to maximise yield and oil content. Previous research shows that oil content is higher when grain fill occurs during cooler temperatures. Break-even yields for canola are around 0.65 t/ha on Upper Eyre Peninsula based on $320/t Pt Lincoln, therefore early sowing is essential to maximise returns and reduce risk. Recommendations not to sow canola before the fourth week in May appear to be appropriate.

Acknowledgments

I would like to acknowledge the Jason & Julie Burton and Mick & Geoff Scholz for allowing access to their properties. I also acknowledge the following:

Trent Potter, Senior Research Officer, Field Crop Evaluation, SARDI

Ingrid Kennerley, former Researcher at Minnipa.

This Project is funded by the South Australian Grains Industry Trust Fund (SAGITF).

Fertiliser Toxicity in Canola

Brendan Frischke, SARDI, Minnipa Agricultural Centre.

Location:
Minnipa Agricultural Centre

Rainfall
Av. Annual total: 326 mm
Av. GSR: 241 mm
Actual Annual total: 390 mm
Actual GSR: 299 mm

Yield
Potential: 2.8 t/ha
Actual: 0.63 t/ha (23%)

Paddock History
1999: Bt Schomburgk wheat
1998: Chemical fallow
1997: Grassy pasture

Soil
Sandy clay loam pH 8.5

Plot size
1.48m x 10m
4 Replicates

Other factors
Late start to season, high moisture/ heat stress at end of flowering, late rains causing canola to re-flower.

Why do the trial?

Conservation tillage practices using knife points are becoming more common in low rainfall areas of Eyre Peninsula. Knife points concentrate fertiliser in a narrower band than conventional sowing systems using wide shares. The aim of this trial is to determine the effect of different fertiliser rates and placement on canola emergence, yield and grain quality using no-till sowing systems.

This article follows on from last year's article – "The Effect of Nitrogen Rates Deep Banded on Yield, Quality & Profitability of Canola" (p33).

How was it done?

Two rates of phosphorus (P) and nitrogen (N) were used in combination. One combination was 40 units of N with 15 units of P, the other was a higher rate using 65 units of N and 20 units of P.

Within each combination all P was applied with the seed while the N was applied both with the seed and below the seed at different ratios. P and N rates were achieved using different combinations of DAP (18:20:0), Urea (46:0:0) and Triple super phosphate or TSP (0:20:0). Table 1 shows how this was achieved.

The trial was direct drilled with 4 kg/ha of Monty canola using knife points at 185 mm row spacing set up with double shoot boots for deep banding. Sowing on June 6 followed approximately 16 mm of rain. This was the first significant rainfall event for 2 months and the soil broke up very cloddy from sowing. This indicated that soil moisture levels were low. Although sowing was late, such conditions are common at seeding when trying to sow early. *Measurements* of emergence, vigour, early dry matter, dry matter at maturity, yield and oil content were taken.

What happened?

Emergence was significantly affected by the amount of fertiliser sown with the seed (Figure 1). Phosphorus alone with the seed reduced emergence; as nitrogen fertiliser rates with the seed were increased, emergence was further reduced. Emergence was reduced to very low levels and plots were very patchy when all nitrogen was sown with the seed.

Dry matter production at stem elongation and at maturity was not affected by fertiliser placement. Treatments with the lower plant densities produced larger more vigorous plants because of less competition between plants.

There was no significant yield response to fertiliser in 2000, with nil fertiliser yielding as well as the other treatments. Only treatments with all the nitrogen placed with the seed suffered any significant yield penalty (Figure 2). Treatments with up to 20 units of N applied with the seed did not suffer a reduction in yield, even though emergence was reduced.

Plants with the lower fertiliser rate was slightly higher yielding than those with the higher fertiliser rate when 7-15 kg/ha of N was placed with the seed, otherwise yields were similar.

Table 1: Trial treatments with various combinations of nitrogen

Fertiliser with seed	Fertiliser below seed	Total P kg/ha	Total N kg/ha	% N with seed
Nil	Nil	0	0	
75 kg/ha TSP	87 kg/ha urea DB	15	40	0%
56 kg/ha TSP & 19 kg/ha DAP	80 kg/ha urea DB	15	40	9%
38 kg/ha TSP & 37 kg/ha DAP	73 kg/ha urea DB	15	40	17%
75 kg/ha DAP	58 kg/ha urea DB	15	40	34%
75 kg/ha DAP & 58 kg/ha urea		15	40	100%
100 kg/ha TSP	141 kg/ha urea DB	20	65	0%
75 kg/ha TSP & 25 kg/ha DAP	131 kg/ha urea DB	20	65	7%
50 kg/ha TSP & 50 kg/ha DAP	122 kg/ha urea DB	20	65	14%
100 kg/ha DAP	102 kg/ha urea DB	20	65	28%
100 kg/ha DAP & 102 kg/ha urea		20	65	100%

TSP = Triple super phosphate fertiliser 0:20:0 , Urea = 46:0:0, DAP= 18:20:0

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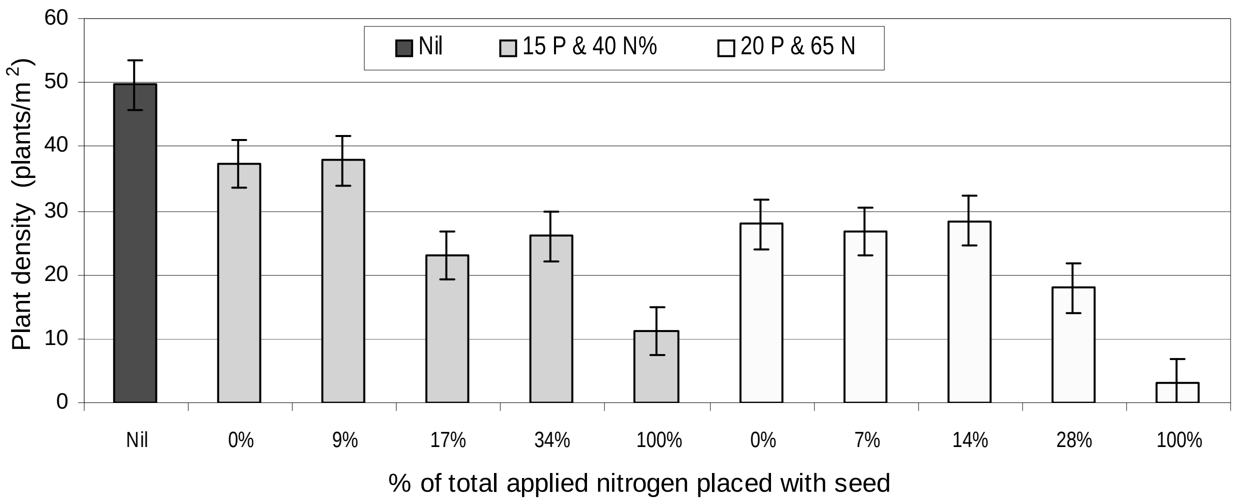


Figure 1: Plant densities of two fertiliser rates with varying amounts of the total nitrogen placed with the seed compared with no fertiliser.

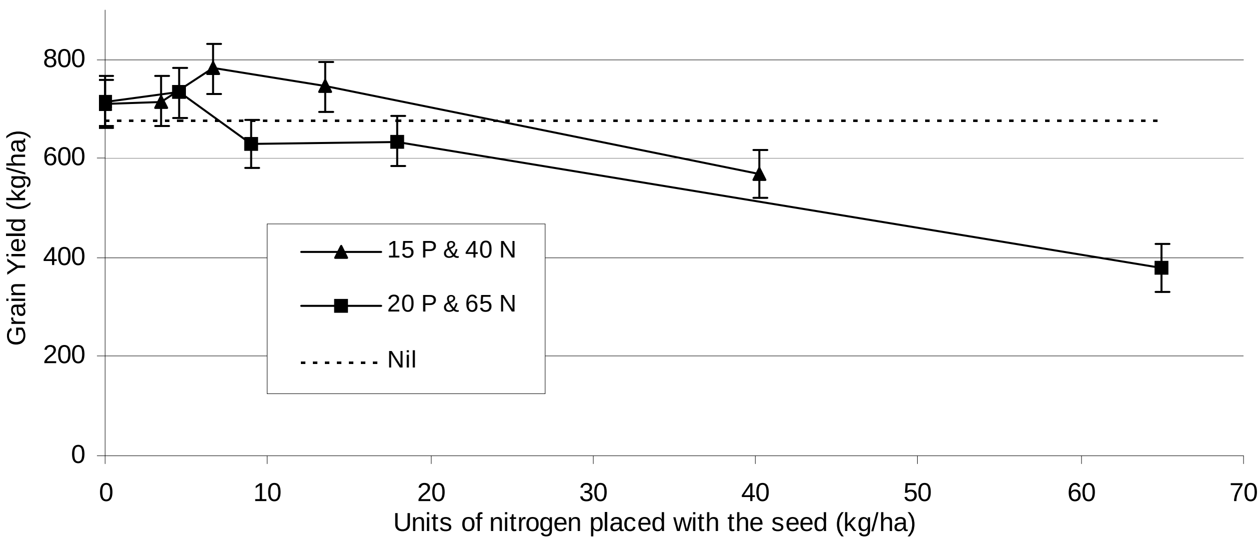


Figure 2: Grain yield response to nitrogen placement. All Phosphorus was placed with the seed. Nitrogen was sown with the seed at different rates and extra nitrogen was deep banded to maintain the total nitrogen input. Two rates of fertiliser were used.

(Continued from page 40)

What does this mean?

This trial has shown that when sowing canola with knife points, emergence is significantly reduced by moderate fertiliser rates placed with the seed. Reduced emergence does not cause lower canola yields, unless emergence is extremely poor. Other plant density trials in low rainfall areas have shown that yield is unaffected by plant densities above 15 plants/m^2 (with weeds controlled). However, good emergence levels are desirable and necessary for good weed competition and quick ground cover to protect plants from sand blasting.

When high fertiliser rates are required, application methods used depend on machinery available. While deep banding systems are the simplest because of their one pass sowing approach, they are expensive to set up and should only be considered if they are to be used for a larger cropping program than just for canola. Broadcasting after sowing and pre-drilling are two alternatives. Previous trial work has shown these methods to be effective. Reduced emergence did not effect grain yield of canola.

Acknowledgments

I would like to acknowledge the following people for input into this trial:

Trent Potter, Senior Research Officer, Field Crop Evaluation, SARDI

Ingrid Kennerley, Former researcher at Minnipa.

This Project is funded by the South Australian Grains Industry Trust Fund (SAGITF).

SA GRAIN INDUSTRY TRUST FUND
TARGETING RESEARCH

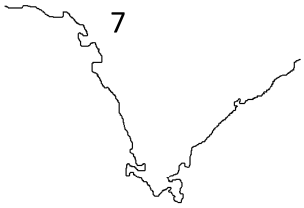
Section Three

Section Editor: Ian Creeper
SARDI, Minnipa Agricultural Centre
Pasture Researcher

Pastures

Legume based pastures remain an important part of cropping rotations in low rainfall environments. Legume based pasture can improve soil fertility and can provide a break from weeds and diseases in the following cereal crop. However intensified cropping, the use of sulfonylureas and low wool prices have led to a large area of pasture being dominated by many unpalatable and problem weeds. These weeds can create problems at seeding, reduce valuable soil nutrients and may increase disease. Research on Eyre Peninsula is currently considering ways to improve the amount of legumes in pastures through pasture manipulation, clay spreading, evaluating nodulation performance and sowing new medic and alternative legume varieties.

AusBulk



Alternative Legume Pastures for Upper Eyre Peninsula

[1]Jake Howie and [2]Ian Creeper, SARDI
[1]Pasture Group, Adelaide, [2]Pasture Researcher, Minnipa Agricultural Centre

Location:
Minnipa Agriculture Centre

Rainfall
Av. Annual total: 326 mm
Av. GSR: 241 mm
Actual annual total: 390 mm
Actual GSR: 299 mm

Paddock History
1999: Wheat
1998: Wheat
1997: Failed Canola

Soil
Sandy Loam

Why do the Trial?

The productivity of many pastures in the cropping zone is inadequate for maximum production of following cereal crops. Potential factors implicated in this poor performance include poor pasture management, inadequate nutrition, root diseases, sulfonylurea herbicide residues and changing farming systems. Alternative pasture legume species may be able to complement the role of traditional pastures by bringing with them a suite of different attributes that could be advantageous to existing and new systems.

How was it done?

Over the past three years Jake Howie, SARDI, has evaluated a number of alternative pastures legumes at Cungena and a selection was seeded at Minnipa Agriculture Centre in 2000, with a number of released and soon to be released medics.
Seeding rate: 10 kg/ha (100% germination)
Seeding date: 01/06/00
Non replicated trial

What Happened?

Herald strand medic (*Medicago littoralis*)
The main target zone for Herald strand medic is the low-to-medium rainfall (275-400mm) cereal livestock area with neutral to alkaline soil types ranging from loamy sands to loams. This variety has good resistance to both spotted alfalfa aphid (SAA) and bluegreen aphid (BGA) and a moderate resistance to cowpea aphid (CPA). It is readily distinguished from Harbinger and Harbinger AR by a distinctive dark brown leaf blotch (like Jemalong), and pods that coil in the opposite direction (clockwise). It performed extremely well and shows great potential on Upper Eyre Peninsula.

Caliph barrel medic (*M. truncatula*)
This is an early flowering barrel medic recommended for low-to-medium rainfall areas (275-375 mm) with neutral and alkaline sandy loams to clays. It has good resistance to SAA and BGA but not CPA. Caliph is an excellent herbage and seed yielder in its preferred environment. Produces high levels of hard seed and thus regenerates best after a crop (ie. not in the year after sowing). It has moderate boron tolerance and performed extremely well at Minnipa and Cowell. Being very hard seeded this variety may be an advantage in an extended cropping rotation.

Toreador (aphid resistant disc x strand medic hybrid)
Due to be released in 2001, this early flowering, disc/strand medic hybrid line combines the specific adaptability of disc medics to deeper sands over clay with good aphid resistance to BGA and low to moderate resistance to SAA. It is targeted for the low-to-medium rainfall (275-375 mm) country with sand and sandy loam soil types. It performed extremely well and flowers slightly earlier than Herald with a more determinate flowering pattern. This may be an advantage in a spray topping situation. May be well suited for use in mixtures in the dune swale land system.

Table 1: Establishment, growth score and seed yield of Medics varieties released and soon to be released.

Variety	Caliph	Toreador	Cavalier	Jester	Frontier	SA 5045	Gland	Herald	Prolific
Establishment Plants/m^2	191	267	213	164	574	259	629	388	401
Visual Score(Best = 5)	5	5	4	4	1	3	2	5	1
Seed Yield kg/ha	647	678	417	537	20	170	175	508	50

Jester (aphid resistant Jemalong)
A barrel medic hybrid line due to be released in 2001, which combines the good all round agronomic performance of Jemalong (plus the distinctive Jemalong blotch) with excellent aphid resistance to BGA and SAA. Targeted for sandy loams/clay loams receiving > 350mm rainfall. It performed well, but other medics appear to be better suited to the Minnipa environment.

Cavalier burr medic (*M. polymorpha*) - Seed will be available in 2003. This is a spineless burr medic of similar maturity to Circle Valley. Cavalier is also more productive, softer seeded and thus better suited to phase pastures. It is aphid susceptible and performed well, but other varieties may be more appropriate.

Alternative Pasture Legumes
SA5045 *(Trigonella balansae)*
This species is under nationwide evaluation. Medium maturity; high seed potential; good herbage production and compatible with background medic rhizobium bugs. It has an upright growth habit that is maintained at maturity and at least some pods are retained on plant for easy harvesting. It is fairly hardseeded. Best of the alternative pasture legumes and shows potential due to its harvesting ease. May struggle below 325 mm rainfall.

Gland clover *(Trifolium glanduliferum)*
Close to commercialisation in WA. Medium maturity (92 days to first flowers in Perth). It is targeted for areas receiving at least 350 mm rainfall. Under test nationally but appears to have very broad adaptation to a range of soil types from sands to clay loams, acid and alkaline. Excellent tolerance to redlegged earth mite. Small seeded, slow growing in winter but productive in spring. Very upright, aerial seeded. Easily harvested with a header. Performed poorly at Minnipa, producing unacceptably low early and late dry matter production.

Frontier balansa clover *(T. michelianum)*
The earliest maturing balansa clover cultivar and is targeted for 350-500 mm rainfall areas. The early season production of Frontier is often better than that of Paradana and Bolta. Frontier is softer seeded than medics and has, on occasions, demonstrated better regeneration than medics in the year after sowing. Glasshouse studies have shown Frontier to be susceptible to pasture aphids, although no significant damage has yet been observed in the field. Performed poorly at Minnipa, producing extremely low amounts of dry matter, especially early. Even with good finishing rains Frontier struggled.

Prolific persian clover *(T. resupinatum)*
Prolific Persian Clover flowers early enough to consider its use in low rainfall zones but it also performs well where rainfall is more favourable. Can be grown on soils in the pH range 5.5-8.5($CaCl_2$). Upright; aerial seeded; small seeded and can be harvested with a conventional header. Performed poorly at Minnipa, produced little dry matter early and struggled to respond to late spring rains.

Pastures typically perform best in the year of regeneration where they are able to germinate early and make full use of growing season rainfall. Could this be true for the above alternate pasture legumes? The trial will be allowed to

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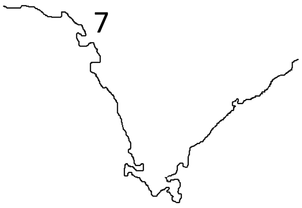

"Best Practice" - Establishing Annual Legume Pastures to Enhance Soil Fertility and Crop Yields

Ian Creeper, Pasture Researcher, Minnipa Agricultural Centre, SARDI

Location:
Wirrulla
Craig Rule

Rainfall
Av. Annual total: 300 mm
Actual annual total: 346 mm
Actual GSR: 272 mm

Paddock History
1999: Oats
1998: Wheat
1997: Pasture, grass

Soil
Calcareous sandy loam

Plot size:
10m wide strips

Why do the Trial?

The need to improve pastures in low rainfall areas with alkaline soils is extremely important, since very few rotational options are available. Annual legume based pastures provide nitrogen and disease breaks to the subsequent cereal crop and significantly reduce the risk associated with growing grain legumes. Increased intensity of cropping and low livestock returns has led to the pasture phase being neglected resulting in weedy "pastures" between crops that are low in legume content. Weedy pastures deplete valuable soil nutrients and contribute significantly to the carryover of cereal diseases.

This trial was established to record firstly the performance of the medic (2000) and secondly measure the benefits to the following cereal crop (2001) compared to current practice.

Wirrulla

How was it done?

Seeding - Two medic varieties, Herald x 3 seeding rates (3, 5 and 8 kg/ha) and Caliph x 2 seeding rates (4 and 8 kg/ha)
Sown 24th May 2000, small seeds spreader, prickle chained
Plot length – 10 m strips
Sown dry, but significant rain fell 3 days after sowing.
Spraying - Sprayed strips 28th July 2000

1. Broadstrike® @ 24 gm/ha
2. Tigrex® @ 100 ml/ha
3. LVE MCPA® @ 75 ml/ha
4. MCPA 500® @ 150 ml/ha

What Happened?

Table 1: Plant counts (plants/m^2) and medic seed yield.

Seeding Rate kg/ha	Rye Grass plants/ m^2	Ward's Weed plants/ m^2	Medic plants/m^2	Yield kg/ha	Seeding costs $/ha
Not sown	242	180	12	30	0
Herald 3 kg	286	202	104	220	$24
Herald 5 kg	302	294	172	203	$32
Herald 8kg	240	178	296	237	$44
Caliph 4 kg	162	210	96	93	$28
Caliph 8 kg	200	170	94	113	$34

Costs: seeding ($2.00/ha), seed ($4.00/kg), Correct 220ml/ha ($10)

Table 2: Wirrulla—Spray treatments for Ward's weed control

Spray treatment 28/7/00	Broadstrike 24gms/ha	Tigrex 100mls/ha	LVEMCPA 75mls/ha	MCPA Amine 150mls/ha
Cost	$13.50/ha	$2.20/ha	$0.70/ha	$0.75/ha
Comment	Suppression and some control	Poor control	Very poor control	Poor control

Refer to" Chemical control of broadleaf weeds in a regenerated medic stand" in this section for further info

Seeding rate and grain yield - Seeding rate increased emergence and initial dry matter, however seed yields were quite similar (Table 1). Competition with Ward's weed and the lack of moisture at the end of the growing season may have contributed significantly to the small seed yield differences. Herald performed considerably better than Caliph in terms of emergence, visual score and seed yield.

Control of Ward's weed - Ward's weed was a major problem at this site and where unchecked became the dominant plant. Four broadleaf herbicides were applied in strips; Broadstrike® @24 g/ha, Tigrex® @100 ml/ha, LVE MCPA® @75 ml/ha and MCPA ® @150 ml/ha (Table 2). Broadstrike® was the only chemical to provide any sort of control, but only approximately half of the Ward's weed

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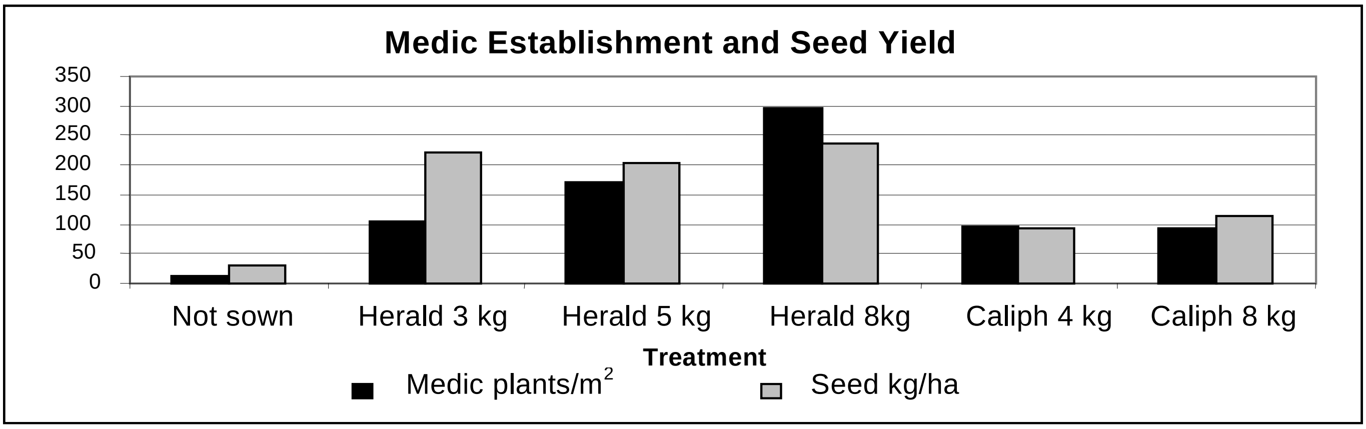

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plants were killed, with the remainder being suppressed. This is quite different to the results gained at the Piednippie trial “Chemical control of broadleaf weeds in a regenerated medic stand and the effect on medic dry matter and grain yield”. Broadstrike® at Piednippie gave very good control of Ward’s weed. This indicates that spray conditions or stressed plants may have resulted in poor control at Wirrulla.

In general, medic performed poorly even when sufficient rain fell in spring. This could be caused by the competition from Ward’s weed for moisture or some other constraint.

Penong

How was it done?

Two medic varieties, Herald and Caliph x 3 seeding rates, (3, 5 and 8 kg/ha)
Sown 16th May 2000 with small seeds spreader
Prickle chained to cover seed
Plot length – 200m x 10m
Sown after 7.5 mm rain but the prickle chaining raised dust; no effective subsoil moisture
Sprayed MCPA/diuron mix.

What Happened?

Seeding rate and seed yield

Seeding rate played an important role in dry matter and final yield at this site, especially at the higher seeding rate 8 kg/ha (Table 1). Interestingly there was very little difference in emergence between the 5 and 8 kg/ha rates for Caliph. Full emergence may not have occurred until a significant rainfall event later in the growing season. However seed yield was certainly better with the higher seeding rates for both Caliph and Herald.

Other observations

Initially there was very little grass in all of the treatments, although when significant rain fell in August, barley grass became more evident in all Caliph plots and at the low seeding rate of Herald 3 kg/ha. The extra dry matter produced in the Herald plots helped reduce barley grass numbers and/or seed set.

What does this mean?

Herald (strand medic) performed consistently better than Caliph (barrel medic) in both establishment and seed yield. Herald has performed well in past variety trials on Upper Eyre Peninsula and is a replacement for Harbinger and Harbinger AR. The main target zone for Herald strand medic is the low-to-medium rainfall (275-400 mm) cereal livestock area with neutral to alkaline soil types ranging from loamy sands to loams. It is readily distinguished from Harbinger and Harbinger AR by a distinctive dark brown leaf blotch and pods that coil in the opposite direction (clockwise).

Note. Due to the cost of seed it is difficult to recommend seeding rates of 8 kg/ha in low rainfall areas and a rate of 5 kg/ha would be more reasonable. Dry matter production would be reduced, especially early dry matter, but if managed correctly satisfactory seed yields can be expected. Seed yield is an important factor in the success of subsequent medic stands.

Note: Cost of seeding should be spread over the life of the pasture, which includes regeneration in the crop-pasture rotation.

Table 1: Results of variety and seeding rate trial at Penong

Variety and Seeding Rate	Plants/m^2	Visual score 1 – 5 (5 = best)	Seed Yield kg/ha	Cost/ha
Not sown	0	1	0	$5
3kg Herald	220	3	155	$19
5kg Herald	304	4	168	$27
8kg Herald	350	5	228	$39
3kg Caliph	98	2	94	$19
5kg Caliph	162	3	93	$27
8kg Caliph	168	3	211	$39

Acknowledgments

This work is funded by GRDC and would not have been possible without the cooperation of Craig Rule and Sean Freeman.

Location
Charra
Penong
Sean Freeman
Charra Ag Bureau

Rainfall
Av. Annual total: 312.5 mm
Actual annual total: 300 mm

Paddock History
1999: Oats (not reapt)
1998: Wheat

Soil
Calcareous sandy loam

Plot size
200 X 10m not replicated

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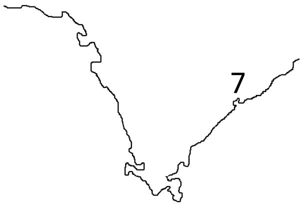


Determining Best Practice for Establishing Medic

Ian Creeper, Pasture Researcher, Minnipa Agricultural Centre, SARDI

Location:
Cowell
Steve Edwards
Franklin Harbour Ag Bureau

Rainfall
Av. Annual total: 285 mm
Av. GSR: 205 mm
Actual annual total: 256 mm
Actual GSR: 185 mm

Paddock History
1999: Canola
1998: Barque Barley
1997: Pasture, spray topped

Soil
Red sandy loam

Plot size
1.5m x 10m

Why do the Trial?

With the adoption of reduced tillage and the move towards continuous or at least intensified cereal cropping the need for a grain legume break crop has increased. However in many low rainfall areas the risk associated with growing grain legumes has led to medic having an extremely important role in providing the break for following cereal crops. This was the case for the Franklin Harbour region as peas, the only grain legume option, failed in many cases to be profitable and canola was seen as an opportunity crop. Discussions with the Franklin Harbour Ag Bureau led to a small plot trial in which the best practice of establishing medic would be determined.

How was it done?

Trial 1: Seeding rate (3 & 5 kg/ha) x Variety (Herald, Caliph and Parabinga), and Lucerne @ 5 kg/ha
Trial 2: Using Herald sown at 5 kg/ha as a standard, other inputs were examined including inoculating vs not inoculating, phosphorus vs nil phosphorus.
All treatments were compared to a control – natural pasture
Sowing date: 15th May 2000
Combine, 7 inch spacing, spear points, followed by harrows.

Table 1: Results of comparison of seeding rate, variety, other inputs, lucerne and natural pasture.

Treatment	Cost $/ha	Emergence	Visual Score (5 = best)	Seed Yield kg/ha
8kg/ha Herald	$42.70	200 a	5	341 b
5kg/ha Herald	$30.70	154 abcd	4	303 b
3kg/ha Herald	$22.70	115 def	3	327 b
5kg/ha Caliph	$30.70	100 ef	4	524 a
3kg/ha Caliph	$22.70	82 ef	2	301 b
5kg/ha Parabinga	$26.45	130 bcde	3	274 b
3kg/ha Parabinga	$20.15	129 cde	3	321 b
5kg/ha Herald - not inoculated	$29.70	180 ab	4	298 b
5kg/ha Herald inoculated	$30.70	182 a	4	358 b
5kg/ha Herald inoculated + Triple super (50kg/ha)	$49.70	95 ef	4	329 b
Natural Pasture	$0	4.5 f	1	84 c
Lucerne		74 g	2	0 c

Costs: knockdown ($7.20/ha), seeding ($2.50/ha), seed ($3.15-$4.00/kg), inoculation ($1/ha) and triple super @ 50kg/ha ($19/ha)

What Happened?

Seeding rate and variety on emergence

Seeding rate of Herald had a significant effect on plant emergence, especially between the lower rate (3 kg/ha) and the higher rates (5 & 8 kg/ha), and dry matter production was visually better with the higher seeding rates (Table 1). However, this was not observed in seed yield where there were no significant differences. This could be due to, medic dry matter production increasing, resulting in less seed set, or because water became a limiting factor at flowering, later in the season.
Strangely no significant differences in emergence were recorded with the seeding rates of Caliph and Parabinga, although Caliph at 5 kg/ha produced the highest seed yield of all treatments in the trial. Dry matter scores for Caliph at 5 kg/ha were better than for the lower seeding rate and for both seeding rates of Parabinga.

Inoculating vs Non Inoculating

Inoculating had no significant effect on emergence, plant growth or final grain yield. Root examination showed effective nodules on both the inoculated plants and the non-inoculated plants. This suggests that the rhizobia needed to effectively induce Herald (*Medicago littoralis)* to nodulate was present in the soil.

Phosphorus

Application of phosphorus reduced medic plant emergence significantly. This is difficult to explain as 50 kg/ha of triple super is unlikely to cause seedling toxicity. Final seed yield was equivalent to other treatments and shows the ability of medic to compensate with reduced plant emergence.

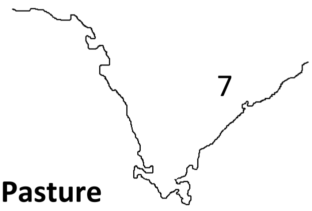
What does this mean?

The results suggest that sowing rate had little impact on final seed yield in 2000 at Cowell, and it may be possible to reduce seeding rate and therefore costs if conditions suit (ie. little competition from weeds, good growing conditions, early start). However dry matter will be reduced, especially in terms of early plant growth. Observations suggest the higher the seeding rate, the higher the eventual dry matter production. In many situations inoculation may not be required although it is good insurance to inoculate, especially if sowing in wet conditions. If sowing dry then inoculation would be unnecessary and a satisfactory level of nitrogen fixation should still occur. (refer to *Nodulation of Medic at Cowell and other Upper Eyre Peninsula Sites*, in this section).

Acknowledgments

This work is funded by GRDC, and would not have been possible without the cooperation of the Franklin Harbour Agricultural Bureau and Steve Edwards, Mitchellville.

Nodulation and N-fixation of Herald Medic with Rhizobia from EP Soils



Ross Ballard & Nigel Charman, SARDI Pasture Group, Adelaide and Ian Creeper, Pasture

Why do the Trial?

Medic in the cropping rotation provides a disease break to the following cereal crop, an opportunity to control grasses and importantly can contribute a significant amount of nitrogen to the soil. However, some farmers have reported poor nodulation and that the nodules have appeared to be ineffective (nodules green or white). This has led to speculation that the root nodule bacteria (rhizobia) may not be up to the job. The Cowell Agricultural Bureau had noticed this to be the case in their area. Several soils were subsequently collected and their rhizobial status determined to address these concerns.

How was it done?

Both the presence and the effectiveness (ability to fix nitrogen) of the medic rhizobia was assessed.

1. Assessing if suitable medic rhizobia are present

Specific medic rhizobia are needed in the soil for medics to form nodules that fix nitrogen. Soil samples were collected from Cowell and other Eyre Peninsula sites. Plants grown in the soils were assessed for nodules and the number of rhizobia estimated in a number of the samples.

2. Assessing the effectiveness of the rhizobia

The effectiveness of the rhizobia in some of the soils was assessed. The growth of plants with soil rhizobia was compared to the growth of plants inoculated with a highly effective inoculation treatment. Where the plants with soil rhizobia achieved 80% of the effective inoculation treatment, the soil rhizobia were considered to be very effective at fixing nitrogen.

What Happened?

All samples, with the exception of the Wirrulla Scrub paddock, had sufficient naturalised rhizobia (av. 7000/g of soil) to form nodules on Herald medic. The ability of these rhizobia to fix nitrogen varied significantly between soils, ranging from 100% with a Wirrulla soil to only 15% with the Penong soil. Despite this variation the rhizobia in 6 of the 8 soils appear more than adequate in their ability to fix nitrogen. Although this study is based on a very small number of samples, it is worth noting that the findings are supported by some soon to be published, and more detailed work, by John Brockwell of CSIRO.

Location of soil sample	Rhizobia present (yes/no)	Effectiveness %
Franklin Harbour 1	Yes	80
Franklin Harbour 2	Yes	Not Assessed
Franklin Harbour 3	Yes	Not Assessed
Wirrulla	Yes	100
Penong	Yes	15
Haslam	Yes	65
Wirrulla – Scrub	No	Not Assessed
Cungena 1	Yes	47
Kyancutta	Yes	80
Minnipa	Yes	80
Cungena 2	Yes	67

What does this mean?

The high levels (7000/g of soil) of naturalised rhizobia indicate that there will be few responses (improved symbiosis) to introduced rhizobia (i.e. as inoculated seed). As a rule of thumb responses to inoculation are rarely seen where there are more than 100 rhizobia per gram of soil. Having said this, farmers should look at paddock histories to guide decisions on inoculation. Where there is no recent history of nodulated medic (eg the Wirrulla Scrub paddock) or soil pH falls below 7, inoculation is still a good strategy and strongly recommended..

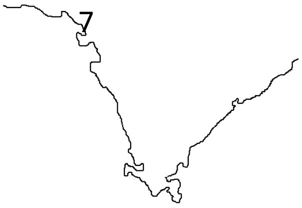
The question arises as to how these findings (plenty of rhizobia which are generally effective) tally with the farmer observations of nodules which were a green colour. Green coloration (a breakdown product of the nitrogen fixation apparatus) is generally an indication that the nodules have been fixing nitrogen, but stresses on the plant have impeded the process. These stresses might include the effect of herbicides, poor environmental conditions such as drying soil, and diseases. This study did not consider any of these factors or their effect on the symbiosis.

In Summary

- Eyre Peninsula soils generally contain large numbers of naturalised medic rhizobia.
- These rhizobia are generally effective with Herald strand medic. However, their effectiveness can vary significantly from one location to the next.
- Inoculation is unlikely to improve symbiosis in most situations, but paddock history and soil pH should be considered carefully before deciding not to inoculate.
- Reports of poor nodulation are more likely to be caused by interactions with other factors which may stress the plant, such as herbicides and diseases. It does not appear to be simply associated with either the presence or effectiveness of rhizobia in the soil.
- Remember: Effective nodules that are fixing nitrogen are pink. Nodules that have in the past, but are not currently fixing nitrogen may appear green. Ineffective nodules are white and usually small (size of a pin-head)
- A note of caution. Different legumes need different rhizobia. These results only apply to Herald strand medic and are based on a small sample set. Similar responses can not be assumed to apply to other regions or for other legume species.

Acknowledgments

The support of Eyre Peninsula farmers who allowed us to collect soil samples from their properties is greatly appreciated.



Broadleaf Weed Control in a Regenerated Medic

Ian Creeper, Pasture Researcher, Minnipa Agricultural Centre, SARDI and **Andy Bates,** AWB (formerly, PIRSA Rural Solutions)

Location:
Streaky Bay
Cactus Feltus

Rainfall
Av. Annual total: 330 mm
Av. GSR: 260 mm
Actual annual total: 360 mm
Actual GSR: 270 mm

Paddock History
1999: Pasture
1998: Wheat
1997: Pasture

Soil
Grey calcareous sandy loam

Plot size
2 X 10m X 3 reps

Why do the Trial?

Broadleaf weeds, if unchecked, can significantly reduce medic production and seed set. This can result in a paddock being dominated by unpalatable weeds, reducing possible stocking rates and causing problems when sowing the following cereal crop. Cheap, effective and easy to manage options for the control of broadleaf weeds in a medic stand are limited and often result in unacceptable damage to the pasture legume. Common broadleaf weeds on Upper EP include Ward's weed, wild turnip, capeweed, Lincoln weed and onion weed. This trial was established to examine some of the common broadleaf weed control sprays, how well they control the weeds, and the effect they have on dry matter production and seed yield of medic.

How was it done?

Piednippie was selected as a suitable site as it had an excellent stand of medic and contained an even stand of Ward's weed, Lincoln weed and grass.

Trial details: Nine broadleaf spray treatments were applied to an actively growing medic stand on the 1st August (temp 20 °C). A common grass selective herbicide Targa®, was applied separately to all nine treatments. Water rate was constant over all treatments at 50 L/ha. Dry matter cuts were taken on the 25th September and seed was harvested on the 15th November. Visual assessment and weed counts were undertaken on the day of dry matter cuts.

What Happened?

Lincoln weed control

No chemical treatments had a significant effect on the control of Lincoln weed. Suppression (reduced growth and flowering) was noticed for the Broadstrike® 24 g/ha and MCPA 500® treatments.

Ward's weed control

Total control of Ward's weed was achieved using Broadstrike 24 g/ha and MCPA 500® at 350 ml/ha. Significant control was achieved using lower rates of MCPA 500®. All other treatments gave poor to very poor

(Continued on page 51)

Table 1: Effectiveness of Spray treatments on Lincoln weed, Wards weed and on medic dry matter and seed yield

Treatment	Weeds/m²		Visual Assessment of Weed Control			
	Lincoln Weed Plants/m²	Wards Weed Plants/m²	Lincoln Weed	Ward's Weed	Dry matter t/ha	Seed Yield kg/ha
350ml/ha MCPA 500 + Targa 200ml/ha $13.80/ha	2.13	0.00 d	Poor	V. Good	1.32 c	484 c
250ml/ha MCPA 500 + Targa 200ml/ha $13.25/ha	2.40	0.13 d	Poor	Good	1.32 c	488 c
150 ml/ha MCPA 500 + Targa 200ml/ha $12.75/ha	2.93	0.33 cd	Poor	Poor	1.68 bc	558 bc
LVE Ester 85ml/ha + Targa 200ml/ha $12.75/ha	1.67	1.07 b	V. Poor	V. Poor	1.60 bc	588 b
300ml/ha MCPA 250 + Targa 200ml/ha $13.20/ha	1.53	0.47 cd	V. Poor	Poor	1.53 c	602 b
400ml/ha MCPA 250 + Targa 200ml/ha $13.60/ha	2.27	0.77 bc	V. Poor	Poor	1.45 c	601 b
Tigrex 120ml/ha, water, Oil + Targa 200ml/ha $14.50/ha	1.67	0.40 cd	V. Poor	Poor	1.81 bc	554 bc
NIL	2.53	2.87 a	V. Poor	V. Poor	2.73 a	348 d
Zinc Sulphate 2l/ha, 250ml/ha MCPA 500 + Targa 200ml/ha $14.65/ha	1.13	0.13 d	Poor	Good	1.53 c	596 b
Broadstrike 24g/ha + Targa 200ml/ha $25.50/ha	2.07	0.00 d	Poor	V. Good	2.36 ab	693 a
		LSD 0.75			LSD 0.43	LSD 96

Note: Control of weeds can vary from one year to the next depending on time of application, plant stresses etc. Results should be taken as a guide only.

(Continued from page 50)
control.

Dry matter production and seed yield

The nil weed control treatment provided the highest dry matter (2.53 t/ha), but the plot was dominated by grass which resulted in the plot having the lowest medic seed yield (348 kg/ha). Furthermore a pasture dominated by grass would not provide a disease break to the following cereal crop.

Essentially there are four chemical treatments worth discussing in terms of their effect on medic dry matter and seed yield, since other treatments provided poor control of weeds.

- Broadstrike @ 24 g/ha, and MCPA 500 @ 350, 250 and 150 ml/ha
- Broadstrike is recommended for the control of certain broadleaf weeds in medic based pastures. This was observed to be the most effective chemical and had the highest medic dry matter (2.36 t/ha) and final seed yield (693 kg/ha).
- MCPA 500 also provided good control of Ward's weed, but dry matter production and seed yields were significantly reduced.
- MCPA 500 @ 350 ml/ha reduced dry matter by 44% and grain yield by 30% compared with Broadstrike.
- MCPA 500 @ 250 ml/ha reduced dry matter by 44% and grain yield by 29.5% compared with Broadstrike.
- MCPA 500 @ 150 ml/ha reduced dry matter by 29% and grain yield by 19.5% compared with Broadstrike.
- MCPA 500 @ 250 ml/ha plus zinc sulphate 2 l/ha reduced dry matter by 35% and seed yield by 14% compared with Broadstrike.

What does this mean?

Grasses were the most dominating weeds in the trial, and when uncontrolled severely hindered medic dry matter production and reduced seed yields by as much as 50%. Further, grassy pastures could potentially lead to disease being a problem in the following cereal crop.

Secondly, a grass selective herbicide in combination with a broadleaf weed control herbicide led to dramatic differences in medic production and seed yield. High medic production and seed yields were obtained using Broadstrike + Targa. However the cost of Broadstrike ($13.50/ha) has led to reduced use by farmers. Using a less expensive chemical such as MCPA 500 @ 350 ml/ha ($1.80) certainly helped reduce Ward's weed, but the effect on medic was enormous, reducing production by as much as 44%. In pasture dominated by Ward's weed but with a good stand of medic it is certainly worth while considering the use of Broadstrike.

Acknowledgments

Thanks to Cactus Feltus for allowing the trial to be conducted on his property.

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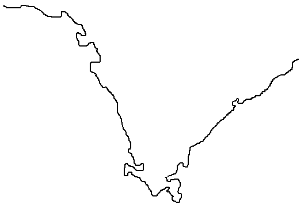


Sulfonylurea Tolerant Medic

John Heap and Jake Howie, SARDI, Adelaide

Why do the Trial?

Annual medics are highly susceptible to residues of sulfonylurea (SU) herbicides (≥0.25 parts per billion) resulting in severe stunting, reduced dry matter production, seed yields, persistence, and N fixation. There is also an increase in seedling mortality, and susceptibility to root diseases and nutrient and moisture stresses.

The cost of controlling problem weeds, especially Lincoln and onion weed, has lead to SU herbicides being commonly used in low rainfall areas and has helped play a part in the poor regeneration and production of previously good medic stands. An SU tolerant medic would certainly help to reverse this trend and could lead to a more sustainable and profitable farming system especially in the low rainfall regions.

How was it done?

The new line, "FEH-1", was bred from Herald using mutation breeding by John Heap (SARDI) and Chris Preston (CRC for Weed Management Systems) as part of a GRDC-funded project.

What Happened?

A new line of strand medic with increased resistance to soil residues of sulfonylurea (SU) herbicides is being evaluated for potential release. FEH-1 has useful levels of resistance to chlorsulfuron (e.g. Glean®), metsulfuron-methyl (e.g. Ally®) and triasulfuron (e.g. Logran®). FEH-1 also has increased resistance to some other Group B herbicides, including Spinnaker®. In a preliminary field experiment FEH-1 was not affected by low levels of soil residues (Glean® and Logran®), while Herald was severely stunted.

What does this mean?

Potential benefits of the mutant line include:

- Increased dry matter production and thus N fixation, in the presence of SU residues.
- Increased seed yields, soil seed reserves, regeneration, and thus persistence.
- More vigorous root systems resulting in:
  - better nodulation and thus N fixation
  - increased tolerance of root diseases such as Rhizoctonia and Pratylenchus
  - increased ability to extract soil moisture and nutrients
- enhanced ability to take advantage of the residual weed control of SU herbicides
- potential to systemically control broomrape with applications of Spinnaker®

Future work will include confirmation of the preliminary results with more field trials, especially on calcareous soils. FEH-1 appears to be identical to Herald, except for herbicide resistance, but its agronomic performance and morphological consistency with Herald need to be further tested.

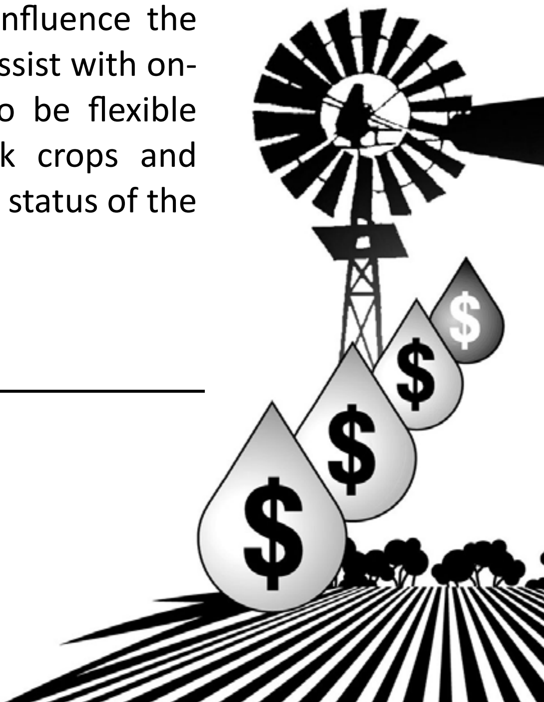
Provisional PBR has been granted for FEH-1. Although not a genetically modified organism (GMO), consultation will need to be undertaken with various interest groups before its release could be considered. If approved, not only could this particular line be released directly, but it could also be used in the medic breeding program to generate SU tolerant hybrids of species other than strand medic.

Section Four

Section Editor: Jon Hancock
SARDI, Minnipa Agricultural Centre
Farming Systems Researcher

Rotations

Choice of rotation is one of the most important management issues for a profitable and sustainable farming system. Rotations need to be designed to maximise all opportunities for generating income while, at the same time, ensuring that they are sustainable and robust enough to carry the farming operation well into the future. There are some major factors that need to be taken into account when making decisions about rotations, including profitability, risk, disease and nutrition. These major issues need to be considered in conjunction with other factors such as soil type, rainfall, available machinery and labour inputs. This section attempts to outline how different crop sequences influence the farming system and to provide information that will assist with on-farm decision making. Ultimately, rotations need to be flexible with a particular emphasis on profitable, low risk crops and choices should reflect the current disease and fertility status of the paddock.



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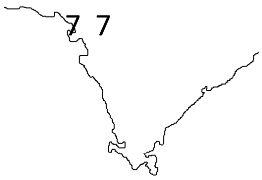

Long Term Rotation, Tillage and Stubble Handling Comparison

Jon Hancock, SARDI, Minnipa Agricultural Centre

Locations
Cungena: M & K Tomney,
Minnipa: Minnipa Ag. Centre
Rainfall
Cungena
Av. Annual total
(1995 to 2000): 307 mm
Av. Growing season
(1995 to 2000): 253 mm
Minnipa
Av. Annual total
(1995 to 2000): 318 mm
Av. Growing season
(1995 to 2000): 248 mm
Wheat Yield
Cungena Potential
(1995-2000): 2.46t/ha
Cungena Actual
(1995-2000): 1.20t/ha
Minnipa Potential
(1995-2000): 2.77t/ha
Minnipa Actual
(1995-2000): 1.44t/ha
Soil
Cungena: Highly calcareous grey sand
Minnipa: Moderately calcareous red loam
Diseases
CCN, Rhizoctonia, Take-all
Plot size
Cungena – 36m x 1.7m
Minnipa – 18m x 1.7m

Why do the trials?
The trials aim to evaluate the long-term impact of rotation, tillage and stubble on the profitability and sustainability of farming on Upper Eyre Peninsula.

This article updates the results of this trial so far and follows on from last year's article on page 38 of the 1999 Eyre Peninsula Farming Systems Summary.

How was it done?
In 1994, two trials were set up to investigate the long-term impact of different farming practices. The trials are situated on a highly calcareous grey sand at Cungena and on a moderately calcareous red sandy loam at the Minnipa Agricultural Centre. The current management of the trials is summarised in Table 1. In recent years, some of the varieties have been updated to promote the success of each crop.
Pastures were initially sown with a mixture of Caliph, Harbinger and Parabinga and have been allowed to regenerate since. Pastures grown prior to wheat had the grasses removed (GF pasture) and all other pastures were spray topped (ST pasture).

Table 1. The crop variety, fertiliser type and sowing rates currently used in the trial.

Crop	Variety	Seeding Rate (kg/ha)	Fertiliser	Rate (kg/ha)
Wheat	Excalibur	65	10:22	60
Barley	Barque	50	10:22	60
Triticale	Tahara	100	10:22	60
Oats	Potoroo	50	10:22	60
Peas	Parafield	105	10:22	70
Vetch	Languedoc	45	10:22	70
Canola	Monty	4	18:20	100
			Urea	40
Mustard	CSIRO6	4	18:20	100
			Urea	40

The trials currently contain 7 established rotations at Cungena and 8 established rotations at Minnipa. Each phase of each rotation has been sown since 1994. These rotations are:
- Pa/Pa/W/Ce[1]
- Pa/W/B
- Pa/W
- Pa/Pa/W (Cungena only)
- Pe/W/B
- C/W/B/Pa (Minnipa only)
- M/W/B/Pa (Minnipa only)
- Pa/Pa/W/O
- Le/W/Ce[2]

Pa = Pasture, W = Wheat, B = Barley, Pe = Peas, C = Canola, M = Mustard, O = Oats, V = Vetch, Ce[1] = Cereal (generally barley but wheat at Cungena since 1999), Le = Legume (Vetch or Peas) Ce[2] = Cereal (Barley or Triticale)

Each rotation has three tillage treatments which are:
- Conventional cultivation – two workings prior to sowing
- Minimum tillage – one working prior to sowing
- Direct drill – sown after knockdown herbicide application

Cultivations were carried out with 15 cm wide shears and all plots were sown with Super Seeder® points. The direct drill plots have consistently been sown about a week earlier than the conventional and minimum till plots.

Each rotation has two stubble treatments, stubble retained and stubble removed.

What Happened?
This summary does not include any data from 1994 as this was the first year of the trial and crops were not in an established rotation. In 1998, crops at Cungena were sown too late to reflect district performance and so yield data from 1998 is excluded. In 1999, several of the rotations at Cungena were modified to better reflect the needs of farmers. These rotations now incorporate wheat on wheat and continuous cereal but are omitted from this summary as they cannot yet be used to make valid comparisons.

Yield
Wheat yield has not been significantly different between any of the rotations trialed at either site (Table 2). Wheat has continued to be as good after well managed pasture as after pulse or oilseed crops.

Direct drilling has significantly improved wheat yield at Cungena, increasing the average wheat yield by 77 kilograms per hectare over conventional cultivation since

(Continued on page 55)

Table 2: Wheat yield (t/ha) when grown in different rotations at Cungena (95-97,99-00) and Minnipa (95-00).

Rotation	Cungena (95-97,99-00)	Minnipa(95-00)
Pa/Pa/W/Ce	1.14	1.40
Pa/W/B	1.23	1.49
Pa/W	1.10	1.43
Pa/Pa/W	1.32	-
Pe/W/B	1.20	1.42
C/W/B/Pa	-	1.41
M/W/B/Pa	-	1.38
Pa/Pa/W/O	1.28	1.53
Average	1.20	1.44
lsd	0.22	0.16

Table 3: Influence of tillage practice on average wheat yield (t/ha) at Cungena (95-97,99-00) and Minnipa (1995 to 2000).

	Cungena	Minnipa
Conventional cultivation	1.17	1.44
Minimum tillage	1.20	1.44
Direct drill	1.24	1.46
lsd	0.40	0.34

Table 4. Average crop yield and economics of the different crops grown at Cungena (1995 to 1997, 1999 to 2000) in a district practice scenario.

Crop	Average Grain Yield (t/ha)	Income ($/ha)	Expenses ($/ha)	Gross Margin ($/ha)
Wheat	1.20	219	95	124
Barley	1.25	174	95	79
Oats	1.01	117	77	39
Triticale	0.96	117	88	29
Peas	0.44	103	145	-42
GF pasture	-	10	15	-5
ST pasture	-	10	5	5

Table 5: Average Crop Yield and Economics of the different crops grown at Minnipa (1995 to 2000) in a district practice scenario.

Crop	Average Grain Yield (t/ha)	Income ($/ha)	Expenses ($/ha)	Gross Margin ($/ha)
Wheat	1.44	264	100	163
Barley	1.62	227	102	125
Oats	1.36	156	84	72
Triticale	1.33	163	95	68
Peas	0.86	201	154	48
Canola	0.51	172	126	46
Mustard	0.44	151	124	27
Vetch	0.58	152	119	33
GF pasture	-	20	15	5
ST pasture	-	20	5	15

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1995 (Table 3). This effect has been less pronounced at Minnipa where the influence of tillage has not had a significant impact on the average long term wheat yield.

Stubble has not significantly affected crop emergence, growth or yield at either site.

Profitability

The most important factor to consider when making rotation decisions is profitability. As these trials have been in operation for six years, an accurate account of relative profitability can be achieved through comparing their gross margins averaged over the time of the trial. Gross margins were calculated for each plot in each year using actual plot data. Commodity prices were averaged over the time of the trial (1994 to 2000) and used in each gross margin to minimise the confounding affect of price variability between years. For the purpose of these gross margins, historical estimated silo returns (ESR's) for wheat were assumed to be equivalent to the current ESR under the harvest payment scheme. The current fees and levies were deducted from the average grain prices and the Golden Rewards system of payment was applied for wheat with premiums or discounts given for the protein and screenings content of the grain. Mustard, which doesn't have a market yet, was given the same price as canola, and pastures which were not grazed were given values of $10/ha and $20/ha for Cungena and Minnipa respectively. The GST was taken into account during the construction of the gross margins and the bottom line of each gross margin is given GST exclusive.

A valid comparison was created through constructing two sets of gross margins. In one, costs were attributed to the actual management of the trial and in the other, to a typical management practice used in the district. This has been done as the large number of plots in this trial and the associated limitations has meant that the most cost effective chemicals have not always been used. The overall profitability of the different crops grown can be seen in Tables 4 and 5.

At Cungena, the Pa/W/B rotation was more profitable than the Pe/W/B rotation in the long-term (Figure 1). Although peas are one of the more profitable break crop options for this area (refer to last year's article), they have still resulted in a net cost to the system, with an average loss of $42/ha. Good pasture management comes at a much lower cost than this (approx. $15/ha for grass removal and approx. $5/ha for spray topping) and as pastures are still able to provide similar cereal yields in the subsequent two years, Pa/W/B had the superior gross margin. Rotations having fewer years of cereals tended to be less profitable. However it is interesting that Pa/Pa/W was very similar in long term profitability to Pa/Pa/W/Ce. While the intensity of cropping is low in the Pa/Pa/W rotation, it had a higher average wheat yield than the Pa/Pa/W/Ce rotation (1.32t/ha *vs* 1.14t/ha respectively) which created a similar overall gross margin. The Le/W/T rotation was the poorest performer in the long-term at Cungena. Vetch was grown in this rotation from 1995 to 1998 when it was replaced by peas. In the years vetch was grown, it incurred an average yearly loss of $78/ha and these large losses considerably reduced the overall gross margin.

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At Minnipa, peas were more profitable in the long-term (average GM of $45/ha) than pastures (estimated GM of $20/ha). This gave peas a distinct rotation advantage over pasture, hence the gross margin of the Pe/W/B rotation was greater than that of Pa/W/B (Figure 2). The other rotation dominated with cereals, V/W/T, had a similar overall gross margin to that of Pa/W/B. Vetch returns at Minnipa have been more profitable in the long-term than pasture (Table 5), but in each year that Triticale has been grown (1997 to 2000), its average gross margin return has been below that of barley ($67/ha vs $119/ha respectively for 1997 to 2000). Rotations incorporating only 50% cereals had lower gross margins, with variations being attributed to the type of cereal present in the rotation and the profitability of the break crop component.

Gross margins were also averaged between the different tillage and stubble treatments (Tables 6 and 7). Overall, there were no substantial differences between stubble treatments but minimum tillage generally out-performed the conventional and direct drill treatments. This was primarily due to the extra cost of cultivation associated with conventional cultivation and the extra cost of the knockdown herbicide associated with direct drilling.

Figure 1: The economics of growing various rotations at Cungena (1995 to 1997, 1999 to 2000)

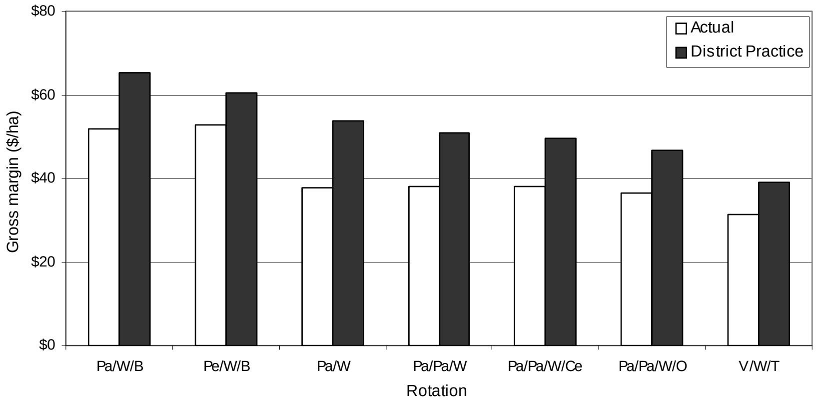
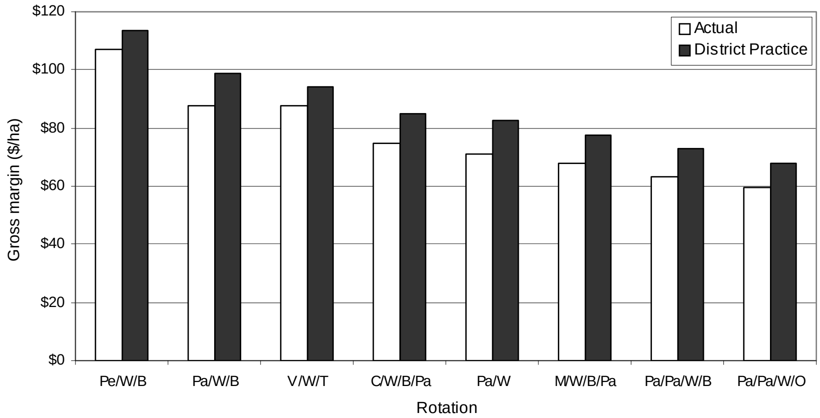


Figure 2: The economics of growing various rotations at Minnipa (1995 to 2000)



The gross margins provide good comparisons between different crops, rotations and management practice by taking into account the income and variable costs directly attributable to the crops within each rotation. It is important to realise that they do not take into account capital costs or risk which may vary with different management practices and rotation types.

Disease

Throughout the time of the trial, wheat plant roots have been scored for Cereal Cyst Nematode, Common Root Rot, Rhizoctonia and Take-all. Scores were given on a scale of 0 to 3 and while scores have generally been low, some interesting trends have emerged.

Cereal Cyst Nematode

The average root scores for cereal cyst nematode (CCN) in the different rotations are shown in table 8. For the majority of rotations, CCN levels have been low. However root scores were higher in the Pa/W rotation at both sites (although only significant at Cungena). This rotation only has a one year pasture break between susceptible crops and as a two year break is required for CCN control, a higher incidence of CCN has occurred in this rotation at both sites.

Table 6: Average gross margins for different tillage and stubble treatments over all rotations at Cungena (1995 to 1997, 1999 to 2000) in a district practice scenario.

Stubble Practice	Stubble removed			Stubble retained		
Tillage Practice	CC	MT	DD	CC	MT	DD
Total Income ($/ha)	112	117	122	116	118	118
Total Expenses ($/ha)	66	65	72	67	65	71
Average GM ($/ha)	46	52	51	49	53	47

Table 7: Average gross margins for different tillage and stubble treatments over all rotations at Minnipa (1995 to 2000) in a district practice scenario.

Stubble Practice	Stubble removed			Stubble retained		
Tillage Practice	CC	MT	DD	CC	MT	DD
Total Income ($/ha)	163	169	169	163	164	167
Total Expenses ($/ha)	78	76	83	78	76	83
Average GM ($/ha)	85	92	85	84	88	84

Table 8. Average root scores for CCN (0-3) at Cungena and Minnipa for 1996 to 2000.

Rotation	Cungena	Minnipa
Pa/Pa/W/B	0.073	0.015
Pa/W/B	0.041	0.013
Pa/W	0.506	0.051
Pa/Pa/W	0.089	-
Pe/W/B	0.043	0.000
C/W/B/Pa	-	0.019
M/W/B/Pa	-	0.007
Pa/Pa/W/O	0.096	0.029
Le/W/Ce	0.094	0.006
LSD (P<0.05)	0.238	0.045

Rhizoctonia

The incidence of Rhizoctonia has been significantly influenced by tillage practice at Minnipa, where reduced tillage resulted in a higher level of Rhizoctonia infection in the roots of wheat plants. There was not a significant difference at Cungena (Table 9). Tillage is able to break up Rhizoctonia when it is actively growing through the soil which will reduce the inoculum and subsequent level of infection in the crop. While the level of Rhizoctonia was higher in direct drill plots, these plots were able to grow through the disease and maintain yields similar to other tillage treatments.

Take-all

The level of Take-all infection on wheat plants was found to be influenced by rotation and tillage (Tables 10 and 11). Reduced tillage has tended to increase Take-all infection in wheat plants. Pulse and oilseed crops were found to reduce Take-all inoculum more than a pasture. The timing of grass (host plant) control and the length of the break until the following crop varies between these rotation types. The pulse and oilseed crops had grass control from sowing time but grass control in pastures occurred later in the season allowing some early build up of Take-all thereby reducing the effectiveness of the break.

Table 9: Influence of tillage practice on the incidence of rhizoctonia in wheat (score 0-3) at Cungena and Minnipa over 1996 to 2000.

	CC	MT	DD
Cungena	0.74	0.74	0.76
Minnipa	0.83	0.93	0.97

(lsd = 0.07 for Minnipa)

Table 10: Take-all (score 0-3) on roots of wheat plants grown at Cungena from 1996 to 2000.

	CC	MT	DD	Previous Crop Average
Pulse	0.00	0.05	0.09	0.04
Single Pasture	0.21	0.19	0.34	0.25
Two Year Pasture	0.21	0.23	0.18	0.20
Tillage Average	0.15	0.17	0.20	0.17

(lsd for tillage = 0.05, lsd for previous crop = 0.10)

Table 11: Take-all (score 0-3) on roots of wheat plants grown at Minnipa from 1996 to 2000.

	CC	MT	DD	Previous Crop Average
Pulse	0.06	0.05	0.09	0.06
Oilseed	0.03	0.04	0.13	0.07
Single Pasture	0.12	0.17	0.17	0.15
Two Year Pasture	0.06	0.14	0.13	0.11
Tillage Average	0.07	0.10	0.13	0.10

(lsd for tillage = 0.03, lsd for previous crop = 0.08)

Table 12: Influence of tillage practice on the average concentration of zinc in the YEB of wheat plants at Cungena and Minnipa for 1995 to 2000.

	CC	MT	DD	LSD
Cungena	24.4	23.8	22.4	1.0
Minnipa	21.2	19.6	18.3	0.8

Table 13: Influence of stubble retention on the average concentration of zinc in the YEB of wheat plants at Cungena and Minnipa for 1995 to 2000.

	Retained	Removed	LSD
Cungena	24.0	23.1	0.8
Minnipa	20.1	19.3	0.6

Nutrition

Tissue samples from the youngest emerged blade (YEB) of wheat plants were randomly taken at early tillering and analysed for nutrient concentration. Most nutrients were adequate however phosphorus was marginal at Cungena (mean of 2652 ppm) and zinc nutrition was marginal at both sites. Phosphorus and zinc are considered adequate when levels at early tillering exceed 3000 and 24 ppm respectively.

Tillage and stubble retention had a significant impact on the concentration of zinc at both sites (Tables 12 and 13). The zinc concentration in the youngest emerged blade of wheat plants was lower in reduced tillage situations. Direct drilling yields may have been restricted because of this marginal zinc status.

What does this mean?

Wheat yield has not been significantly influenced by any of the rotations trialed. Wheat yield after pulse and oilseed crops has been as good as after well managed pastures. The important thing to consider when making rotation decisions is profitability which needs to be weighed up against risk, machinery inventory and labour availability. For example, peas have shown to be more profitable than pasture at Minnipa in the long-term, but have a higher level of risk and require additional machinery and labour inputs than pasture.

The gross margins calculated for each rotation have demonstrated that maximised productivity is achieved through sound rotations dominated by cereals which is consistent with results from last year. Pulse and oilseed crops provide a worthwhile break and can offer some additional income in good seasons, however the average gross margin of all break crops trialed at Cungena has been negative. Such losses can impact severely on cash flow. Well managed pastures grown in such an environment do not have high returns but their benefit to following wheat crops is similar and they have less financial risk. The rotations used in this trial are only a sample and a guide. In practice, rotations need to be flexible, adapt to paddock disease and nutrition status and fit around existing machinery and labour resources.

The disease and nutrition responses present have not led to any significant yield differences between treatments. Neither the higher levels of CCN in the Pa/W rotation, nor

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the benefit of pulse and oilseed crops compared with pasture in reducing Take-all levels, have translated to any significant yield differences at this stage. This is probably due to the low presence of both diseases. The increase in Rhizoctonia levels at Minnipa and Take-all levels at both sites in direct drilling systems did not lead to any yield differences although it may have inhibited some of the yield benefit direct drilling could have provided through more timely sowing. The poorer zinc nutrition of plants grown in reduced cultivation plots may have contributed to this disease difference. Zinc is a relatively immobile nutrient so its distribution throughout the soil is aided by cultivation. In reduced till systems uptake of zinc through plant roots can be restricted because of poor zinc distribution. Zinc plays an important role in the strength of cell membranes. These membranes can become weak and susceptible to invasion by disease when zinc levels are low. Ensuring plants have adequate zinc nutrition will reduce the chance of such infection and allow potential yield increases.

Acknowledgement

I would like to thank the trial co-operators, Myles and Kylie Tomney for the continuing provision of the Cungena trial site. The assistance of MAC staff, particularly Ron Harwood and the contributions from local farmers is greatly appreciated.

GRDC

Grains Research & Development Corporation

Nitrogen Cycling & Water Use.

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Why do the trial?

What is a Calcarosol? It is one of the dominant soil types on the Upper Eyre Peninsula. So what? Calcarosols have a low capacity for water retention due to the presence of hard carbonates and a shallow soil depth. They are also characterised by a number of chemical limitations, namely alkalinity, boron toxicity and salinity. If that's not enough, highly calcareous soils have additional soil fertility disorders such as phosphorus and micronutrient deficiencies. To overcome these limitations to crop production, a fundamental understanding of the effects on nutrient cycling and water use is required. The farming systems trial at Tuckey was established to develop such an understanding. How? By measuring some of the basic soil carbon (C) and nitrogen (N) processes and the water use efficiency of particular crop rotations, in the dune-swale land systems. Why? To determine if continuous cropping can be sustained without degrading soil quality. Soil quality is intrinsically associated with soil organic matter content (SOM) . SOM is critical for efficient crop production due to its role in cation exchange and water holding capacity and is a major source of carbon, nitrogen, sulphur and phosphorus.

What has been done?

The trial was established at 'Pendeen', the property of Matt and Mignon Dunn, near Rudall in 1999 (pg. 45-46, Eyre Peninsula Farming Systems 1999 Summary). Plots (barley, canola, vetch, wheat and medic in 1999) were sown to Excalibur wheat @ 70kg/ha on the 19th of April 2000. 70kg/ha of DAP + 2% zinc was applied at sowing.

These plots were monitored throughout the year and sampled at tillering, anthesis and harvest to assess dry matter and grain production, soil nitrate-N, total plant N and soil water availability. Daily weather station data was collected for application to simulation models. Plant evapotranspiration and soil evaporation measurements are yet to be determined.

What happened?

Climate and crop production

Above average rainfall and wheat yields were the norm for most of the Eastern and Upper Eyre Peninsula this season. The mean yield of grain, dry matter and the average percentage of protein and screenings for the trial site is summarised in Table 1. Despite 48mm more rain during the growing season (average GSR: 254mm), available water to the wheat crop during the important post-flowering period was limited in September and October, resulting in additional screenings and pinched grain with high protein levels. All screenings were above 5%.

Table 1: Yields, protein and screenings of wheat in 2000.

Rotation	Grain yield (t/ha)	Yield potential (% max)*	Dry matter (t/ha)	Protein %	Screenings %
BW	2.6	93	6.8	14.2	7.5
CW	2.4	86	5.5	14.0	7.7
VW	2.2	79	7.2	13.4	6.4
WW	2.4	86	6.5	15.0	10.2
MW	2.4	86	5.9	13.5	7.65

 # Barley, Canola, Vetch, Wheat & Medic pasture
**Yield efficiency measured as a percentage of potential maximum (2.8 t/ha)*

The yields of wheat following each rotation phase were not significantly different, despite the apparently lower performance of the VW rotation. More interesting is the yield of dry matter produced by the wheat crop following vetch (7.2 t/ha). This is probably due to all the vetch biomass (dry matter and seed) being returned to the soil.

Soil and plant nitrogen

There were minimal differences in residual soil nitrate nitrogen (NO_3-N) in 1999. However the amounts are surprisingly large, reflecting poor crop utilisation when soil water availability is minimal. It is possible that late mineralisation events, occurring with late September rainfalls, contributed to the large pools of soil nitrate that were measured at anthesis in 1999 (30th September).

There were considerable differences in the amounts of NO_3 -N at sowing in 2000 following the various rotations (Table 2), particularly after vetch (103 kg), probably due to the whole crop being left as residue. Comparatively, 62 kg of NO_3-N was measured after canola, probably due to the absence of summer weeds and volunteer cereals, compared to the barley, wheat and medic plots. Considering the varying amounts of NO_3-N available at sowing, plant uptake of N differed only marginally until tillering. However, by flowering the amount of N accumulated in the

Table 2: Soil nitrate at depth (0 – 20 cm.) 1999 – 2000.

Rotation 1999	27/04/99 (kg/ha)	04/08/99 (kg/ha)	30/09/99 (kg/ha)	Rotation 2000	19/04/00 (kg/ha)	18/07/00 (kg/ha)	11/10/00 (kg/ha)
B	37	19	47	W	33	28	8
C	29	21	45	W	63	29	12
V	28	23	51	W	103	24	11
W	31	16	35	W	52	24	10
M	29	30	37	W	32	39	8

(#measured soil nitrate on September 30th 1999)

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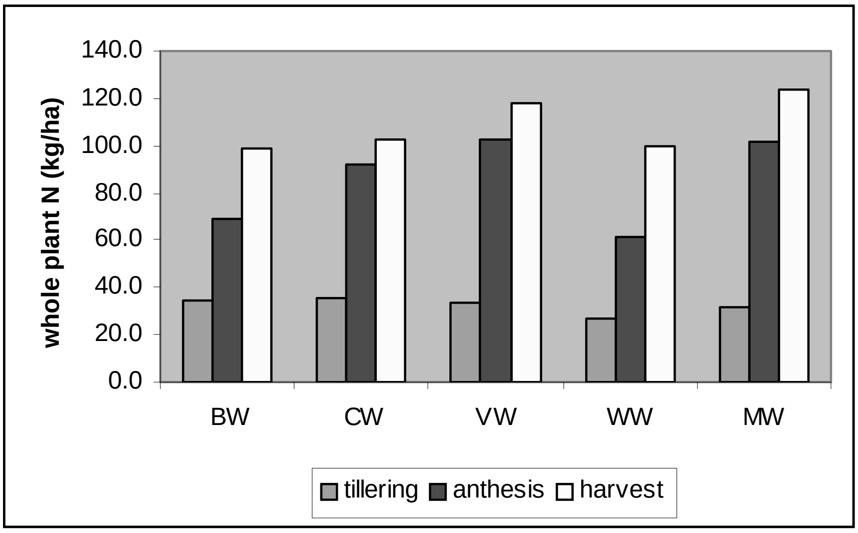


Figure 1: Plant N uptake at tillering, anthesis and harvest.

wheat crops differed markedly. Wheat after legumes accumulated the greatest amounts of nitrogen at flowering and harvest (Figure 1).

Significantly large amounts of nitrate are held at 60-80 cm depth in the soil profile. More importantly, soil nitrate and water at this depth is considered unavailable due to the hostile nature of the subsoils. The greatest amounts at depth were measured under the vetch and wheat rotations; followed by canola, pasture medic and barley respectively (Table 4). The movement of nitrate into the subsoil should be recognized as an additional cost to production and the environment.

Soil water availability

Available soil water utilised by the crops did not appear to differ greatly throughout the season. The largest volumes of soil water were available under the CW and VW rotations at sowing, continuing through until tillering. From tillering onwards there was no apparent difference in available soil water under any of the rotation treatments. All experimental plots experienced moisture stress in September and October.

Table 4: Soil nitrate profiles (kg/ha) at anthesis (11/10/2000).

Soil depth (cm)	BW	CW	VW	WW	MW
0 – 20	8	12	11	10	8
20 – 40	4	6	5	4	7
40 – 60	5	19	8	7	11
60 - 80	10	13	20	28	11

Once again neutron moisture meter measurements indicated that extraction of water at depths greater than 40 – 60 cm is limited by the hostile nature of the subsoil. Useful data for comparing plot water use (volume of soil water/cm soil) will be calculated when the neutron probes are calibrated this February.

What does this mean?

Additional uptake of N failed to provide extra grain protein in the wheat crop after vetch. It was instead used for extra dry matter production, so soil water was exhausted and a yield penalty was incurred. In comparison, the continuous wheat rotation, which experienced the lowest rate of plant nitrogen uptake, actually had the highest protein levels and the most screenings. Ample soil nitrate appears to be available within the system, even under all cereal rotations, however the utilization of that nitrate by crops is relatively poor and obviously intrinsically linked to some other constraints. The relationship between N mineralisation, crop uptake of nitrate and associated soil water availability is complex and is influenced by a number of factors. It must be remembered that the differences in the amount of NO_3-N available in the soil and the utilisation by this year's wheat crop is due to a combination of rotational effects such as:

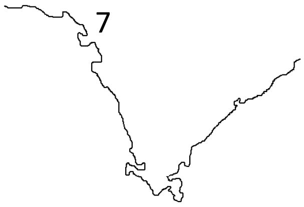
1. residue quantity and quality returned to the soil,
2. control of weeds and volunteers over the summer,
3. disease break procured from the previous crop,
4. alterations to soil structure by priming crops,
5. soil microbial population dynamics, and
6. changes to the rate and amount of soil nitrogen mineralised.

It is obvious that there is a need to quantify the gross inputs and outputs of N from all sources and the interaction of available soil water. Doing so will enable the determination of N use efficiencies for various rotations and provide an improved understanding of soil and water processes. Investigations this year will examine the influence of these factors on each of the rotations.

THE UNIVERSITY OF ADELAIDE

Long Term Cungena Rotation Trial

A 12 Year Study of the Rotation and Fertiliser systems on Upper EP.



Neil Cordon, Hi-Fert and Amanda Cook, Minnipa.

Location Cungena
Malcolm and Alice Baldock.
Hi-Fert and Cungena Agricultural Bureau
Rainfall (12 year period)
Av. Annual total: 293.5 mm
Av. Growing season: 239 mm
Yield (12 year period)
Cungena Potential: 2.52 t/ha
Cungena Actual: 1.206 t/ha
Soil
Highly calcareous grey sand.
Diseases
Rhizoctonia, CCN, Takeall, Pratylenchus.
Plot size
Each fertiliser treatment covers 0.25 ha.
Measurements Taken
Rainfall, Disease levels (CCN, TakeAll, Rhizoctonia, P.neglectus, P. Thornei), Soil Extractable Phosphorus, Soil Organic Carbon, Sulphur, NO_3N, pH, Tissue analysis (P,Cu,Zn,Mn,S), Grain Yield, Grain Protein, Screenings and Gross Margins calculated.

Why do the trial?:

During the last decade, farmers in South Australia have intensified rotations to improve farm profitability. The Cungena Agricultural Bureau and Hi-Fert developed the rotation and fertiliser trial in 1988. It aimed to assess alternative rotation systems available to farmers on Eyre Peninsula where rainfall limitations restrict the use of grain legumes. The effects of these systems on soil fertility and cereal diseases were also monitored. Management decisions such as cereal varieties, herbicides and tillage practices varied to allow for seasonal conditions and to reflect farming practices.

How was it done?

The trial involved four paddocks or blocks with each one representing a different rotation.
In each crop phase of the rotation there were five fertiliser treatments:

Treatment A – Nil fertiliser
Treatment B – 15:13:0:11 at 80 kg/ha*
Treatment C – 10:22:0 (MAP) at 45 kg/ha
Treatment D – 18:20:0 (DAP) at 50 kg/ha
Treatment E – 10:22:0 (MAP) at 90 kg/ha**

***** In 1994 a change to the trial was implemented, Treatment B was originally 0:20:0 at 50 kg/ha and was changed to 15:13:0:11 at 80 kg/ha (added 12 kg N/ha).
** In 1993 a change to the trial was implemented, Treatment E was originally Urea (46:0:0) at 20 kg/ha and was changed to 10:22:0 at 90 kg/ha (added 20 kg P/ha).

Each fertiliser treatment covered a quarter of a hectare (0.25), therefore each rotation covered 1.25 ha, with the total area being approximately 5 ha. The trial was sown with an air seeder, which covers eleven metres, harvested using the co-operators header, and weighed with a grain-weighing trailer.

What happened?

Rotation

Profitability

Gross margins were calculated each year, with the average over the twelve year period (Graph 1). There were no statistically significant differences between the four rotations, but Rotation III was the most profitable due to the greater number of cereal crops included within this rotation. There was little difference between Rotation I and Rotation II, given they were both year in, year out rotations.

Sustainability

There was no evidence that these rotations could not be maintained over the twelve year period, with adequate inputs. The grain quality (protein levels and screenings) and organic carbon levels were maintained over the period of the study. The nil fertiliser treatment (Treatment A) was not sustainable in any system, indicating fertiliser application is necessary in this environment. All other fertiliser treatments were sustainable.

(Continued on page 62)

Year	Rotation 1	Rotation 2	Rotation 3	Rotation 4
1988	Wheat (Spear)	Wheat (Spear)	Wheat (Spear)	Regenerating Pasture
1989	Vetch and Oats	Medic and Oats	Wheat (Molineux)	Wheat (Spear)
1990	Wheat (Molineux)	Wheat (Molineux)	Medic and Oats	Grass Free Sown Pasture
1991	Vetch and Oats	Medic and Oats	Regenerating Pasture	Regenerating Pasture
1992	Wheat (Molineux)	Wheat (Molineux)	Wheat (Molineux)	Wheat (Molineux)
1993	Regenerating Pasture	Medic and Oats	Barley (Galleon)	Grass Free Sown Pasture
1994	Wheat (Excalibur)	Wheat (Excalibur)	Peas (Alma)	Canola (Narendra)
1995	Regenerating Pasture	Medic and Oats	Wheat (Excalibur)	Wheat (Excalibur)
1996	Wheat (Spear)	Wheat (Excalibur)	Wheat (Spear)	Grass Free Sown Pasture
1997	Regenerating Pasture	Medic and Oats	Medic and Oats	Regenerating Pasture
1998	Wheat (Excalibur)	Wheat (Excalibur)	Wheat (Excalibur)	Wheat (Excalibur)
1999	Regenerating Pasture	Dry Sown Oats	Wheat (Excalibur)	Dry Sown Oats

(Continued from page 61)

Disease

There were no clear trends between root disease and the rotations. Seasonal conditions were the major factor in influencing disease levels. The use of different crop varieties can be used to minimise the effect of disease, regardless of the rotation.

Risk

As cropping is intensified for both wheat and alternative crops, there is increased financial risk especially during a poor season. Including alternate crops (peas and canola) within the rotations on upper EP during this study resulted in negative gross margins for 1994. Poor vegetative growth of the peas and canola resulted in almost a grass free fallow, but there was evidence of a benefit to the following wheat crop.

The pasture phase of the rotation consistently returned ($10 -15/ha) from grazing, regardless of the season , with a maximum of $40/ha from sheep in the late 1980's due to high wool returns. This highlights the role sheep have in this environment to provide cash flow during lean times. However, positive gross margins during the pasture phase (from livestock) can be quickly eroded by excessive inputs during that year (ie. grass free herbicides and medic seed).

Nutrition

Phosphorus

The twelve year study has shown the district practices of 10:22:0 at 45 kg/ha (Treatment C) and 18:20:0 at 50 kg/ha (Treatment D) have the best gross margins over the different rotations, with 18:20:0 at 50 kg/ha having a slight economic advantage. Treatment E with 10:22:0 at 90 kg/ha showed no economic advantage. Plants were still showing marginal to deficient phosphorus levels with 10:22:0 at 90 kg/ha, indicating increasing phosphorus application to the soil has not increased the phosphorus available to the plant, due to the soil have having a high tie up of phosphorus (Wilhelm and Growden, 1999 Eyre Peninsula Farming Systems). The delivery of phosphorus to the wheat plants as liquid phosphorus is showing promising results on previous trials in these highly calcareous soils (Holloway and Frischke, 1999 Eyre Peninsula Farming Systems).

The nil fertiliser treatment (Treatment A) was not sustainable over the long term in any system with the treatment having lower yields, lower protein and having a lower extractable soil phosphorus level, indicating fertiliser application is necessary in this environment. However as a short term strategy, (*i.e.* one year) during periods of extreme shortage of cash flow, nil fertiliser application is unlikely to significantly reduce yields, and therefore gross margins, if phosphorus application has been adequate previously.

Sulphur

Over the twelve year period of the study there has been no indication of sulphur deficiency. There has also been no evidence of acidic type fertiliser (Treatment C- MAP) or sulphur fertiliser (Treatment B) having any influence on reducing soil pH and influencing nutrient uptake.

Zinc

Early monitoring identified zinc deficiency, which was corrected in 1990 with a pre-seeding soil spray applied at a rate of 2.2 kg zinc/ha (10 kg/ha of zinc sulphate). The residual effect of soil applied zinc varies with soil type, from two years on heavy calcareous clays to ten years on Mallee loams (Hannam and Wilhelm, CRC, June 1994). These results indicate the residual effect of soil applied zinc is effective for at least nine years in this environment.

Over the twelve year period, limitations on reaching potential yield have been time of sowing, root disease, moisture stress, boron toxicity and phosphorus deficiency.

What does this mean?

Rotation

- The most profitable gross margin over the twelve year period was due to the higher number of cereal crops in the rotation.
- The nil fertiliser treatment was not sustainable over the long term in any system, indicating fertiliser application is necessary in this environment.
- With the increased intensity of cropping (both wheat and alternative crops) there is increased financial risk especially during a poor season (*i.e.* negative gross margin)
- The pasture phase of the rotation provided consistent returns regardless of the season from grazing, to provide cash flow during lean times.

Nutrition

- The district practices of 10:22:0 at 45 kg/ha (Treatment C) and 18:20:0 at 50 kg/ha (Treatment D) show the best gross margins over the different rotations.
- On this soil type there has been no indication of sulphur deficiency.
- There is also no evidence of acidic type fertiliser or sulphur fertilisers influencing soil pH and therefore nutrient uptake.
- Zinc deficiency can be corrected with a pre-seeding soil spray applied at a rate of 2.2 kg zinc/ha and the residual effect of soil applied zinc is effective for at least nine years in this environment.

For further information contact Neil Cordon, Hi-Fert, Pt Lincoln.

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Australian Wheat Board Limited
Sunbeam

7

Gentlemen, choose your weapons!

Samantha Doudle, with assorted comments from:
Researchers Team (Captain – Mark Bennie), Advisers Team (Captain – Justin Wundke),

Why do the trial?

Is profitability gained at the expense of sustainability or can a balance be easily reached?

This question and many others will be answered over the next few decades with the beginning of the great Farming Systems Competition on the Minnipa Agricultural Centre (MAC).

The success of our farming enterprises is determined by how well we utilise the soil and environmental resources we have. This competition aims to demonstrate the management and consequences of four different broadacre farming systems on the bank balance and soil health.

You can follow the progress of the competition every year at the Minnipa Agricultural Centre Field Days and through this publication.

How was it done?

The competition is divided into three teams – the Farmers (Mid West Farmers Group), the Advisers (both private and PIRSA Rural Solutions) and the Researchers (MAC staff). Each team has been allocated an adjacent 3 ha paddock on MAC with the challenge of farming that paddock to become the most profitable and sustainable team in both the short and long term. A fourth paddock will contain "district practice", a farming system decided by consensus of the three teams.

INTRODUCING….THE TEAMS

Team 1: The Farmers (*The Not Too Cocky Cockys*)

Team Motto: To farm profitably today, while giving our kids the chance to do the same tomorrow.

2000 Treatments: Refer to Table 1

2001 Plans: We hope to take advantage of the disease control from sorghum to grow a very profitable wheat crop.

Our message to the other teams: If you always do what you have always done, you'll always get what you've always got!

Team 2: The Advisers (*De$perately $eeking $olutions*)

Team Motto: If we get trounced, please blame Ed Hunt.

2000 Treatments: Refer to Table 1

2001 Plans: TOP SECRET

Our message to the other teams: We're like John West, we only take the best, the rest we send to Canada!

Team 3: The Researchers (*The Starship Enterprise*)

Team Motto: Boldly going where no man has been before!

2000 Treatments: Refer to Table 1

2001 Plans: Without giving too much away (!), we will probably broadcast our paddock.

Some of our team also plan to erect a large shed over the De$perate's paddock to cut out their light and water. The water caught on the shed roof will be stored in a tank in our paddock and used to value-add to our first barley crop in the small brewery we aim to build on the Cocky's paddock.

Our message to the other teams: We are going to practice what we preach and put our money where our mouths are!

(Continued on page 64)

INTRODUCING….THE PADDOCKS

Years and Dates		The Paddocks			
		Farmers	Advisers	Researchers	District Practice
1999 Paddock Use		Parafield Peas @ .36 t/ha	BT Schomburg Wheat @ 1.33 t/ha	Wallaroo Oats @ .67 t.ha	Chemical Fallow
2000 Management					
	30/08/2000	Chemical Fallow Glyphosate @ 1.2 litres + l/ha + Liase	Chemical Fallow Glyphosate @ 1.2 litres/ha	Chemical Fallow Glyphosate @ 1.2 litres/ha	Chemical Fallow Glyphosate @ 1.2 litres/ha
	6/10/2000	Legend Sorghum @ 2kg/ha, 18:20 @ 60 kg/ha (below seed)		Grazed for 4 weeks by ewe hoggets	
	1/11/2000			Worked up	
	2/11/2000	Broadacre Zn @ 1.5l/ha, 24-D Amine @ 1.4 l/ha			
	10/11/2000	Soil Moisture/Salinity Test		Soil Moisture/Salinity Test	
	28/11/2000		Summer Weed Control Spark (75ml/ha), Ester 800 (.3 l/ha), Ally (5 g/ha), Glyphosate (.4 l/ha), LI700 (1 L/ha)		
2001 Management					
	29/01/2001	Soil Moisture/Salinity Test		Soil Moisture/Salinity Test	

(Continued from page 63)

Measurements – soil moisture, soil salinity, root disease tests (taken but not yet analysed), deep nitrate (to be taken prior to seeding, microbial biomass, tissue tests. Other judging criteria is still being finalised.

What happened?

The Cockys Team decided to get a head start on the field last year and boldly planted a crop of sorghum. They anticipated gaining some weed and disease control advantages, plus just maybe gaining some profit from the sorghum….summer rain permitting. One of the concerns expressed about growing summer crops in areas like Minnipa was the high salt and boron levels in the subsoil. All teams were unsure as to what impact these high levels would have on the sorghum.

Figures 1 and 2 show the soil moisture salinity levels in two of the competition paddocks – the Cockys with their sorghum and the Researchers with their weedy fallow. The sorghum paddock initially had more moisture at depth than the fallow paddock. Both paddocks ended up with approximately the same amount of soil moisture throughout the soil profile, despite their different treatments.

Soil salinity under the sorghum has been transferred from deeper in the profile (50 –70 cm) to be distributed from 20 cm downwards. In contrast, the soil salinity under the weedy fallow barely changed.

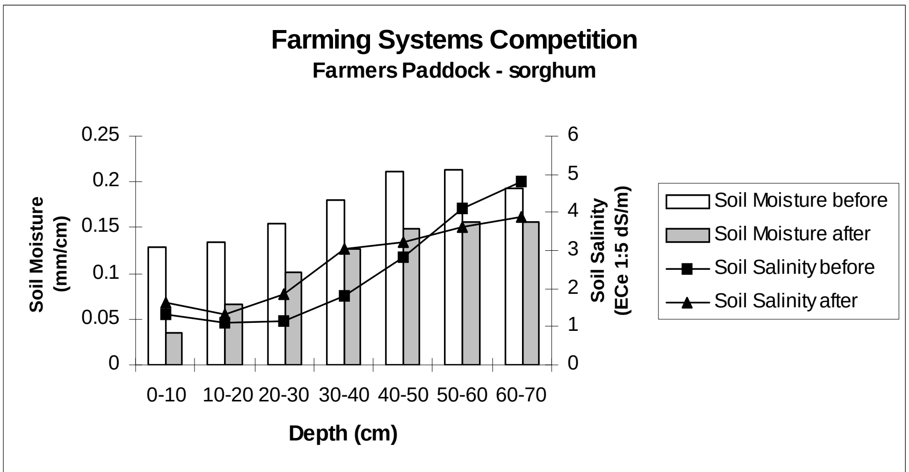


Figure 1: Soil moisture and salinity in farmers paddock on MAC, before and after summer crop growing season

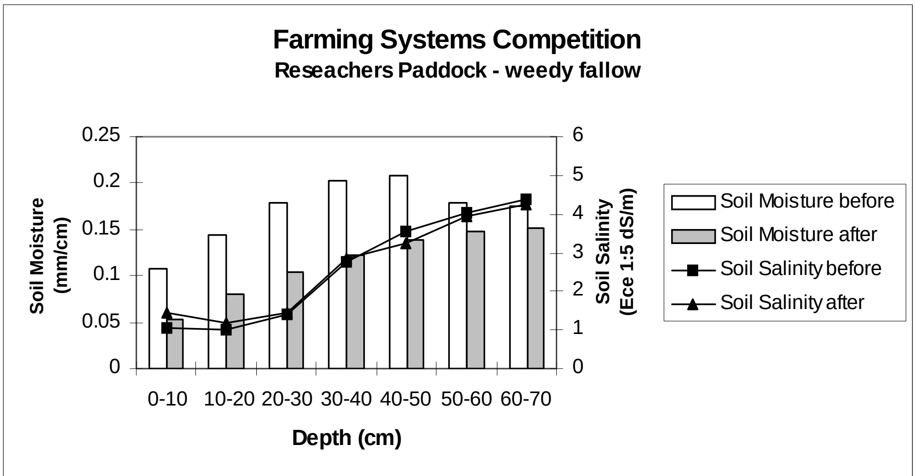


Figure 2: Soil moisture and salinity in researchers paddock on MAC, before and after summer crop growing season

Summer Crop Growing Season Rainfall – October – 43.4 mm, November – 33.6 mm, December – 15.6 mm, January – 6.2 mm (Comment—we don't get this much summer rain too often!).

What does this mean?

Very interesting!!

It appears "*The not too cocky Cockys*" have managed to bring some of their subsoil salt up higher into the profile. The sorghum obviously grew its roots to about 50 cm depth and used the available water. The deeper moisture then moved up the profile via capillary action to also be used by the sorghum. Unfortunately it wasn't just the water that moved up the profile. The salt, which was dissolved in the soil moisture, also took a journey up the profile, but since this was excluded when the sorghum drank the water, it remained right where it had been dragged to. Figure 1 shows this accumulation of salt in the 15 to 40 cm layer to a level that could affect the following wheat crop. In contrast, the salt levels in the weedy fallow were higher to begin with and hardly changed at all over time. It is likely that the salt did move up the profile but that the summer rainfall that was received over this period was enough to leach the salt back to where it started from in the soil profile.

Another interesting revelation was that both paddocks had roughly the same amount of soil moisture remaining in the profile at the end of the summer crop growing season. The Cockys paddock had more subsoil moisture in the 50 – 70 cm zone than the Researchers paddock at the beginning of the summer crop growing season and therefore the sorghum used more water. This would explain why the end of season soil moisture levels are the same in both paddocks, but the Researchers paddock had no change in soil salinity, ie. more water moving up the profile is capable of transporting more salt.

So on these competition paddocks, it doesn't appear to matter whether you grow a crop of sorghum or weeds on a fallow, the soil moisture you will have available for the next season will be nearly the same. The only difference the Cockys need to contend with is the higher salt levels now in the upper levels of their soil profile.

There is more information to be gained already from these measurements so come along to the Minnipa Ag. Centre Field Day to find out which team pulls a rabbit out of the hat in 2001!

...LET THE GAMES BEGIN...

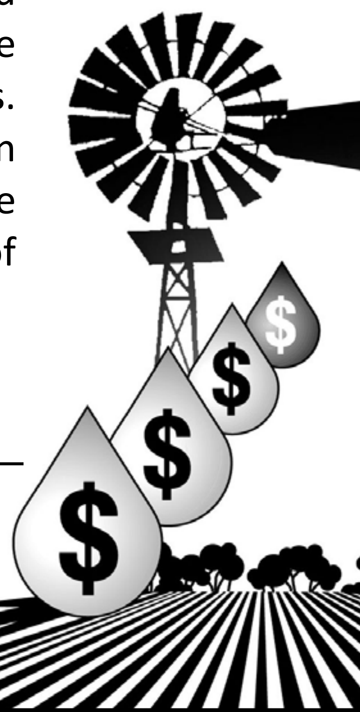
Section Five

Section Editor: Alison Frischke
SARDI, Minnipa Agricultural Centre
Farming Systems Researcher

Disease

The most prominent disease in 2000 on Eyre Peninsula was leaf rust in Excalibur and Krichauff. Leaf rust was seen across the state, and if seasonal conditions prevail, the 2001 season is poised for a rust epidemic. The yellowing of Frame and Yitpi varieties remains a puzzle. It looks and behaves like a disease, but to date no pathogens have been isolated and there appears to have been no yield penalties.

On western EP, the most significant diseases were Rhizoctonia and *Pratylenchus*. The 1999 drought favoured the build up of *Pratylenchus*, and led to the high nematode levels in 2000, which will in-turn be carried into 2001 crops. On eastern EP, patches of Yellow Leaf Spot and Septoria (on heavy sodic clay soils) caused crop damage where susceptible varieties were exposed to extended periods of leaf wetness.



Planning for Rust in 2001

Dr Hugh Wallwork
SARDI, Plant Research Centre, Waite

Three factors are involved in determining whether there will be a rust problem in crops in the coming year. Firstly, there is the amount of rust built up in 2000 and surviving on volunteers through summer. Secondly, the seasonal weather conditions during the growing season which favour or hinder development of an epidemic, and thirdly, the choice of varieties and the time at which they are sown.

What happened in 2000?

Seasonal conditions in 2000, as well as allowing record production levels of cereal grains, also favoured the development of rust diseases in South Australia.

Significant summer rainfall resulted in widespread growth of volunteer wheat plants which were responsible for allowing an early build up of leaf rust. The disease is known to have been present very early in the season in crops on the eastern Eyre Peninsula as well as on the Wakefield Plains and southern end of the Yorke Peninsula.

The widespread use of varieties susceptible to leaf rust meant that the disease was able to multiply rapidly and spread before cooler winter conditions slowed the disease. Come spring, warm and moist conditions again favoured spread of the disease.

High levels of leaf rust either in 1999 or 2000 were responsible for the emergence of a new strain of leaf rust that was first observed in October. The new strain, virulent on the gene *Lr*24, has meant that Krichauff and Worrakatta are now susceptible to this disease. Janz, which also carries the *Lr*24 gene is now also more susceptible but this variety was less affected and therefore retains a useful, if at this stage uncertain, degree of resistance at later growth stages. The new Victorian varieties Mitre and Mira are also likely to be susceptible from now.

Conditions in 2000 were very favourable for stripe rust. Had it not been for the widespread use of resistant varieties, it is most likely that 2000 would have seen very damaging levels of stripe rust, similar to the 1992 season. As it was, almost no stripe rust was observed in wheat in South Australia during 2000. A new strain of stripe rust with virulence for Trident, Camm, Bowie and other interstate varieties with the VPM resistance (old stripe rust resistance gene) was observed near Kaniva, Victoria and in NSW at the end of the season. The value of this resistance is therefore questionable and caution should be used with these varieties in 2001.

The warm humid conditions in October and November also favoured development of stem rust. Naturally infected plants were observed in the lower North although mainly in trial plots where susceptible varieties were growing. Whilst no problems were encountered, there could have been serious damage had more susceptible varieties been widely grown.
Stem rust caused very serious losses in oats, especially the varieties Euro, Potoroo and Echidna. Had similarly susceptible varieties of wheat been grown, then the SA wheat harvest would have much lower than it turned out.

Prospects for 2001

Clearly there has been a lot of leaf rust. With any luck this will have mostly disappeared with the hot dry conditions of early summer. Experience tells however that some rust will be hanging on somewhere and that if a significant rainfall event occurs in February or March and some crops get sown early in the same area, then the cycle could well begin again and leaf rust become a problem in 2001.

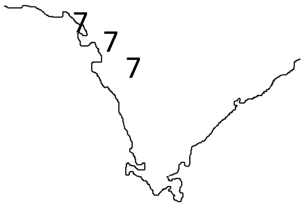
Stripe rust is very unlikely to be a problem on the Eyre Peninsula in 2001 although depending on the survival and fitness of the new VPM race, it could emerge as a concern in later maturing areas further east in the state.

Reducing the threat

There are three main strategies for reducing the threat of rust:

- Reduce the opportunity for rust to survive and spread into crops by eliminating or reducing volunteer stands of wheat and barley.
- Reduce our exposure to rust threats by avoiding varieties that are the most susceptible. Excalibur is a leading culprit and should no longer be grown. As improved varieties are released we should avoid susceptible varieties such as Frame, Yitpi and now Krichauff and Worrakatta.
- In the meantime, growers should monitor their crops closely and consider applications of fungicides at early stages of infection to avoid allowing the disease to build up in crops.

Fungicides should not be seen in future as a substitute for resistant varieties. Relying on fungicides means accepting rust in crops even at a low level. This will only encourage the evolution of further new strains able to attack existing resistant varieties and lead to greater dependence on fungicides in future.



EP *Pratylenchus* Management Research

A: Variety, Rotation and Time-of- Sowing Management

Vivien Vanstone [1] and Alison Frischke [2]
[1] Adelaide University, Waite Campus and [2] SARDI, Minnipa Agricultural Centre

Location
Minnipa Agricultural Centre
Red sandy clay loam
Av. Annual Rainfall: 325 mm
Av. GSR: 250 mm

Miltaburra
Grey highly calcareous sandy loam
Av Annual Rainfall: 275 mm
Av. GSR: 200 mm

Cungena
Grey highly calcareous sandy loam
Av. Annual Rainfall: 299 mm
Av. GSR: 210 mm

Plot size
12m x 1.44m, 4 replicates

Other factors
Dry period during grain fill

Pratylenchus research in South Australia and Victoria over the last six years has confirmed the resistance/tolerance ratings for cereal crops and more recently for pulse, oilseed, pasture and weed species. While the effects of crop type, variety and tillage on *Pratylenchus* populations are now well established, less is known about other agronomic practices. Research on Eyre Peninsula has been exploring these issues, and presented below are the outcomes from trials assessed in 1999/2000

1. BREEDING WHEAT FOR RESISTANCE TO *P. neglectus*

Why do the trial?

Breeding lines from the Waite Wheat Breeding Program (Tony Rathjen and staff) have been assessed in the field over the last 2 years. This material has been under development for *P. neglectus* resistance since 1990, and is now undergoing intensive field testing. The trial was sown at 5 sites across SA in 2000, including Minnipa.

How was it done?

Trial Details: Wheat was sown at Minnipa Agricultural Centre with a small plot seeder on 29/5/00. All treatments were sown at 60kg/ha and received DAP @ 60kg/ha. The site received standard knockdown and in-crop broadleaf herbicides.

Treatments: Seven test lines were sown, plus a range of cereal checks to allow comparison of nematode numbers and yields.

Measurements: RDTS soil analysis at sowing, *P. neglectus* counts, grain yield.
(RDTS - Root Disease Testing Service, now called the PreDicta B™ Root Disease Test marketed by Aventis CropScience. The test uses DNA analysis to quantify levels of pathogens (fungi, nematodes etc) in the soil.)

What happened?

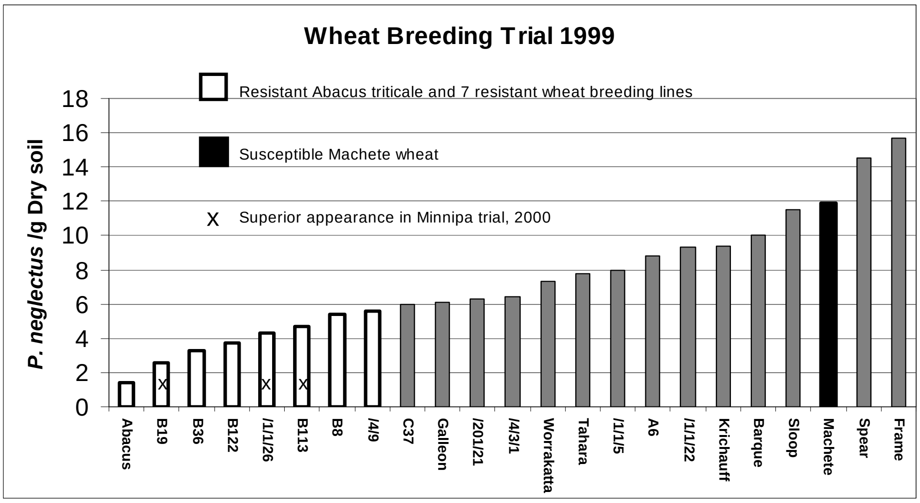
RDTS analysis at sowing recorded the following disease levels:
CCN – low; Take-all - low; Rhizoctonia - medium; *P. neglectus* - low.

Thirteen lines were tested in the field at Roseworthy in 1999. Seven were as resistant to *P. neglectus* as Abacus triticale (Figure 1) and had 50-80% fewer nematodes than Machete. (Abacus is the current 'benchmark' for *P. neglectus* resistance, and is the most resistant commercially available cereal). These 7 lines were again sown in 2000 and at least 4 are once again as resistant as Abacus. However, data from all sites are not yet analysed. Visual assessment of the trial at Minnipa indicated 3 of the resistant lines had superior performance compared to the susceptible wheats (Figure 1). Those that saw this trial during the Minnipa Field Days were impressed by the appearance of these resistant lines.

What does this mean?

Production of commercial wheat with resistance to *P. neglectus* is another step closer. However, further field testing is required and another 7 trials will be sown in 2001 for validation of resistance and testing new lines from the breeding program, including 2 on Eyre Peninsula.

Figure 1: Waite wheat breeding lines tested in the field for resistance to P. neglectus, Roseworthy, 1999.
The 7 most resistant lines were tested again in 2000, including a trial at Minnipa, where at least 3 lines appeared superior compared with susceptible wheat.



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2. CUNGENA ROTATION TRIAL

Why do the trial?

Frame wheat grown after crops with different levels of resistance to *P. neglectus* was sampled to determine crop effects on nematode numbers and the subsequent yield of the wheat crop.

How was it done?

Trial Details and Treatments: Frame wheat was grown in 1999 following different crops sown in 1998: Dundale pea (R), Languedoc vetch (MR), Wimmera ryegrass (MR), improved pasture, Potoroo oat (MR/MS), Monty canola (MS). (Resistance ratings for these crops to *P. neglectus* in brackets). The site received standard knockdown and in-crop broadleaf herbicides.
Measurements: Initial and final *P. neglectus* counts from each plot, grain yield.

What happened?

Resistant pea had the lowest nematode numbers and moderately susceptible oat and canola the highest (Figure 2). After pea there were 66% fewer nematodes than after oats. Of these crops, grain yields were highest after resistant pea and lowest after oat (41% grain yield increase after pea compared with oat).

What does this mean?

Resistant crops in the rotation decrease nematode numbers and enhance yield of the following wheat crop. Increased frequency of resistant or MR crops in the rotation benefit following crops by reducing nematode populations in the soil.

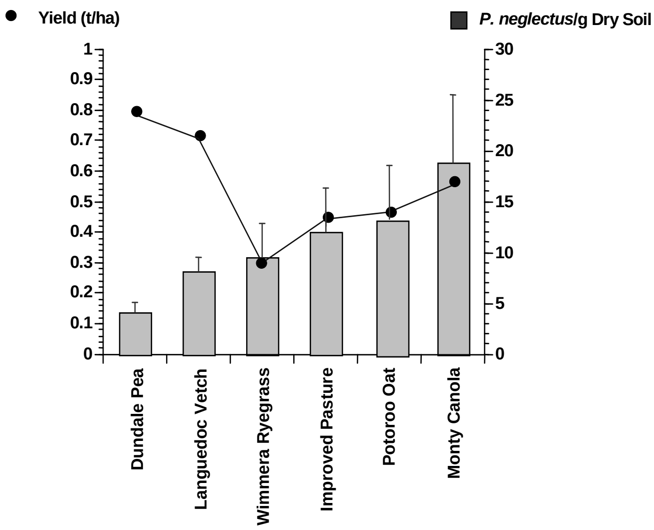

Figure 2: Nematode numbers following different crops grown in 1998 and yield of Frame wheat in 1999.

3. MILTABURRA PASTURE ROTATION TRIAL

Why do the trial?

This trial was established in 2000 at a site with high *P. neglectus* numbers. Crops with different levels of resistance and susceptibility were sown to create high, medium and low nematode densities in the soil. By over-sowing the trial in 2001, each crop will then be tested at each of the different levels within the one trial site. The main aim of the trial is to determine *Pratylenchus* effects on resistant or susceptible cereal following pasture, and on pasture following each of the cereals. We will also gain data on changes in nematode numbers following successive resistant or susceptible crops. Grassy and grass-free pasture will also be compared, as we know that some grass weeds (particularly wild oat) can lead to build-up in *P. neglectus* levels.

How was it done?

Trial Details: Wheat was sown with a small plot seeder 31/5/00. Cereals were sown at 70kg/ha and medic at 5kg/ha. Cereal plots also received DAP @ 60kg/ha. The site received standard knockdown and in-crop broadleaf herbicides.

Treatments: Resistant wheat (Krichauff), susceptible wheat (Machete), MS barley (Barque), grassy and grass-free pasture. Plots will be over-sown in 2001 so that crops are tested in all rotational combinations.

Measurements: RDTS soil analysis at sowing, initial and final *P. neglectus* counts from each plot, grain yield.

What happened?

RDTS analysis at sowing recorded the following disease levels: CCN – below detection; Take-all – below detection; Rhizoctonia - low; *P. neglectus* - high.

What does this mean?

We will find this out at the end of 2001!

4. TIME OF SOWING EFFECTS ON *P. neglectus*

Why do the trial?

To assess the effect of time of sowing on *P. neglectus* levels and the effect of *P. neglectus* on yield for cereal varieties with different tolerance ratings.

Victorian trials by Grant Hollaway (VIDA, Horsham) in 1999 indicated that delayed sowing should be avoided where *P. thornei* levels are high, especially if sowing intolerant varieties. Delayed sowing increased the yield loss caused by *P. thornei* and varieties intolerant to the nematode suffered much greater yield losses. The experiment at Minnipa was sown to determine whether time of sowing has a similar effect on *P. neglectus* in South Australia.

How was it done?

Trial Details: A trial site was established at Minnipa on a BT Schomburgk stubble with a small plot machine. Five cereal varieties with different resistance/tolerance ratings to *P. neglectus* (Table 1) were sown into plots @ 70 kg/ha at 3 sowing times (determined by the timing of sufficient opening rain): 29th May, 8th June and 16th June. Each plot was sown with DAP @ 60 kg/ha.

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Table 1: Cereal varieties and ratings for P. neglectus resistance and tolerance.

Cereal variety	*P. neglectus* Resistance/Tolerance Rating
Tickit triticale	MS-MR/MT
Excalibur wheat	MR/MT
Schooner barley	MS/MT
Frame wheat	S-MS/MT
Machete wheat	S/I

Treatments: Sowing date (late May, early June or mid June) x cereal variety (Table 1) x 4 replicates.

Measurements: RDTS soil analysis at sowing, initial and final P. neglectus counts for each plot, grain yield.

What happened?

RDTS analysis at sowing recorded the following disease levels:
CCN - low; Take-all - below detection; Rhizoctonia - medium; *P. neglectus* - high.

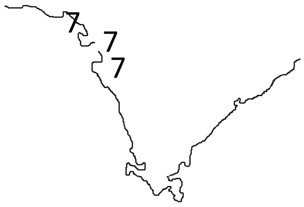
At all sowing times, nematode numbers were lowest for the more resistant varieties (Tickit and Excalibur) and as expected, higher for MS Schooner and Frame and highest for susceptible Machete (Table 2). At later sowing times, numbers tended to decrease for Excalibur and Frame compared with the earliest time of sowing. However, overall, time of sowing had no significant effect on nematode numbers. Interestingly, in this trial time of sowing had no effect on grain yield. Even for the variety most intolerant of *P. neglectus* (Machete), sowing time had no effect on yield.

What does this mean?

Unlike the trial conducted by Grant Hollaway in Victoria, time of sowing at Minnipa in 2000 had no effect on grain yield. Time of sowing also had little effect on nematode numbers and yield loss due to *P. neglectus* was not influenced, even for the most intolerant variety (Machete). To confirm results, similar trials would need to be conducted at additional sites in more seasons. Sowing times in the Victorian trial were further apart (late May to mid-July) than those used in the Minnipa trial. At Minnipa, sowing from late May to mid-June had no effect on yield or nematode numbers.

Table 2: Final nematode numbers and grain yield, time of sowing trial, Minnipa,

Time of Sowing	Variety	Final *P. neglectus*/g Dry Soil	Grain Yield (t/ha)
1	Excalibur Wheat	12.35	2.56
2		6.08	2.80
3		6.13	2.62
1	Frame Wheat	15.40	2.62
2		17.03	2.44
3		8.70	2.41
1	Machete Wheat	16.05	2.23
2		20.63	2.56
3		16.03	2.37
1	Schooner Barley	14.85	3.81
2		12.68	4.06
3		17.30	4.00
1	Tickit Triticale	5.75	2.35
2		6.20	2.63
3		4.05	2.61



EP *Pratylenchus* Management Research

B: Nutritional Management

Vivien Vanstone [1] and Alison Frischke [2]

[1] Adelaide University, Waite Campus and [2] SARDI, Minnipa Agricultural Centre

Location
Emerald Rise
Red calcareous sandy loam
Ave. rainfall: 300 mm
Ave GSR: 220 mm

Miltaburra
Grey highly calcareous sandy loam
Av. Annual Rainfall: 275 mm
Av. GSR: 200 mm

Yandra
Grey highly calcareous sandy loam
Av. Annual Rainfall: 400 mm
Av. GSR: 320 mm

Plot size
12m x 1.44m, 4 replicates

Other factors
Dry period during grain fill

Pratylenchus research in South Australia and Victoria over the last six years has confirmed the resistance/tolerance ratings for cereal crops and more recently for pulse, oilseed, pasture and weed species. While the effects of crop type, variety and tillage on *Pratylenchus* populations are now well established, less is known about other agronomic practices. Research on Eyre Peninsula has been exploring these issues, and presented below are the outcomes from trials assessed in 1999/2000.

1. PHOSPHORUS RATES

Why do the trial?

Trials were sampled in 1999 to assess the effect of granular phosphorus (P) on *Pratylenchus neglectus* (*P. neglectus*) levels, and the subsequent effect of *P. neglectus* on yield. In 2000, fluid and granular P formulations were compared, to determine whether some of the additional response gained by using fluid (compared with granular) P is due to *P. neglectus* control.

How was it done?

Trial Details: Trial sites were established at Miltaburra and Yandra in 1999 and 2000. Frame wheat was sown at 74 kg/ha. In 2000, phosphorus was applied in granular form as MAP (10:22:0), or in fluid form as Technical Grade MAP (TG MAP) (12:26:0). All treatments received 20 kg N/ha. Where formulations required extra nitrogen (N), this amount was made up by adding ammonium nitrate. All fertilisers were placed 3 cm below the seed. Zinc (Zn) was also applied in solution @ 2.5kg elemental Zn/ha to all treatments. With the granular treatments, Zn solution was applied simultaneously and at the same depth as the fertiliser granules. This ensured that all treatments, both granular and fluid, received a total volume of 400L of water per hectare.
Treatments: P rates: 0, 4, 8, 12, 16 and 20 kg P/ha; each rate applied as granular or fluid fertiliser.
Measurements: RDTS soil analysis at sowing in 2000, *P. neglectus* counts, grain yield.

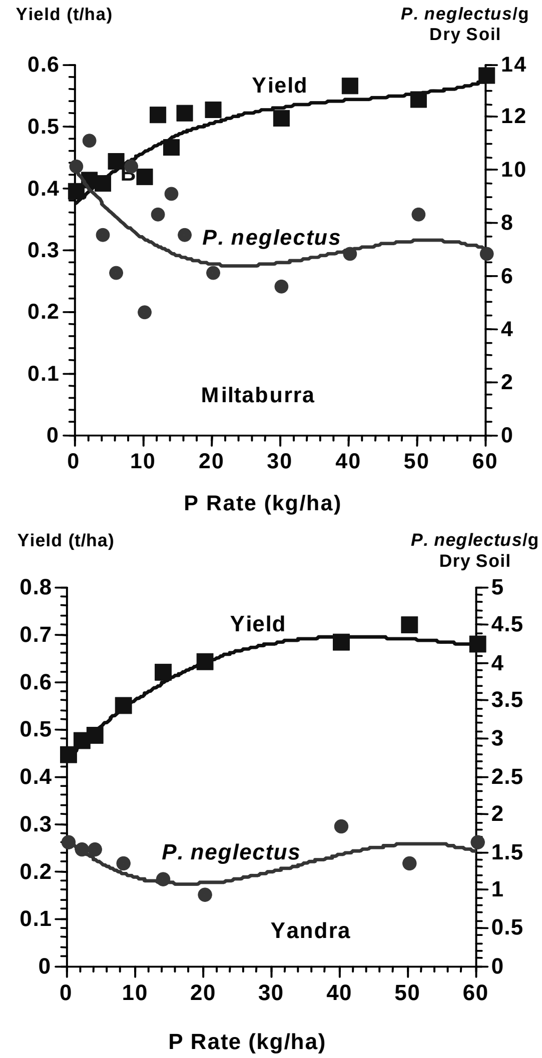


Figure 1: Effect of granular phosphorus on P. neglectus numbers and grain yield for Frame wheat, Miltaburra and Yandra, 1999.

What happened?

In 1999, *P. neglectus* numbers at Miltaburra (5-11/g dry soil) were higher than at Yandra (1-3/g dry soil), although yield response and changes in nematode numbers in relation to P rate were similar for both sites.

There was an obvious yield response to P, maximised at 20-30 kg P/ha. *P. neglectus* numbers decreased as P rate increased (Figure 1). At 10-30 kg P/ha, nematode numbers were reduced by about 30% compared with plots with no added P. Rates higher than 20-30 kg P/ha did not further

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reduce nematode numbers or increase yields.

RDTS analysis at sowing in 2000 recorded the following disease levels:
Miltaburra: CCN – below detection; Take-all - below detection; Rhizoctonia - low; *P. neglectus* – medium;
Yandra: CCN – below detection; Take-all - below detection; Rhizoctonia - low; *P. neglectus* – low.

In 2000 (Figure 2), nematode numbers at Miltaburra (8-25/g) were again higher than at Yandra (1-3/g). There was no consistent difference between granular and fluid P. However, overall reductions in nematode numbers were similar to those measured in 1999. At Miltaburra, 20 kg P/ha reduced *P. neglectus* levels by 22% with fluid P and by 37% with granular. Granular P did not reduce nematode numbers at Yandra, but 20 kg/ha fluid P reduced nematode numbers by 32%.

Miltaburra

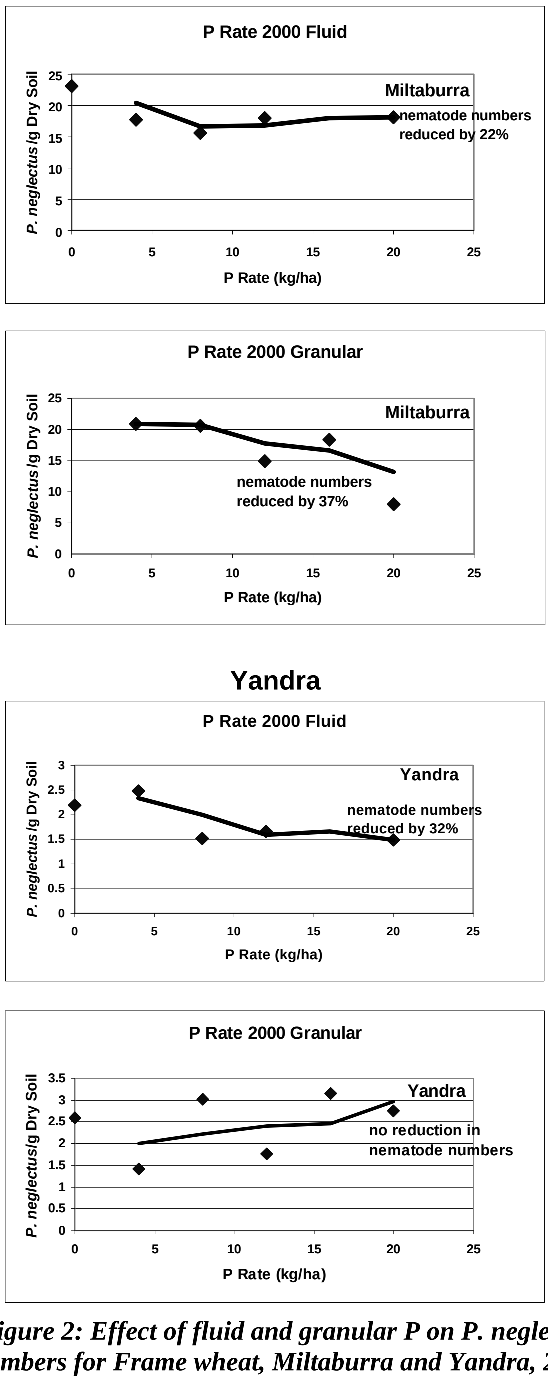

Figure 2: Effect of fluid and granular P on P. neglectus numbers for Frame wheat, Miltaburra and Yandra, 2000.

What does this mean?

- Increasing P rate up to 20-30 kg/ha reduced density of *P. neglectus* in the soil by as much as 30%.
- Fluid P did not necessarily decrease nematode numbers more than granular P treatments.
- These nutritional effects contrast to those recorded by Grant Hollaway in Victoria, where P (and other nutrients) had no effect on *Pratylenchus* numbers. The inherent nutrient deficiencies on Eyre Peninsula, the different soil type, organic matter levels, rainfall and associated high *P. neglectus* populations may have led to a significant interaction between *P. neglectus* and nutrition at these sites.

2 B. PHOSPHORUS x NITROGEN x ZINC

Why do the trial?

To assess the effect of the interaction between phosphorus with nitrogen and zinc on *P. neglectus* levels.

How was it done?

Trial Details: Trial sites were established at Miltaburra and Emerald Rise. Frame wheat was sown at 74 kg/ha. Phosphorus was applied in granular form as TSP (0:20:0), or in fluid form as Phosphoric Acid (H_3PO_4). All treatments received 10 kg P/ha. Where formulations required extra N, this amount was made up by adding urea. All fertilisers were placed 3 cm below the seed. Zinc was applied in solution @ 2.5kg elemental Zn/ha. With the granular treatments, water or Zn solution was applied simultaneously and at the same depth as the fertiliser granules. This ensured that all treatments, both granular and fluid, received a total volume of 400L of water per hectare.

Treatments:	P fluid	P granular
	P + N fluid	P + N granular
	P + N + Zn fluid	P + N + Zn granular
	P + Zn fluid	P + Zn granular

Measurements: RDTS soil analysis at sowing, *P. neglectus* counts, grain yield.

What happened?

RDTS analysis at sowing in 2000 recorded the following disease levels at Miltaburra and Emerald Rise: CCN – below detection; Take-all - below detection; Rhizoctonia - low; *P. neglectus* – low.

Nematode numbers at Miltaburra (up to 16/g) were much higher than at Emerald Rise (less than 2/g) (Figure 3).

Although Holloway and Frischke have shown distinct advantages with fluid compared with granular formulations on these soils types and yields in these trials were higher with fluid than with granular fertilisers, there was no difference in *P. neglectus* numbers between the fluid and granular treatments. However, lowest nematode numbers at both sites followed P or P+N (without Zn) treatments. P+N+Zn, or P+Zn had higher nematode numbers. There was no apparent interaction between these treatments, *P. neglectus* and yield, *i.e.* these treatments did not reduce nematode numbers and lead to corresponding yield differences that could be attributed to *P. neglectus*.

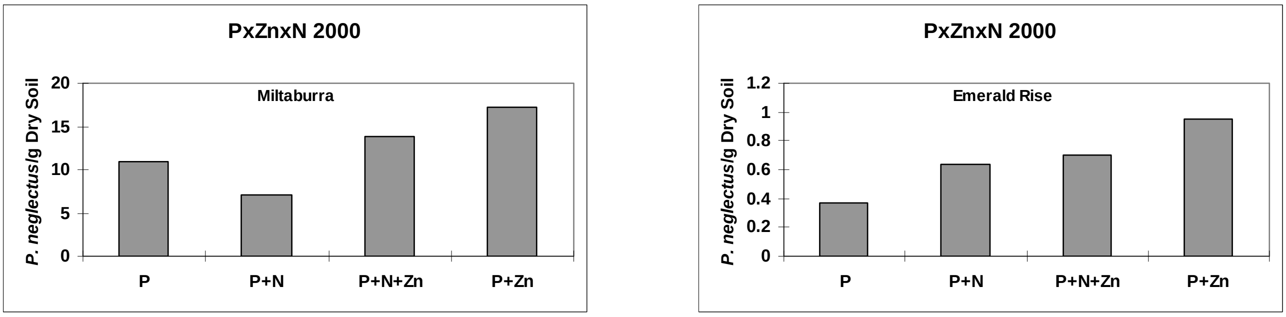

Figure 3: Effect of P with or without N or Zn, on P. neglectus at Miltaburra and Emerald Rise, 2000.

What does this mean?

It is difficult to understand why the combined treatments (P+N+Zn and P+Zn) had higher nematode numbers than the P and P+N treatments. Nevertheless, better nutrition in general will help plants tolerate root lesion nematodes and other diseases.

We know from other trials that P tends to decrease *P. neglectus* numbers, and ammonium forms of N (eg. urea) have nematicidal effects that have been documented worldwide and in our trials in South Australia. In preliminary pot tests, Zn reduced the effect of *P. neglectus* on Machete wheat but did not necessarily reduce actual nematode numbers in the plants, *i.e.* plant tolerance, not resistance, was enhanced by Zn treatments.

To better define the effect of these nutrient combinations and interactions with *P. neglectus*, future trials may need to investigate each of these nutrients (especially Zn) separately at different rates, as well as in combination.

***P. neglectus* Assessment of Eyre Peninsula Farming Systems Trials in the Future**

There have been changes to the collaborative SARDI/ Adelaide University/VIDA root lesion nematode GRDC project - the current 5 year project ends in June 2001, and a new project (3 years) will begin in July. Sharyn Taylor (SARDI) will continue trial work on crop resistance/ tolerance, and effect of environmental conditions and initial nematode numbers on yield loss. Wheat breeding trials will also continue. However, continued assessment of EP Farming Systems trials (especially nutrition) will be reduced. Vivien will remain at Adelaide University until at least June 2002 and would like to take this opportunity to sincerely thank everyone on Eyre Peninsula for their enthusiasm and support for Prat research over the last 12 years.

Acknowledgments

This work was funded by the GRDC and would not have been possible without the valuable assistance of Michelle Russ (Adelaide University), Wendy Payne, Kaye Brace and Wade Shepperd (Minnipa Agricultural Centre). We also

GRDC Grains Research & Development Corporation

Crown Rot Management

Jerry Dennis[1] and Alison Frischke[2], SARDI
[1]Plant Research Centre, Waite, [2]Minnipa Agricultural Centre

Why do the trials?:

Crown rot is caused by a soil borne fungus which survives on crop residues and is an increasing problem with closer cereal rotations and increased stubble retention. The disease is worse on crops suffering from stresses such as drought, nutrient deficiency and other root diseases.

These trials were set up to provide data for the development of crown rot management techniques and will determine:

- The effect of stubble incorporation or burning on inoculum survival and disease development,
- The number of break crops for effective disease control by measuring the rate of inoculum decline in non-host crops (eg. fallow, grass-free pasture),
- The effect of fluid fertiliser and trace element application on disease tolerance,
- The effectiveness of plant resistance in controlling crown rot.

How was it done?

Trial sites: Trials were established at Minnipa and Wharminda in paddocks severely affected by crown rot in 1999. These trials will run for at least 3 years and all plots will be pasture in 2001.

Minnipa Treatments: Stubble from 1999 was either retained, buried by discing, or raked and burned in May. Plot treatments (Frame wheat with granular fertiliser; Frame wheat with fluid fertiliser; Frame wheat with fluid fertiliser + trace elements; Tamaroi durum; Grass free medic pasture; Chemical fallow) were sown into each of these areas on June 7th 2000 after treatment with Roundup and Treflan.

Wharminda Treatments: The site was pre-drilled with 50 kg/ha Urea, and plots (Schooner barley (tolerant); Tamaroi durum (very susceptible); Frame wheat (susceptible); Kukri wheat (moderately susceptible); 2/49 wheat (unreleased), (moderately resistant); Frame wheat + trace elements with seed; Frame wheat + trace elements 10cm below seed; Grass free medic pasture; Pasture) sown on May 19th 2000 after treatment with Treflan.

All treatments at both sites received 12 kg P/ha and 10.8 kg N/ha applied as granular fertiliser, or fluid fertiliser in 400L solution/ha. Trace elements applications were Zn @ 2 elemental kg/ha, Cu @ 2 elemental kg/ha and Mn @ 5 elemental kg/ha. 400L/ha of water was also applied with the 'Frame wheat with granular fertiliser' treatment at Minnipa, to ensure all Frame wheat treatments received the same water rate.

Measurements: Plots were scored for infected plants and whiteheads (%) in October and harvested for grain yields in December.

Grass free pasture plots were sampled for soil inoculum in October and will be sampled every 6 months to determine changes in soil inoculum. This data will be used to determine the number of break crops needed for effective crown rot control.

Location
Minnipa Agricultural Centre
Red sandy loam
Undulating hills
Av. Annual Rainfall: 325 mm
GSR: 250 mm

Wharminda
Siliceous sand over clay
Dune-swale
Av. Annual rainfall: 320 mm
GSR: 240 mm

Diseases
Low levels of Take-all at both sites

Plot size
26m x 1.44m, 4 replicates

Other factors
Dry spell during grain fill

What happened?

Significant levels of crown rot developed on plants at both sites even though crop growing conditions were very favourable in 2000. The good conditions, however, reduced the amount of whitehead development and associated yield loss which were less than would be expected in drier years.

Minnipa

- There was a slight reduction in plant infection by burning or discing stubble but stubble burial (discing) caused a significant reduction in yield. This yield reduction is most likely associated with a treatment effect on moisture or nutrient availability to the plants rather than from disease.
- Disease infection was high for Tamaroi and there was more than 15% whiteheads, indicating significant yield losses despite the good growing conditions. This emphasises the risk of significant yield losses from disease when durums are grown in paddocks with high amounts of crown rot inoculum.
- Fluid fertiliser, and fluid fertiliser plus trace elements gave a slight reduction in disease compared to granular fertiliser but there were no significant effects on yield. The fluid fertiliser plus trace element treatment was more vigorous than other treatments during early crop development and may have been more effected by moisture stress in the dry spring period.

Wharminda

- Application of trace elements reduced disease and increased yields, indicating more vigorous crops are less affected by crown rot.
- The more resistant varieties (2/49 and Kukri) significantly reduced disease levels compared to Frame. Yields of these varieties, however, are low since they are not as well adapted to the region as Frame.

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Table 1: Results from 2000 crown rot trials at Minnipa and Wharminda

Site	Treatment	% Infected plants	Yield (t/Ha)
Minnipa	Retain stubble	21.7	2.15
	Burn stubble	18.6	2.06
	Disc stubble	17.6	1.79
	Tamaroi	42	1.49
	Frame with granular fertiliser	13.3	2.16
	Frame with fluid fertiliser	11.2	2.28
	Frame with fluid fertiliser + trace elements	10.8	2.07
Wharminda	Schooner	8	3.30
	Tamaroi	17	1.98
	2/49	4	1.44
	Kukri	4	2.17
	Frame	10.5	2.44
	Frame + trace elements with seed	8.8	2.65
	Frame + trace elements 10cm below seed	7.3	2.71

What does this mean?

This is the first year of these trials and it is too soon to provide crown rot management recommendations.
At this stage indications are:

- Removal of infected stubble by discing in or raking and burning reduces disease but the immediate effect is minor. The value of these treatments may show up in subsequent years as soil inoculum breaks down.
- Improved crop nutrition from fluid fertilisers and trace elements reduces the effect of crown rot.
- Available levels of resistance in cereal varieties are effective in reducing crown rot, but better yielding varieties are required. Resistant varieties may also have a long term effect on crown rot by reducing inoculum build up.

Acknowledgments

This work was funded by the GRDC and would not have been possible without the valuable assistance of Wade Shepperd (Minnipa Agricultural Centre). We also thank Ed Hunt and Minnipa Agricultural Centre for allowing access to their properties to conduct trials.

Grains Research & Development Corporation

Assessment of Management Options for Yellow Leaf Spot

Alison Frischke[1], O'Brien Enterprises[2]
[1]SARDI, Minnipa Agricultural Centre, [2]Farmers, Kyancutta

Location
Closest town: Kyancutta
Cooperators: P & K O'Brien & Sons
Rainfall
Av. Annual total: 299mm
Av. Growing season: 227mm
Actual annual total: 358mm
Actual growing season: 279mm
Yield
Potential: 3.38t/ha
Actual: 2 t/ha (trial site)
Paddock History
1999: Machete
1998: Medic – spray topped
1997: Excalibur
Soil
Land System: Undulating hills with red calcareous flats
Major soil type description: red calcareous sandy loam
Diseases
Low level of Yellow Leaf Spot, high levels of *Rhizoctonia*
Plot size
Expt 1 - 40m x 6m
Expt 2 – 40m x 3m
4 replicates
Other factors
4 dry weeks Sept-Oct

Why do the trial?

To evaluate the effect of different stubble management techniques, and the application of trace elements on the incidence of Yellow Leaf Spot (YLS) in a wheat-on-wheat crop.

YLS attacks the leaves of wheat plants causing poor vigour and grain yield losses. The incidence of YLS has been rising with the intensifying of rotations, more paddocks being sown to wheat-on-wheat and changes in tillage practices which include stubble retention. YLS spores survive over summer on stubble, consequently techniques which aid stubble breakdown or removal are the most effective control measures. There is also anecdotal evidence that an early application of zinc (2 leaf stage) can suppress initial infection, where the zinc acts as a protective barrier, rather than a cure for the disease.

Despite low YLS infection levels, experiments at Kyancutta in 1999 showed some degree of disease suppression where stubble was either double slashed, buried, or burnt (*i.e.* stubble removed), or where 4 kg/ha zinc sulphate was applied early in plant growth (2-5 leaf stage). Disease levels in 1999 were not high enough to have an effect on yields (EP Farming Systems 1999 Summary, pg. 49). These experiments were repeated in 2000.

1. STUBBLE MANAGEMENT

How was it done?

Trial Details: Machete wheat was sown at 65 kg/ha on 25/5/00 with DAP @ 60 kg/ha and 50 kg/ha of urea. The wheat plots were sown over different stubble treatments, as listed in Table 1 below.
Measurements: YLS infection (lesions per leaf), grain yield. To score YLS infection, the 2nd fully emerged blade on the main stem (of 20 plants) was sampled at late tillering, and scored for percentage of leaf covered by lesions.

Table 1. YLS infection levels at late tillering, and grain yield for Machete wheat sown over different stubble management treatments.
(NB: Treatments with the same letter are not significantly different.)

Stubble treatment	% of leaf affected by lesions	Grain Yield (t/ha)
Zero-till	52.0 a	1.61
Raked off & burnt	38.5 b	1.75
Stone rolled	37.5 b	1.73
Double working	37.2 b	1.86
Single working (control)	35.5 b	1.79
Significance	P<0.05	Not significant

What happened?

YLS infection levels in 2000 were again relatively low. This was most probably a consequence of low infection levels in 1999, where seasonal conditions which were unfavourable for YLS infection, and levels of inoculum carried by stubble over the summer period into 2000 would have been low.

There was a significant difference between stubble management techniques - the zero-till treatment (which had the least stubble interference) had approximately 15% more lesions than other treatments, which all had some physical impact on the stubble. Despite this difference, there was no significant effect of stubble treatments on grain yield.

In 1999, the 'burnt' plots (which had straw raked up and burnt on the plot) had significantly lower YLS infection than all other treatments. In 2000, there was insufficient straw on the 'burnt' treatment plots to generate a self-sustaining burn, therefore straw was dragged off the plot and heaped so that it could be burnt. This would have reduced the effectiveness of the 'burnt' treatment (*i.e.* maximum straw removal) as many straw fragments would have remained on the plot. Achieving a good stubble burn would remove a good proportion of the straw fragments which could serve to carry YLS inoculum.

The experimental site was severely affected by Rhizoctonia, which made the Machete crop very patchy. While not significant, the double working treatment yielded between 0.07 – 0.25 t/ha more than other treatments, and the zero-till crop had the lowest yields. This result was probably a direct

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result of soil disturbance, and its impact on Rhizoctonia before sowing.

2. EARLY ZINC APPLICATION

How was it done?

Trial Details: Machete wheat was sown at 65 kg/ha on 25/5/00 with DAP @ 60 kg/ha, and 50 kg/ha of urea. At 2-3 leaf stage trace element treatments were sprayed onto plants. (zinc sulphate – Zn_2SO_4, manganese sulphate – $MnSO_4$, copper sulphate – $CuSO_4$)

Measurements: YLS infection (lesions per leaf), ICP tissue analysis, grain yield.

What happened?

There was a significant difference in percentage of leaf area affected by YLS lesions between trace element treatments. The nil treatment had significantly more lesions (11 - 15%) than both treatments containing 4 kg/ha Zn_2SO_4, and the 2 kg/ha Zn_2SO_4 treatments had significantly more lesions (8 - 9%) than the 4 kg/ha Zn_2SO_4 treatment *i.e.* the 4 kg/ha rate of zinc has managed to significantly reduce YLS infection.

The 4 kg/ha Zn_2SO_4 treatment also had a higher tissue zinc concentration (20.7 ppm) than other treatments, although tissue zinc concentrations in all treatments were marginal. There were no significant changes in manganese or copper concentrations between treatments and all tissue concentrations were adequate.

Differences in YLS infection and tissue zinc concentration had no significant effect on yield.

What does this mean?

Data from the 2000 trials complement results measured at Kyancutta in 1999. Results from both seasons lend support to using stubble management techniques which aid stubble breakdown or removal and to the practice of using an early application of foliar zinc (2 leaf stage) to assist with suppressing YLS infection. Clearer results are needed using trials with higher levels of infection.

The data also illustrates that applying zinc at such an early stage in plant growth will not overcome a zinc deficiency, given the small leaf area and limited capacity for foliar uptake of nutrients. A second foliar application of zinc is needed at the 4-5 leaf stage when leaf surface area has increased.

Where YLS is likely to be a potential threat, the most resistant varieties should be selected wherever possible.

Acknowledgments

This work was funded by the GRDC and would not have been possible without the valuable assistance of Peter, Darren, Craig and Brett O'Brien and Wade Shepperd

Table 2. YLS infection levels at late tillering, tissue zinc concentrations and grain yield for Machete wheat treated with different foliar trace element mixes.

(NB: Treatments with the same letter are not significantly different)

Trace element application	% of leaf affected by YLS lesions	Tissue zinc concentration (mg/kg)	Grain Yield (t/ha)
Nil	43.7 a	18.5 b	2.07
2 kg/ha $ZnSO_4$	37.7 ab	19.0 b	2.05
2 kg/ha $ZnSO_4$, 3 kg/ha $MnSO_4$, 0.5 kg/ha $CuSO_4$	36.7 ab	18.1 b	2.14
4 kg/ha $ZnSO_4$	28.9 c	20.7 a	2.01
4 kg/ha $ZnSO_4$, 6 kg/ha $MnSO_4$, 1 kg/ha $CuSO_4$	33.0 bc	18.5 b	2.02
Significance	0.098	$P<0.05$	Not significant

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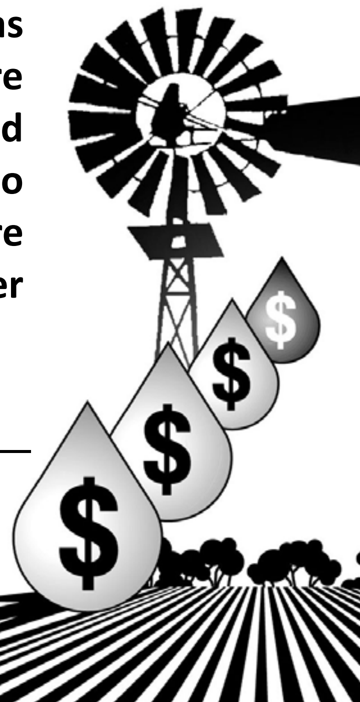
Section Six

Section Editor: Alison Frischke
SARDI, Minnipa Agricultural Centre
Farming Systems Researcher

Nutrition

After some time in the wilderness, the whole field of plant nutrition research has attracted a great deal of interest from farmers, commercial companies and researchers. The challenges of meeting plant nutritional needs on some of the most difficult soil types in Australia (in terms of cereal production) are now being addressed and some glimpses of what may be possible can be seen in this chapter.

Conventional fertilising systems, upon which we have relied for more than a century, do not appear to be as efficient as we once believed, particularly on many of Eyre Peninsula's unique soils. Research in the field of fluid fertilisers has now produced sufficient data to demonstrate that the initial impressive results are repeatable in a variety of seasons. These results offer much encouragement to the farmers of Eyre Peninsula.



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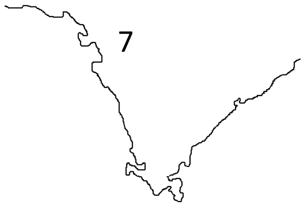


Are Fluid Fertilisers Going to Work on My Farm?

Some Useful Farmer Advice

Malcolm and Bruce Heddle, Farmers, Minnipa

As a result of the trial work done with fluid fertilisers, and the variable responses according to soil type, many farmers are wanting to know if similar responses can be expected on their own farms.

It will obviously not be possible for the researchers at Minnipa Agricultural Centre to put trials in every situation we would like to see it tried. So some people will be looking for a cheap and relatively easy way to get some observation strips, using their own equipment.

There will probably be as many different ways of applying fluid fertilisers as there are farmers. These are some of the things we did that worked for us, and ideas for things to think about before starting:

- At least some of the products being used are highly corrosive to equipment and require extensive safety measures to use. Consider using one of the technical grade powdered products which have shown promise (eg. tech grade MAP) and can be dissolved in the same manner as zinc sulfate. They are also readily available at an affordable price.

- The fluid rate applied will be a trade off, dependant on the amount of product needing to be dissolved effectively if you use a powder, applying enough liquid to get effective distribution but keeping the quantities at a practical level. Tech Grade MAP is a 12:26:0 product, and depending on the actual product batch, 25 kilograms dissolves into 100 litres of solution, providing about 6.75 kg P @ 100 litres / hectare.

- Using a product like Tech Grade MAP, pumps useable with zinc sulfate seem to work fine for mixing and metering. A 1000 litre 'computorspray®' with the original 30 litre ground driven pump applied 100 litres/ hectare very accurately. One advantage of using a boomspray unit is that good filtration and plumbing is already in place to keep hassles and costs to a minimum.

- We set up one of two combines being used in tandem to apply fluid. Setting up one half of an airseeder would achieve the same effect if the fertilizer metering mechanism can be blanked off to individual distributors.

- The plumbing on the machine need not be exotic or expensive to handle the Tech Grade powders in solution - about $50 will do a combine. We used a 25mm plastic pipe across the width of the machine, attached under the box to create a manifold. This was drilled and tapped every 175 mm to take 4mm garden dripper flex nipples, connecting 4 mm drip irrigation tube which carried the solution to the back of the seeding boot. (There are different grades of this hose and the more expensive ones may be tougher and more flexible.) A 0.9mm streaming nozzle screwed into the end of the 4mm tube metered and applied the product in a continuous stream onto the seed bed (the stream worked fine from about 5 kph and faster). Cable ties held the tubes on the boots and located the nozzles and proved surprisingly durable. Not very complex or expensive!

- Putting the fluid with the seed is far simpler than banding it below and can be done with almost any point being used. Banding below *may* be better, but the largest part of the response, if any will be from the fluid and for an observation trial, getting it down deeper might not be worth the trouble.

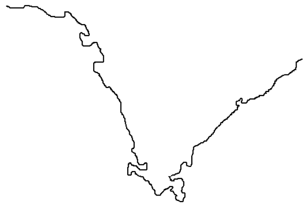
- Pick a paddock with several soil types which represent the bulk of your farm so that the best and worse of the responses can be seen. There is no point putting your trial on a piece of highly calcareous grey soil if it represents an irrelevant portion of your cropping program.

- Leave a control, consisting of your normal application rate and product, across all of the soil types in the paddock. It is pretty hard to fairly assess a response if there is nothing to compare it with.

Finally, be aware that a large visual response may not translate into yield. Getting accurate yield data from lots of soil types won't be easy, but the opportunity to at least observe visual responses might be better than nothing if you are the curious type.

Understanding Soil/Fertiliser Chemistry

A necessity for efficient fertiliser application and formulation



Dr Isabelle Bertrand[1], Dr Bob Holloway[2] and Dr Mike McLaughlin[1]

[1]CSIRO Land & Water, [2]Minnipa Agricultural Centre

Background:

In South Australia and Victoria, calcareous soils and alkaline sodic soils represent more than 50% of the total agricultural area. These regions have a Mediterranean climate with mean annual rainfall ranging from 275 mm/ year for Upper Eyre Peninsula to 500 mm/year for the Wimmera. Major constraints for agricultural productivity associated with these alkaline soils include phosphorus (P) and micronutrient deficiencies (Zn, Cu & Mn). In these very contrasting soils we performed experiments to better understand the chemistry of phosphorus and the efficiency of fluid fertilisers compared to granular products.

How was it done?

1) A large range of chemical and physical analyses were performed on 47 alkaline soil samples from Eyre Peninsula, the Mallee and the Wimmera. Phosphorus adsorption characteristics were also measured and the relationships between chemical characteristics of the soils and P concentrations were measured.
2) A plant experiment was performed in pots with 2 soils representative of Upper Eyre Peninsula and 2 others representative of the western Victoria area. The main aim of this experiment was to assess if the effect of fluid fertilisers observed in the field resulted from a placement effect or a chemical effect. By using isotopic dilution techniques we were able to assess the real efficiency of fluid and granular fertilisers *i.e.* the proportion of P taken up by wheat plants from the fertilisers added relative to the proportion taken up from P already present in the soils. The fertilisers were all applied so that the final rates were equivalent to 60 kg P/ha, 60 kg N/ha and 12 kg Zn/ha. Six P-fertiliser treatments were uniformly mixed with the soil in all pots. Three granular fertilisers, MAP (N:P:K = 10:22:0), DAP (18:20:0), or TSP (0:20:0), and three fluid fertilisers, ZAP (technical grade MAP (TGMAP) + ammonium nitrate + $ZnSO_4.7H_2O$), ammonium polyphosphate (APP, 16:23:0 w/v) or orthophosphoric acid (H_3PO_4)(26% P w/w) were added to the pots. For each type of soil, the total volume of fluid added to all treatments was similar. Controls were grown in the same conditions but without P-fertilisers.

What happened?

1. Phosphorus Chemistry:

As shown in Figure 1, soils from Eyre Peninsula have a greater adsorption capacity than soils from Western Victoria. That is, between 80% to 90% of P added to grey calcareous soils from Eyre Peninsula is rapidly fixed and unavailable to plants. In the case of red calcareous soils the value decreases to 50% (Figure 1b).

Phosphorus Buffer Capacity (PBC) *i.e.* the amount of P that

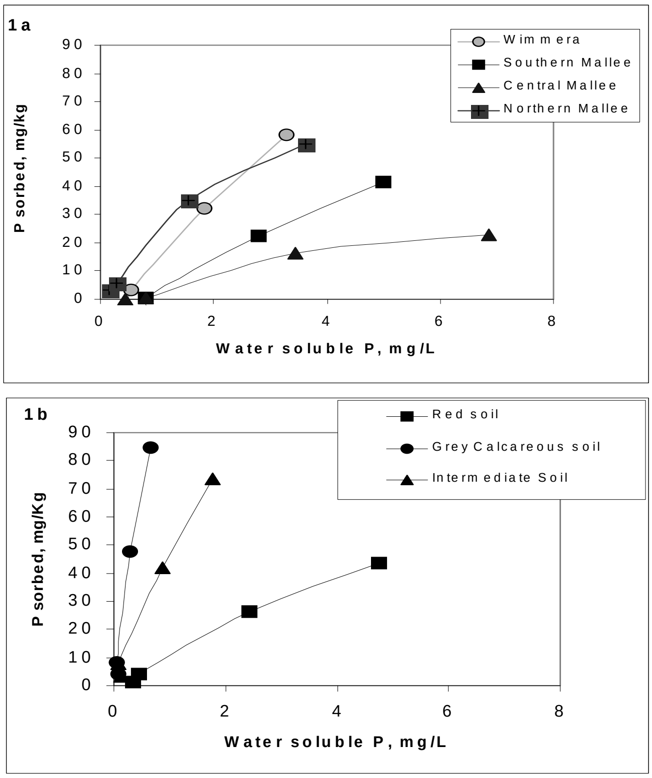


Figure 1: Typical P sorption curves on soils from Western Victoria (1a) and Upper Eyre Peninsula (1b).

a soil can fix, was deduced. Values shown in Figure 2 confirm that soils from Eyre Peninsula are among the most highly phosphorus-fixing soils found in Australia. Previous studies in Western Australia and Spain have shown that in calcareous soils, P is mainly fixed by iron or aluminium oxides associated with calcium carbonate in the soil. Soils from Upper EP appear quite different in this respect. The retention of P in soils from Eyre Peninsula was mainly related to calcium carbonate concentrations in the soil. As the carbonate content of these soils increases, the fraction of P fixed by the soil also increases. The majority of fixed P in these soils originates from fertiliser applications in previous years. In addition, the values for total P reported by the Western Australian study ranged between 142 and 300 mg P/kg soil for calcareous soils fertilised for more than 45 years. On Upper EP, the amount of P present in the grey calcareous soils was greater, ranging from 200 to 750 mg P/kg soil. This data confirms that Upper Eyre Peninsula soils have a unique P chemistry, quite different from that reported in the literature for Mediterranean calcareous soils.

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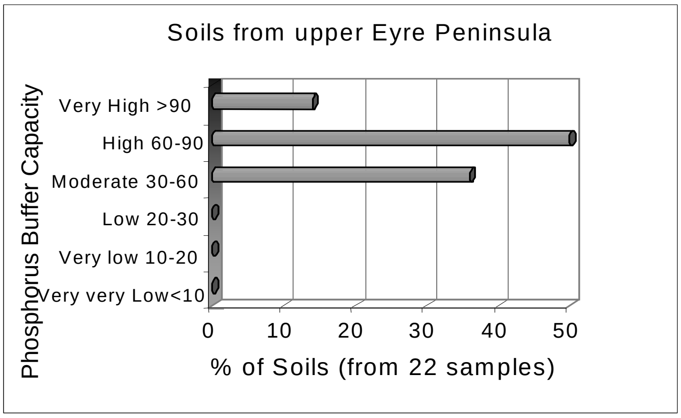


***Figure 2**: Phosphorus buffer of 22 soil samples from upper Eyre Peninsula*.

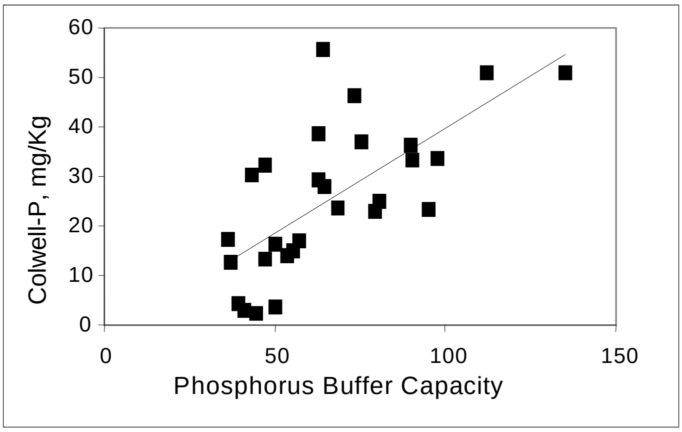


Figure 3: Relationship between phosphorus buffer capacity in alkaline soils with more than 1% $CaCO_3$ and Colwell-extractable P.

We have shown that the Colwell-P test (the standard test used to assess the P-status of soils in SA) is not reliable for predicting P fertilisation requirements on soils from Upper Eyre Peninsula. As shown by Figure 3, this test was positively correlated with the PBC. This suggests that as more P is added to soil, Colwell P increases but the P retention capacity is increased. This is the opposite result to that previously reported for many soil types.

2. Understanding the chemistry of fluid fertilisers:

The amounts of P taken up by shoots of Frame wheat from the fertiliser applied to pots, (not from the pool of P already present in the soil) are shown in Figure 4.

It is noteworthy that fluid fertilisers always performed as well as or better than the granular fertilisers. The percentage of P taken up by plants from the fertiliser applied is an exact indication of the real efficiency of the fertiliser. In the grey highly calcareous soil from Eyre Peninsula, plants took up 50% of their P from the fluid fertiliser and only 30% from the granular. In this case, we can conclude that the efficiency of fluid fertiliser was at least 20% better than the granular product. In the red calcareous soil, even when fluid fertilisers did not increase shoot dry weight or the available P, plants were able to take more P from ammonium polyphosphate or ZAP (Figure 4).

What does this mean?

We conclude that in the grey highly calcareous soil, the effect of fluid fertiliser was due in this instance to a chemical effect rather than a placement effect. Effectively, with this soil type in a pot experiment, fluid fertiliser doubled the production of dry matter and the P uptake by shoots. The increase in available P in the soil was about 40% compared to granular and plants were able to take up nearly double the amount of P from fluid fertiliser compared to granular. These results support the field data obtained by field studies at Minnipa Research Centre.

In the case of the red calcareous soil, field data indicated higher yields with fluid than with granular fertiliser while in the present experiment, no significant increase in dry matter was measured. However, increases in P taken up by plants from ZAP and ammonium polyphosphate treatments were recorded (Figure 4) which strongly suggests that these two forms of fertiliser provided more available P than the others. A possible explanation for the different results obtained between field and laboratory experiments on the red calcareous soil, is that in the pot experiment, soils were maintained at the same level of water, which was relative to the water holding capacity of each soil. However each soil has different water retention curves and the watering of the pots needed to be adjusted according to these curves. The interaction of soil moisture with fluid *vs* granular fertiliser placement is one area that needs further work.

Further research is necessary on the effect of water on the efficiency of fluid and granular fertilisers so that we can predict in which soil type and under which climatic conditions fluid fertilisers are likely to be more efficient than granular products.

If nutrients other than nitrogen and phosphorus are limiting yields, the incorporation of micronutrients such as zinc and manganese in the formulation of fluid fertilisers may have a big impact on yield. This hypothesis needs to be tested.

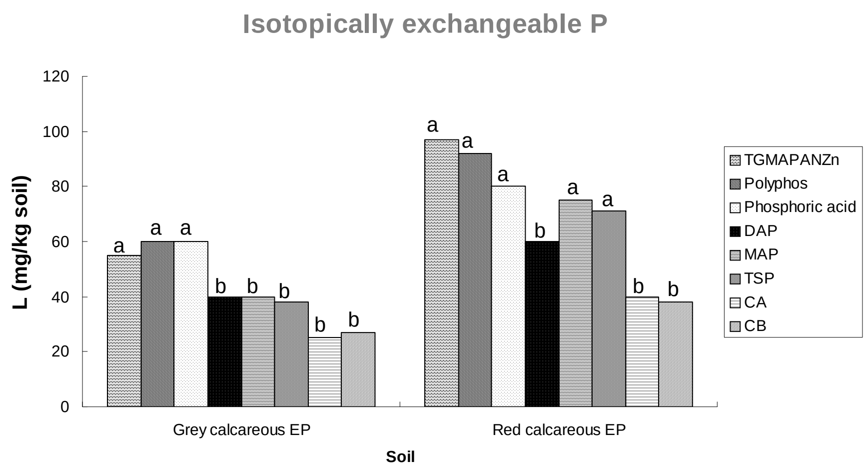


***Figure 4**:* **Percentage of P derived from fertiliser in Frame wheat grown on different soil types.**
(*NB*: Treatments with the same letter are not significantly different.)

Phosphorus Rate Response Experiments

Dr Bob Holloway, Alison Frischke and Dot Brace—SARDI, Minnipa Agricultural Centre

Why do the trial?

To measure the relative effectiveness of fluid and granular fertilisers on an array of low rainfall soil types over a range of application rates of P.

Previous research has shown that on some soil types, certain fluid fertilisers can be more efficient than granular in terms of producing plant dry matter and grain, at low rates of P. The relative effectiveness of fluids tends to be greater at lower rates (*i.e.* < 8 kg/ha). This experiment was designed to explore how wheat crops respond to increasing rates of fertiliser on different soil types, and to assess the relative effectiveness of the two forms of fertiliser. The comparison is designed to measure how much of each form of fertiliser is required to produce the same grain yield.

How was it done?

Trial Details: Trials were established at Miltaburra, Yandra, Emerald Rise, Kyancutta, Lock (2 sites) and Cowell in 2000. Frame wheat was sown at 74 kg/ha. At Miltaburra, Yandra, Kyancutta and Cowell, phosphorus was applied in granular form as MAP (10:22:0), or in fluid form as Technical Grade MAP (TG MAP) (12:26:0). At Emerald Rise and Lock phosphorus was applied in granular form as DAP (18:20:0), or in fluid form as an Agras (18:8:0) - phosphoric acid blend. All treatments at Miltaburra, Yandra, Kyancutta and Cowell received 20 kg N/ha, and at Emerald Rise and Lock, 18 kg N/ha. Where formulations required extra N, this amount was made up by adding ammonium nitrate. All fertilisers were placed 3 cm below the seed. Zinc was also applied in solution @ 2.5 kg Zn/ha in all treatments. With the granular treatments, zinc solution was applied simultaneously and at the same depth as the fertiliser granules. This ensured that all treatments, both granular and fluid, received a total volume of 400 L of solution per hectare.

Treatments: P rates: 0, 4, 8, 12, 16 and 20 kg P/ha; each rate applied as granular or fluid fertiliser.
Measurements: Early dry matter production, grain yield.

What happened?

Miltaburra – Both granular and fluid fertilisers increased yield with increasing rates of P (Figure 1). However, the rate of increase was greater with the fluid fertiliser. The fluid data was less variable than the granular data.

Yandra – The soil at Yandra was considerably less calcareous than at Miltaburra. The rate of increase in grain yield slowed considerably with both forms of fertiliser at an application rate of more than 8 kg P/ha (Figure 2). The rate of increase for both fluid and granular fertilisers was the same over the range of applied P, except that at all P application rates plants treated with fluid yielded about 0.45 t/ha greater than the equivalent granular application.

Emerald Rise – It is interesting that in an experiment applying only P at Emerald Rise (refer to Multi-Nutrient Fluid Fertiliser Experiments article), there was no response to increasing application rates of P when P was applied alone. However, in this experiment when N and Zn were added to the P fertiliser there was a yield increase in the case of the fluid fertiliser up to an application rate of 8 kg P/ha (Figure 3). The granular fertiliser responded to about 5 kg/ha. At an application rate of 8 kg P/ha, grain yield increased with the application of fluid fertiliser by about 0.25 t/ha compared with granular fertiliser. Yields with the fluid treatments were severely curtailed by extremely dry weather in September as these plants were much more advanced earlier in the season.

Kyancutta - The rate of increase in grain yield slowed considerably with both forms of fertiliser at an application rate of more than 12 kg P/ha (Figure 4). The rate of increase for both fluid and granular fertilisers was the same over the range of applied P. At all P application rates, plants treated with fluid yielded about 0.1 t/ha greater than the equivalent granular application. Again, yields with the fluid treatments were severely curtailed by extremely dry weather in September at Kyancutta, as early dry matter production was considerably greater with fluid treated plants.

Lock & Cowell - There were no significant yield responses to P rate, or fertiliser type at Lock or Cowell.

Locations

Miltaburra - L, M & C Mudge
Grey highly calcareous sandy loam
Colwell P: 18 mg/kg
% CaCO3: 59 %
Annual rainfall: 275 mm
GSR: 200 mm

Yandra – I & G Morgan
Grey highly calcareous sandy loam
Colwell P: 25 mg/kg
% CaCO3: 36 %
Annual rainfall: 400 mm
GSR: 320 mm

Emerald Rise – R, D & N Brace
Red calcareous sandy loam
Colwell P: 19 mg/kg
% CaCO3: 14 %
Annual rainfall: 300 mm
GSR: 220 mm

Lock – I Burrows
Grey calcareous sand over clay loam
Colwell P: 50 mg/kg
% CaCO3: 3.3 %
Annual rainfall: 375 mm
GSR: 290 mm

Lock – D Foster
Greyish calcareous sandy loam
Colwell P: 61 mg/kg
% CaCO3: 7.6 %
Annual rainfall: 344 mm
SR: 273 mm

Kyancutta – P & K O'Brien & Sons
Red calcareous sandy loam
Colwell P: 27 mg/kg
% CaCO3: 5.6 %
Annual rainfall: 299 mm
GSR: 227 mm

Cowell – P & A Kaden
Red calcareous sandy loam
Colwell P: 17 mg/kg
% CaCO3: 1.2 %
Annual rainfall: 289 mm
GSR: 203 mm

Plot size
12m x 1.44m, 4 replicates

(Continued on page 81)

Figure 1-4: ***Effect of increasing rate of phosphorus (P) applied as fluid or granular fertiliser on grain yield at Miltaburra, Yandra, Emerald Rise and Kyancutta.***
NB. The chemical formula for calcium carbonate is $CaCO_3$ – the higher the calcium carbonate percentage in a soil, the greater the “fizz” created when hydrochloric acid is added.

Figure 1: MILTABURRA 2000 - P response
Grey, highly calcareous soil - Colwell P 18 mg P kg^{-1}, $CaCO_3$ 59%

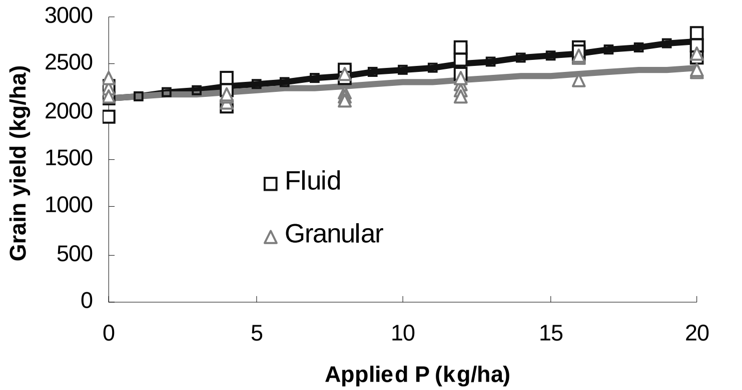


Figure 2: YANDRA 2000 - P response
Grey, highly calcareous soil - Colwell P 25 mg P kg^{-1}, $CaCO_3$ 36%

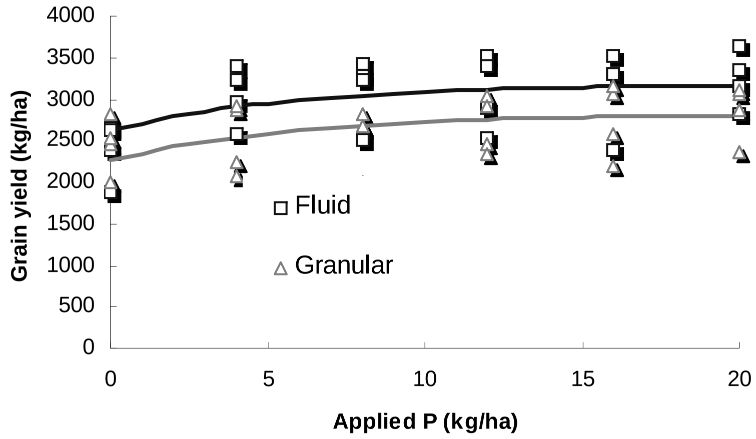


Figure 3: EMERALD RISE 2000 - P response
Red/brown calcareous soil - Colwell P 19 mg P kg^{-1}, $CaCO_3$ 14%

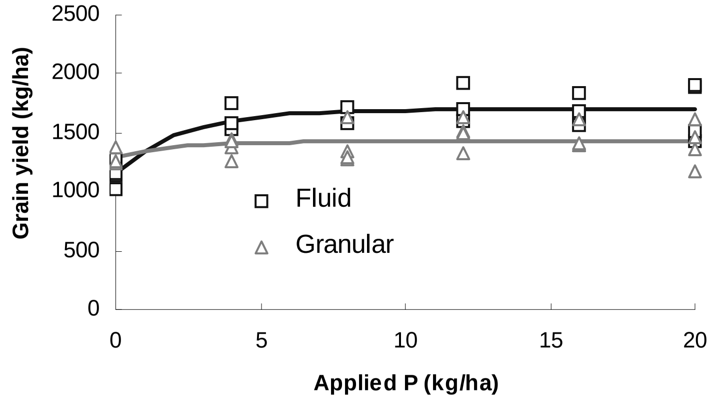
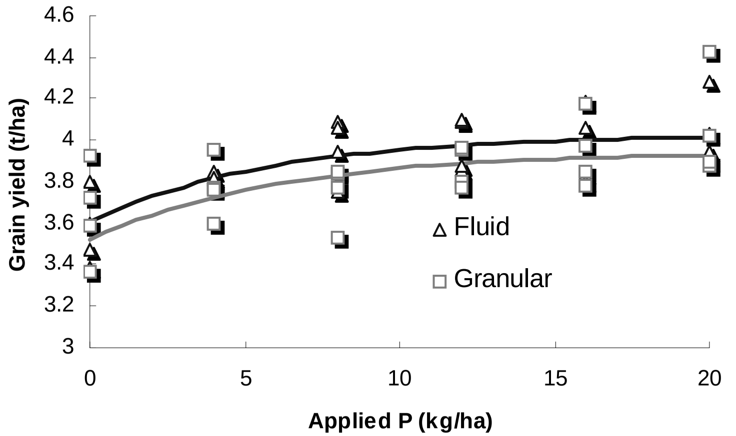


Figure 4: KYANCUTTA 2000 - P Response
Red calcareous soil - Colwell P 27 mg P/kg, $CaCO_3$ 5.6%



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What does this mean?

Our conclusions from the work we have done to date are:

- The relative difference between granular and fluid fertilisers appears to increase as the $CaCO_3$ content of the soil increases.
- Responses to fluid fertilisers are best with multi-nutrient fertilisers.
- Grain yield responses to fluid fertilisers appear to be greater in dry seasons than wet seasons.
- Given the early growth differences at most sites during the year it is possible that the more advanced fluid fertiliser treatments suffered to a greater extent during the dry September of 2000, while the later maturing granular treated plots benefited to a greater extent from good rains in October

Acknowledgments

This work was funded by the GRDC and would not have been possible without the valuable assistance of Wade Shepperd (Minnipa Agricultural Centre). We also thank the co-operators for their time and provision of trial sites.

Liquid Fertiliser Demonstration at Tuckey

Jon Hancock[1], Annie McNeill[2] and Damien Adcock[2],
[1]Minnipa Agricultural Centre, [2]Adelaide University,

Location
Rudall
Matt & Mignon Dunn
Tuckey Ag Bureau
Rainfall
Av. Annual total: 344 mm
Av. Growing season: 254 mm
Actual annual total: 405 mm
Actual growing season: 303 mm
Yield
Potential: 3.86 t/ha
Actual: 2.38 t/ha
Paddock History
1999: Oats
1998: Wheat
1997: Medic Pasture
Soil
Heavy swale, loamy sand over calcrete rubble
pH 7.6 – 8.5 (0-20cm)
pH 9.4 – 10.5 (>20cm)
Plot size
80m x 1.7m
Other factors
Moisture stress during September/October

Why do the trials?

A trial was set up in the same paddock as the 'Nitrogen and Water Use' trial (Rotation section) to compare 'best-bet' liquid fertiliser formulations with conventional granular fertilisers at Tuckey.

How was it done?

The trial was sown to Frame wheat with various fertilisers applied below the seed on the 14th of June.
The fertilisers used were;

- DAP @ 70 kg/ha (12.6N + 14P)
- DAP @ 70 kg/ha + $ZnSO_4$ @ 11 kg/ha (12.6N + 14P + 2.5Zn)
- Agras @ 4 kg/ha + Phosphoric Acid @ 10 kg/ha + $ZnSO_4$ @ 11 kg/ha (9N + 14P + 2.5Zn)
- Tech Grade DAP @ 61 kg/ha + $ZnSO_4$ @ 11kg/ha (12.7N + 14P + 2.5Zn)

The trial was sampled at flowering and harvest to determine the influence of fertiliser type on dry matter production, grain yield and quality.

What happened?

There were no visible differences in growth between any treatments throughout the season. There were also no significant differences in wheat yield, protein or screenings (Table 1).

Yield did not increase with the addition of zinc fertiliser in this trial either, but it is important to realise that this paddock has a sound history of zinc nutrition.

What does this mean?

There were no significant advantages of using fluid compared with granular fertilisers at this site. Note that the trial did not have a nil fertiliser treatment—it may be that this site is non-responsive to phosphorus fertiliser.

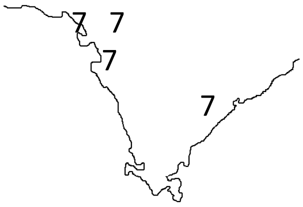
When there is no yield benefit, liquid fertilisers will only be beneficial when they can be applied at the same price as or more cheaply than granular fertilisers, or when there is a logistical benefit of mixing trace elements into the fluid fertiliser to overcome nutrient deficiencies.

Acknowledgements

The support of the nutrition group at MAC for their technical knowledge and assistance with sowing is

Table 1. Yield, Protein and Screenings level of Frame wheat grown with different fertilisers at Tuckey

Fertiliser Treatment	Dry Matter (t/ha)	Grain Yield (t/ha)	Protein (%)	Screenings (%)
DAP (solid)	1.98	2.10	15.0	2.4
DAP + $ZnSO_4$ (solid & liquid)	2.15	2.04	14.6	2.1
Agras + PA + $ZnSO_4$ (liquid)	2.07	2.01	15.0	2.5
TG DAP + $ZnSO_4$ (liquid)	1.91	2.04	15.0	2.4



Multi-Nutrient Fluid Fertiliser Experiments

Dr Bob Holloway, Alison Frischke & Dot Brace—SARDI, Minnipa Agricultural Centre

On the grey highly calcareous soils of upper Eyre Peninsula, it has been observed that wheat crops often do not respond to nitrogen or zinc. Experiments, on these soils have indicated that phosphorus (P) is a major limiting factor affecting plant growth, despite apparently 'adequate' soil Colwell P values. Substantial responses to fluid fertilisers compared with granular fertilisers have been measured in plant uptake of P and grain yields. It is probable that addressing the P requirements of plants on these soils may lead to responses to other nutrients such as N, Mn and Zn. The following experiments were designed to explore interactions of P, N and Zn, and to compare the efficiency of each in granular and fluid fertiliser systems.

EXPERIMENT 1: RATES OF P ALONE

Why do the trial?

To determine how plants respond to increasing rates of P fertiliser on grey highly calcareous soils.

How was it done?

Trial Details: Trial sites were established at Yandra and Emerald Rise. Frame wheat was sown @ 74 kg/ha. Phosphorus was applied in granular form as triple super phosphate (TSP) (0:20:0), or in fluid form as phosphoric acid (H_3PO_4). There was no application of either nitrogen or zinc. Fertilisers were placed 3 cm below the seed. With the granular treatments, water was applied simultaneously and at the same depth as the fertiliser granules, ensuring that all treatments received a total of 400 L water per hectare.
Treatments: Increasing rates of P: 0, 2, 4, 6, 8, 10, 12, and 14 kg/ha in both granular and fluid forms.
Measurements: Grain yield

What happened?

At Miltaburra, early inspections indicated that plots in this experiment were generally more severely affected by root disease, as indicated by patches, than in other experiments where P, N and Zn were applied. Consequently interpretation of results is difficult. However, results show a linear increase in yield with both fluid and granular fertilisers. The highest yield of 1.90 t/ha achieved with 14 kg/ha of fluid, was 6% higher than the highest yielding granular treatment of 1.79 t/ha at the same rate of P.

At Emerald Rise, there were no responses to P applied as fluid or granular.

What does this mean?

At Miltaburra, the application of phosphorus alone increased yields for both fluid and granular fertilisers, but the *rate* of increase was greater with the fluid fertiliser. At Emerald Rise, while the addition of P alone gave no increase in grain yield, other experiments have shown that grain yield responses to the application of increasing rates of P were achieved at this site, when N and Zn were applied with the P.

EXPERIMENT 2: P x N

Why do the trial?

To determine the best combinations of phosphorus and nitrogen as fluids for highly calcareous soils.

How was it done?

Trial Details: Experimental sites were established at Miltaburra and Yandra. Frame wheat was sown at 74 kg/ha with different combinations of P and N fluid fertiliser as phosphoric acid and urea. There was no addition of zinc. Fertilisers were placed 3 cm below the seed.
Treatments:
P rates: 0, 6, 10, and 14 kg/ha
N rates: 0, 5, 8, 10 and 20 kg/ha.
Measurements: Grain yield

What happened, and what does it mean?

At Miltaburra, grain yields responded only to P (*i.e.* there was no response to N, nor was there an interactive effect between P and N). However, there were no significant responses above 6 kg P/ha.

Locations

Miltaburra - L, M & C Mudge
Grey highly calcareous sandy loam
Colwell P: 18 mg/kg
% $CaCO_3$: 59 %
Annual rainfall: 275 mm
GSR: 200 mm

Yandra – I & G Morgan
Grey highly calcareous sandy loam
Colwell P: 24 mg/kg
% $CaCO_3$: 70 %
Annual rainfall: 400 mm
GSR: 320 mm

Emerald Rise – R, D & N Brace
Red calcareous sandy loam
Colwell P: 19 mg/kg
% $CaCO_3$: 14 %
Annual rainfall: 300 mm
GSR: 220 mm

Cowell – P & A Kaden
Red calcareous sandy loam
Colwell P: 17 mg/kg
% $CaCO_3$: 1.2 %
Annual rainfall: 289 mm
GSR: 203 mm

Plot size
12m x 1.44m, 4 replicates

At Yandra, there was an interactive effect between P and N. That is, responses varied depending on the rates of both P and N applied. In general, our interpretation of the results is that the major benefit in terms of grain yield was from the application of 6 kg/ha of P, with no N applied. However, no measurements were made of grain protein, and the long term effects of not applying N have not been taken into account.

It is also important to remember that the results from only one season cannot provide a comprehensive explanation of how plants respond to fertilisers.

EXPERIMENT 3: N x Zn

Why do the trial?

To determine which combinations of nitrogen and zinc, together with a single rate of P (applied as fluid or granular) perform best on a range of soil types.

How was it done?

Trial Details: Experimental sites were established at

(Continued on page 85)

(Continued from page 84)

Miltaburra, Emerald Rise and Cowell. Frame wheat was sown at 74 kg/ha to different combinations of N and Zn as granular and fluid fertilisers. All treatments received 10 kg P/ha as triple super phosphate (0:20:0) in granular treatments, or as phosphoric acid (H_3PO_4) in fluid treatments. Identical treatments were applied in granular and fluid fertiliser form

Treatments:

Granular fertiliser: 0:20:0 / Urea +/- Zinc as a fluid (gr) – denotes granular

Fluid fertiliser: Phosphoric acid/Urea/ +/- Zinc sulphate

1. 10 kg P/ha
2. 10 kg P/ha + 10 kg N/ha
3. 10 kg P/ha + 10 kg N/ha + 2.5 kg Zn/ha
4. 10 kg P/ha + 20 kg N/ha
5. 10 kg P/ha + 20 kg N/ha + 2.5 kg Zn/ha
6. 10 kg P/ha + 2.5 kg Zn/ha
7. 10 kg P/ha (gr)
8. 10 kg P/ha (gr) + 10 kg N/ha
9. 10 kg P/ha (gr) + 10 kg N/ha + 2.5 kg Zn/ha
10. 10 kg P/ha (gr) + 20 kg N/ha
11. 10 kg P/ha (gr) + 20 kg N/ha + 2.5 kg Zn/ha
12. 10 kg P/ha (gr) + 2.5 kg Zn/ha

Measurements: Whole shoot nutrient analysis (selected treatments only), dry matter, grain yield.

What happened?

Miltaburra

- Fluid fertiliser increased the dry weight of shoots of Frame wheat by 38% compared with granular application, while the addition of 10 kg N/ha increased the dry weight of wheat shoots by 2%.
- The application of Zn did not affect shoot dry weight or Zn concentration in shoots, but the application of Zn increased Zn uptake in shoots by 17%. However, the use of fluid, as opposed to granular fertiliser, increased Zn uptake by 31% across all treatments.
- The major effect on P uptake by shoots was the form of fertiliser applied with fluid increasing P uptake in shoots by 37%. P uptake in shoots was also increased by 12% by adding 10 kg N/ha and by 8% by adding 2.5 kg Zn/ha.
- Tissue concentrations and plant uptake of Mn were increased in shoots treated with fluid fertiliser rather than granular – Mn uptake was almost doubled in the fluid treated plants.
- Nitrogen uptake in shoots was increased by 35% with application of fluid fertiliser compared with granular.
- The major effect on grain yield was the form in which fertiliser was applied – fluids increasing grain yield by 14% above the granular yield. Nitrogen applied at 20 kg/ha depressed yields at this site, while the application of Zn had a small positive effect, increasing grain yield by 3%.
- Applying fertiliser in the fluid form also had positive effects on the degree of effective tillering (grain-heads/ m^2) and on total dry matter production (Table 1).
- Rainfall at Miltaburra in 2000 was above average. Data from previous seasons and comparisons between higher and low rainfall sites indicate that the efficiency of fluid fertiliser (compared with granular) may be relatively greater in drier environments and at lower rates of application (*i.e.* 2-8 kg/ha).

Table 1. Effects of form of fertiliser applied on total dry matter at harvest, head density and harvest index of Frame wheat at Miltaburra 2000.

Form of Fertiliser	Total Dry Matter (kg/ha)	Heads/m²	Grain Yield (t/ha)
Fluid	4641	213	2.16
Granular	4138	189	1.87
Significance	P<0.05	P<0.01	P<0.001

Emerald Rise

- The use of N was more effective on the red calcareous soil at Emerald Rise. Shoot dry weight was increased by 27% when 10 kg N/ha was added to the fluid fertiliser, but the same increase had no positive effect in the case of granular fertiliser.

Table 2. Effects of form of fertiliser and N application on the uptake of P in whole plants of Frame wheat at Haun 5 stage, Emerald Rise, 2000.

Form of Fertiliser	P uptake (ug/plant)	
	0 kg N/ha	10 kg N/ha
Fluid	692	975
Granular	643	630
Significance	LSD (P< 0.05) 168	

Table 3. Effects of form of fertiliser and application of N on Mn uptake in whole plants of Frame wheat at Haun 5 stage, Emerald Rise, 2000.

Form of Fertiliser	Mn uptake (ug plant)	
	0 kg N/ha	10 kg N/ha
Fluid	27.8	40.3
Granular	22.7	23.5
Significance	LSD (P< 0.05) 5.0	

- Similarly, the application of fluid increased P uptake in shoots by 29% (Table 2), Mn uptake by 31% (Table 3) and N uptake by 30% when 10 kg N/ha was added. The addition of 10 kg N/ha had no effect on P, Mn or N uptake when 10 kg N/ha was applied as granular. The reason for this is not clear – it is possibly due to a similar mechanism reported in the USA where the application of N and P together (in fluid form) has a synergetic effect on the growth and yield of winter wheat.
- Application of N or Zn at Emerald Rise had no effect on grain yield with granular applications but with fluids, increasing rates of both N and Zn had significant positive effects on yield (Table 4). Increasing applied N from 0 to 20 kg N/ha increased grain yield with fluid fertiliser applications from 1.56 to 1.80 t/ha. The use of N was not effective in the case of granular application. Similarly, the application of Zn was effective only in the fluid fertiliser. As was the case at Miltaburra, effective tillering (*i.e.* producing grain heads) was increased by fluid application and by the application of Zn.

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Table 4. Effect of form of fertiliser and applications of N and Zn on grain yield of Frame wheat at Emerald Rise, 2000.

Grain yield (t/ha)			
Form of Fertiliser	**0 kg N/ha**	**10 kg N/ha**	**20 kg N/ha**
Fluid	1.56	1.71	1.80
Granular	1.53	1.51	1.58
Significance	LSD ($P \leq 0.05$) 0.08		
Form of Fertiliser	**0 kg Zn/ha**	**2.5 kg Zn/ha**	
Fluid	1.62	1.76	
Granular	1.53	1.56	
Significance	LSD ($P \leq 0.05$) 0.04		

Cowell

- Shoot dry matter was not affected by any fertiliser treatments, although the addition of zinc raised dry matter production by 8.4%.
- The addition of zinc significantly increased tissue zinc concentrations from 28.5 to 34.1 ppm. In addition, tissue zinc concentrations were significantly higher with fluids (33.0 ppm) compared with granular (29.7 ppm).
- Tissue P concentrations were adequate for all fertiliser treatments. The addition of N significantly increased P concentrations, which were highest for the N_{10} treatment.
- There were no significant differences in grain yield between any of the fertiliser treatments.

What does this mean?

- On the grey highly calcareous soils at Miltaburra the major response was to P applied in the fluid form. The fluid fertiliser significantly increased shoot dry weight, P, N, Zn and Mn uptake in shoots. Grain yield was increased by 14%.
- Although research is needed to clearly define the issue, the role of Mn may be of considerable importance in these soils, where Mn deficiency can occur and root disease is endemic. The role of micro-nutrients, particularly Mn and Zn, in reducing the effect of root diseases has been clearly demonstrated. Tissue tests generally indicate "adequate" concentrations of Mn in wheat grown on these soils although it is possible that if concentrations of P can be increased, this may lead to deficiency of some micro-nutrients, particularly Mn. When you think about it, the concentrations of micro-nutrients that we normally see in cereals grown on the grey highly calcareous soils are in phosphorus deficient plants. Plants which have adequate P would be expected to grow more vigorously and produce more bulk. The small amounts of some micro-nutrients available in these soils may not be sufficient to supply the needs of healthy well grown plants.
- On the red-brown calcareous soil at Emerald Rise while there was no response to P, the use of fluid fertiliser increased shoot dry weight, P, N and Mn uptake in shoots. The addition of N and Zn to the fluid fertiliser increased grain yields by 11%, but there were no responses with granular treatments.
- At Cowell, the use of Zn in fluid fertiliser showed a small increase in Zn concentration in tissues. Apart from that, there were no other measured benefits.

Acknowledgments

This work was funded by the GRDC and would not have been explored without the curious minds and questioning voices of Upper EP farmers and the valuable assistance of Wade Shepperd (Minnipa Agricultural Centre). We also thank the co-operators for their time and provision of trial sites.

Fluid Fertilisers – Increasing the Range of Options

Dr Bob Holloway, Alison Frischke & Dot Brace
SARDI, Minnipa Agricultural Centre

Location
Calca - R McCallum
Grey highly calcareous sandy loam
Colwell P: 11 mg/kg
% $CaCO_3$: 65 %
Annual rainfall: 400 mm
GSR: 320 mm

Lock – D Foster
Greyish calcareous sandy loam
Colwell P: 54 mg/kg
% $CaCO_3$: 7 %
Annual rainfall: 344 mm
GSR: 273 mm

Plot size
12m x 1.44m, 4 replicates

Why do the trial?

To determine the efficiency of various formulations of new and conventional granular and fluid fertilisers from a selection of an increasing range of products.

How was it done?

Trial Details: – Trials were established at Calca and Lock. Frame wheat was sown @ 70 kg/ha with granular and fluid fertilisers. Each treatment received 10 kg P/ha and 20 kg N/ha, except the Granulock/H_3PO_4 5P treatment which received 5 kg P/ha and 20 kg N/ha. Where extra P was required, the amount was made up by adding phosphoric acid (H_3PO_4). Where extra N was required, it was made up by adding ammonium nitrate (AN). Several of the 'fluids' were standard granular products dissolved or partially dissolved in water. Where there was only partial solution and a residue remained, the residue was agitated at the time of application, although in some cases this caused filter blockage. All treatments, fluid and granular, also received zinc sulphate (except the TGMAP treatment which received chelated zinc) applied in solution @ 2.5 kg Zn/ha. This ensured that all treatments (fluid and granular) received a total of 400L of water per hectare. All fertilisers were placed 3 cm below the seed.

Treatments (Base Products):

1. DAP – di-ammonium phosphate (18:20:0)
2. Granulock 12Z (12:15:0 2%Zn)
3. TSP/S – triple super phosphate (0:20:0) + sulphur blend
4. 12:15:0
5. HiFert A – Hifert DAP experimental product
6. SMAP – Incitec MAP experimental product
7. SMAP/ZnO/AS – Incitec MAP experimental product + zinc oxide + ammonium sulphate
8. TGMAP – Technical grade MAP (12:26) + ammonium nitrate + Zn chelate
9. Planter 317Z – Albright & Wilson experimental fluid fertiliser (3:17:0:4, 2.5%Zn)
10. Granulock/H_3PO_4 10P – Incitec Granulock (12:15:0 2%Zn) + phosphoric acid - 10 kg P/ha suspensions
11. Granulock/H3PO4 5P - Incitec Granulock (12:15:0 2% Zn) + phosphoric acid – 5 kg P/ha
12. NZn'P – Agrichem experimental fluid fertiliser (3:17:0 5%Zn)
13. Agras/H_3PO_4 – CSBP commercial fertiliser + phosphoric acid
14. TGDAP – Technical grade DAP (21:23:0)
15. Pivot A - Pivot experimental product A
16. Pivot B - Pivot experimental product B suspensions
17. Pivot C - Pivot experimental product C

Measurements: whole plant tissue analysis, grain yield.

What happened?

Significant increases in nutrient uptake in shoots and grain yields due to applying fluid fertilisers, compared with conventional DAP, were measured at Calca, but no significant differences were measured at Lock. (See table 1 - significant differences in grain yield of wheat due to fluid fertilisers compared with DAP are followed by an asterisk (*)).

- TGMAP/AN/Zn chelate, TGDAP, Planter 317Z, Granulock/H_3PO_4 10P, NZn'P, Agras/ H_3PO_4, and Pivot A and B suspension treatments all produced significant yield increases over DAP, of between 5 and 11%.
- The dry weight of shoots at mid tillering was significantly increased by all fluid fertilisers compared with DAP. The greatest increases in dry weight occurred with Planter 317ZZ, NZn'P, Agras/H3PO4, and TGMAP/AN/Zn chelate. All of these fluid fertilisers increased the dry weight of shoots at mid tillering by 40% or more compared with those provided with DAP.
- Fluids generally enhanced concentrations of P (mg/kg) in whole shoots, and plant P uptake (µg/plant). P concentrations were significantly higher in shoots with the Planter 317Z treatment than all other fluid formulations.
- Total N% in whole shoots was significantly increased above that in DAP treated shoots by only one fluid fertiliser formulation, Planter 317Z.
- Concentrations of Zn in the TGMAP/AN/Zn chelate fluid formulation were significantly higher than in all other treatments. Tissue Zn concentrations were also significantly increased above those in plants treated with DAP by the granular formulation, HiFert A, and by the fluid formulations SMAP/ZnO, Planter 317Z, Pivot A and Pivot B.

There were no significant grain yield differences between fertiliser treatments at Lock. Extractable P concentration in the soil (Colwell) was 54 mg P/kg and calcium carbonate content 7.0%. The potential for P immobilisation in this

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Table 1: Grain yields, dry weight of shoots at mid tillering, and nutrient concentrations in whole shoots of Frame wheat sown with granular or fluid fertiliser at Calca and Lock 2000.

(For each experimental site, treatments followed by a (*) are significantly better than DAP)

Fertiliser Type: G – granular, F – fluid.

		Calca					Lock
Fertiliser Product	Fertiliser Type	Grain Yield (t/ha)	Dry Matter (% of DAP)	P uptake (µg/plant)	% N in whole shoots	Conc. Zn in whole shoots (mg/kg)	Grain Yield (t/ha)
DAP	G	2.10	100	0.82	4.69	40.2	5.09
Granulock	G	2.14	98	0.86	4.65	42.0	4.99
TSP/S	G	2.05	93	0.78	4.61	42.5	5.06
12:15	G	2.06	92	0.74	4.55	49.1 *	-
HiFert A	G	2.15	89	0.74	4.64	49.0 *	5.11
SMAP	F	2.20	124 *	1.04 *	4.64	42.2	5.01
SMAP/ZnO/AS	F	2.20	120 *	1.14 *	4.70	46.5	5.15
TGMAP/An/Zn chelate	F	2.25 *	143 *	1.31 *	4.53	65.1 *	5.06
Planter 317Z	F	2.37 *	166 *	1.63 *	4.85 *	50.4 *	5.13
Granulock/H_3PO_4 10P	F	2.34 *	128 *	0.86	4.76	42.9	5.15
Granulock/H_3PO_4 5P	F	2.21	125 *	1.05 *	4.58	42.0	5.02
NZn'P	F	2.32 *	150 *	1.35 *	4.62	41.8	5.16
Agras/H_3PO_4	F	2.29 *	146 *	1.38 *	4.70	41.0	5.09
TGDAP	F	2.34 *	136 *	1.27 *	4.74	43.7	5.04
Pivot A	F	2.27 *	118 *	1.13 *	4.65	49.7 *	5.08
Pivot B	F	2.29 *	127 *	1.16 *	4.80	46.9 *	5.05
Pivot C	F	2.24	124 *	1.14 *	4.67	40.9	5.09
Significance		P<0.001 l.s.d 0.14	P<0.001 l.s.d 16%	P<0.001 l.s.d. 0.19	P<0.01 l.s.d 0.14	P<0.001 l.s.d 7.5	Not significant

soil is relatively low. This contrasts with the Calca site where extractable P (Colwell) was 11mg P/kg soil and carbonate content 65%. The likelihood of grain yield responses from fluid fertiliser compared with granular, increases with increasing $CaCO_3$ content in the soil. However, responses have also been obtained on 'red' sandy loam soils with low extractable concentrations of P (Colwell).

Some of the products tested were not easy to use in terms of their applicability through a fluid delivery system. The easiest products to use were clear liquids (or those which produced clear liquids after adding to water) such as Planter 317Z, NZn'P, TGMAP, TGDAP, and Agras + H_3PO_4.

What does this mean?

Fluid fertilisers generally performed better than granular in terms of their ability to increase nutrient uptake, early vigour and grain yield in wheat on soils containing high proportions of calcium carbonate. There were clear differences between fluid formulations in terms of their performance in these areas.

Acknowledgments

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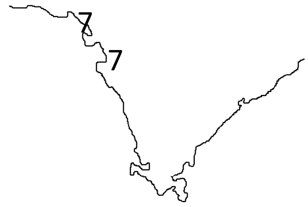
GRDC

Grains Research & Development Corporation

Water Rate Effects on Fluid Fertiliser Performance



Dr Bob Holloway, Alison Frischke & Dot Brace
SARDI, Minnipa Agricultural Centre

Location
Miltaburra - L, M & C Mudge
Grey highly calcareous sandy loam
Colwell P: 18 mg/kg
% $CaCO_3$: 59 %
Annual rainfall: 275 mm
GSR: 200 mm

Yandra – I & G Morgan
Grey highly calcareous sandy loam
Colwell P: 24 mg/kg
% $CaCO_3$: 70 %

Why do the trial?

To assess the effect of water rate of fluid fertilisers at two rates of phosphorus, on grain yield.

Previous experiments were designed on the assumption that a relatively high dilution rate was required to ensure maximum distribution of the fertiliser and that this would improve the availability of nutrients, particularly phosphorus (P) in calcareous soils. The relatively wide spacing of granules applied at conventional rates may increase P tie-up by having a concentrated zone of P diffusing around each granule, driving a P tie-up reaction. With a continuous band of fluid, at any point in the band, lower concentrations of P in the soil solution may allow P to remain in solution. However, farmers would prefer to use as little water as possible when applying fluids, so increasing water rates (from applying neat solution to 400 L/ha) were evaluated for their effects on yield.

How was it done?

Trial Details: Trials were sown with Frame wheat at Miltaburra and Yandra using fluid fertiliser injected beneath the seed over a range of water dilution rates. An ammonium polyphosphate (Polyphos®, 13:20:0 1% zinc) / urea ammonium nitrate (UAN, 32:0:0) / zinc sulphate blend was used to provide two rates of P (6 and 12 kg P/ha), 15 kg N/ha and 600 g Zn/ha.

Treatments: Actual fluid rates applied were, for the 6 kg P/ha applications – 65 L/ha (neat fluid), 119, 166, 225 and 414 L/ha. The 12 kg P/ha application consisted of the same rates except that the rate of neat fluid was 82.5 L/ha.

Measurements: Klepper-Haun score (growth score), YEB (youngest emerged blade of plant) nutrient analysis, grain yield.

What happened?

Yandra—At Yandra, both treatments receiving neat (undiluted) applications of fluid were visibly less vigorous than treatments with diluted fluids up until the Haun 5 (5 leaves on main stem) growth stage.

There was a significant interaction between dilution rate and P rate for P concentration in YEBs. The neat application at 12 kg P/ha produced a significantly higher P concentration in YEBs than all other treatments. However, P concentrations were in the deficient-marginal range for wheat at the late tillering growth stage. Zinc and manganese concentrations were not significantly different between treatments.

Water rate affected wheat yield at Yandra (Table 1). Dilution rates in excess of 120 L/ha increased wheat yields at both rates of P.

Table 1. Grain yield of Frame wheat as affected by dilution rate of fluid fertiliser at Yandra, 2000.

	Water Rate (L/ha)				
	Neat	**120**	**166**	**225**	**414**
Grain Yield (t/ha)	2.35	2.66	2.59	2.67	2.68
Significance	LSD (P≤ 0.05) 0.22				

Miltaburra—Miltaburra received less growing season rainfall than Yandra. While P concentrations in YEBs were not affected by P rate or the dilution rate, early plant vigour was poorer in plants with neat fluid applications than those which received diluted fluids. These early differences had disappeared by late tillering.

Manganese concentrations in YEBs were significantly raised when the rate of applied P was increased, but did not change as water rates increased.

Zinc concentrations in YEBs were significantly affected by the interaction between P rate and water rate, but absolute differences were not great.

Grain yield increased by 7.8% when P applied increased from 6 kg P/ha to 12 kg P/ha (Table 2), but was not influenced by water rate.

What does this mean?

Table 2. Effect of rate of P applied as fluid on the grain yield of Frame wheat at Miltaburra 2000.

Phosphorus Application Rate	Grain Yield (t/ha)
6 kg P/ha	1.97
12 kg P/ha	2.13
Significance	LSD (P≤ 0.05) 0.09

At Yandra, grain yield was significantly reduced when fluids were applied at less than 120 L/ha (the first rate of dilution above the application of neat fertiliser). Water rates in excess of 120 L/ha did not provide any additional yield benefit. At Miltaburra, water rate had no effect on grain yield. Given the visible growth differences at each site early in the season, further water rate research is needed in dry seasons when greater responses are seen with fluid fertilisers. *i.e.* distribution of fertilisers is more important as there is less soil water to enhance the movement of nutrients through the soil.

Acknowledgments

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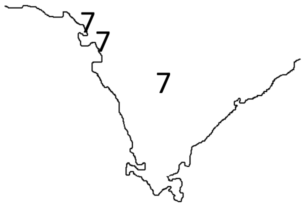


The Role of Fluid Fertilisers as "Plant Starters"

Alison Frischke, Dr Bob Holloway & Dot Brace
SARDI, Minnipa Agricultural Centre

Locations
Miltaburra - L, M & C Mudge
Grey highly calcareous sandy loam
Colwell P: 18 mg/kg
% $CaCO_3$: 59 %
Annual rainfall: 275 mm
GSR: 200 mm

Cungena – M & A Baldock
Grey calcareous sandy loam
Colwell P: 41 mg/kg
% $CaCO_3$: 38 %
Annual rainfall: 299 mm
GSR: 210 mm

Kyancutta – P & K O'Brien & Sons
Red calcareous sandy loam
Colwell P: 27 mg/kg
% $CaCO_3$: 5.6 %
Annual rainfall: 299 mm
GSR: 227 mm

Plot size
12m x 1.44m, 4 replicates

Why do the trial?

To determine whether the same nutrients applied in various proportions of fluid and granular fertiliser, are equally effective in producing grain yield on calcareous soils.

Where fluid fertilisers have been applied on phosphorus (P)-responsive calcareous soil types of Upper Eyre Peninsula, early growth of wheat has been greater than with granular fertiliser at the same P rate. This experiment investigates the possibility of using some fluid fertiliser as a 'starter' source of P to boost early plant growth, so that if dissolution of P from granules is relatively slow, plants can take up P later in the season from the granular fertiliser.

How was it done?

Trial Details: Trials were established at Miltaburra, Cungena, and Kyancutta. Frame wheat was sown @ 74 kg/ha. Phosphorus was applied in granular form as DAP (18:20:0), or in fluid form as an Agras (18:8:0) and phosphoric acid blend. All formulations received 10 kg P/ha, and 15 kg N/ha. Requirements for extra N were met by ammonium nitrate. Zinc was also applied in solution @ 2.5 kg Zn/ha to all treatments. With fluid treatments, the zinc was applied in solution with N and P. With granular treatments, zinc solution was applied simultaneously and at the same depth as the fertiliser granules, ensuring that all treatments received 400L of water per hectare. All fertiliser treatments were applied 3 cm below the seed.

Treatments:
- 100% granular fertiliser (100G)
- 80% granular fertiliser/ 20% fluid fertiliser (80G/20F)
- 20% granular fertiliser/ 80% fluid fertiliser (20G/80F)
- 100% fluid fertiliser (100F)

Measurements: Early dry matter production (Kyancutta only), grain yield.

Table 1: Grain yield and early dry matter (DM) production (Kyancutta only) of Frame wheat at Cungena, Miltaburra and Kyancutta with different fertiliser combinations, 2000.
(NB. Treatments followed by the same letter are not significantly different.)

Fertiliser treatment	Cungena	Miltaburra	Kyancutta	
	Grain Yield (t/ha)	Grain Yield (t/ha)	Early DM (g/plant)	Grain Yield (t/ha)
100G	1.45 b	2.10 c	0.47 b	3.44 b
80G/20F	1.55 b	2.21 b	0.63 a	3.58 a
20G/80F	1.56 b	2.40 a	0.61 a	3.51 a
100F	1.89 a	2.37 a	0.67 a	3.63 a
Significance	P<0.01	P<0.01	P<0.01	P<0.05

What happened?

Significant yield differences were measured between fertiliser combinations at all trial sites (Table 1).

- At Cungena, 100F increased grain yield significantly above combinations of granular and fluid fertiliser treatments, and the 100G treatment.
- At Miltaburra, 100F and 20G/80F treatments produced significantly higher grain yields than 80G/20F and the 100G treatment.
- At Kyancutta, early dry matter production was significantly greater for fertiliser treatments containing a fluid component, compared with the 100G treatment. These early dry matter differences resulted in significant yield differences, *i.e.* all fertilisers containing a fluid component yielded significantly higher than the 100G treatment.

What does this mean?

The grain yield response to combined applications of fluid and granular fertiliser varied according to trial location, and at each site produced the same or higher yields than granular fertiliser. However, a straight fluid fertiliser application is the simplest and most effective method of fertiliser application – straight fluid fertiliser produced grain yields equal to and above the fluid-granular fertiliser combinations and would be much easier to apply.

Acknowledgments

This work was funded by the GRDC and would not have been possible without the valuable assistance of Wade Shepperd (Minnipa Agricultural Centre). Special thanks to CSBP for providing the tissue analysis – your gesture was very much appreciated. We also thank the co-operators for their time and provision of trial sites.

Fluid Fertilisers – Responses of a Range of Crops on Upper EP

Dr Bob Holloway[1], Alison Frischke[1], Dot Brace[1] & Dr Peter Hocking[2]
[1]SARDI, Minnipa Agricultural Centre, [2]CSIRO, Division of Plant Science, Canberra

Locations

Yandra – I & G Morgan
Grey highly calcareous sandy loam
Colwell P: 9.1 mg/kg
% $CaCO_3$: 16 %
Annual rainfall: 400 mm
GSR: 320 mm

Karcultaby Area School
Red brown calcareous sandy loam
Colwell P: 8.2 mg/kg
% $CaCO_3$: 15 %
Annual rainfall: 310 mm
GSR: 230 mm

Lock – I Burrows
Grey calcareous sand over clay loam
Colwell P: 50 mg/kg
% $CaCO_3$: 3.3 %
Annual rainfall: 375mm
GSR: 290mm

Why do the trial?

To determine how crops other than wheat respond to fluid fertilisers on calcareous soils.
To determine to what extent different crop species are able to mobilise P through root exudations (compounds excreted by roots.
Fluid fertiliser research has concentrated on wheat. Experiments were established to see if other cereal crops and peas respond to fluid fertilisers in the same manner as wheat, *ie.* can grain yield increases be achieved by application of fluid fertilisers compared with granular fertilisers?
Some crop species are able to release organic acids from their roots into the soil immediately surrounding the root (rhizosphere) which enable roots to mobilise P for plant uptake. This experiment also serves to investigate the potential of some of these crop species to mobilise P on our calcareous soil types, and measure growth responses in following wheat crops.

How was it done?

Trial Details: – Trials were established at Yandra (grey highly calcareous sandy loam), Karcultaby Area School (red brown calcareous sandy loam) and Lock (grey slightly calcareous sand over clay loam). Different crop species were sown with granular and fluid fertilisers. Each treatment received 12 kg P/ha and 15 kg N/ha. Phosphorus was applied in granular form as MAP (10:22:0), or in fluid form as Technical Grade MAP (TGMAP) (12:26:0). Where extra N was required, this amount was made up by adding ammonium nitrate. All treatments, fluid and granular, also received zinc applied in solution @ 2.5 kg Zn/ha. This ensured that all treatments received a total of 400 L of water per hectare. All fertilisers were placed 3 cm below the seed.
Treatments: Plots of Herald medic, Parafield peas, Fiesta faba beans, rough-seeded lupins and Narbon beans were sown in addition to those listed in the table below at Karcultaby and Yandra, as well as Indian mustard (LN408) and Mystic canola at Yandra, but were not reaped. Each crop was sown with granular or fluid fertiliser. *Measurements*: grain yield.

What happened?

Significant grain yield increases were measured at Karcultaby and Yandra with the application of fluid fertiliser compared with granular (Table 1). At Karcultaby, wheat yield was increased by 13%, barley by 14%, durum wheat by 20%, and canola by 29%. Indian mustard yields were not affected.

At Yandra, significant yield increases with fluid compared with granular fertilisers were achieved by Krichauff wheat (44% yield increase) and barley (27% increase). However, Brookton wheat and Durum wheat did not respond significantly to fluid fertilisers at this site. Brookton wheat is reputed to be more P efficient than Krichauff. In this experiment, while the grain yield of Brookton did not significantly increase with fluid fertiliser, grain yields were increased by 0.30 t/ha with fluid – the difference was close to the least significant difference (0.33 t/ha). However, the yield response of Krichauff wheat to fluid fertilisers was considerably greater than that of Brookton.

There were no significant grain yield differences between fertiliser treatments at Lock. The extractable P concentration in the soil at Lock, as measured by the Colwell P test, was 50 mg P/kg soil, with a calcium carbonate concentration in the top 10 cm of 3.3%, *ie.* the soil has a high concentration of soil P, and the potential for P fixation is low. This contrasts with Karcultaby and Yandra where Colwell extractable P was 8.2 and 9.1 mg P/kg soil respectively and $CaCO_3$ contents were 15 and 16 % respectively. The likelihood of positive grain yield responses to fluids compared with granular fertilisers appears to increase with the carbonate content of the soil.
Extractable P as indicated by the Colwell test, is not a

Table 1: Grain yields (t/ha) of different crops sown with granular or fluid fertiliser at Karcultaby, Yandra and Lock 2000.

Crop	Karcultaby		Yandra		Lock	
	Fluid	Gran.	Fluid	Gran.	Fluid	Gran.
Frame wheat	3.12	2.76	-	-	4.08	3.88
Krichauff wheat	-	-	2.51	1.74	-	-
Brookton wheat	-	-	2.12	1.81	-	-
Barley	3.63	3.19	2.90	2.28	3.62	3.94
Tamaroi durum	2.69	2.24	1.27	1.19	3.32	3.28
Parafield peas	-	-	-	-	1.21	1.19
Indian mustard	1.20	1.24				
Mystic canola	1.29	1.08				
Fertiliser effect	P<0.001 l.s.d. 0.23		P<0.001 l.s.d. 0.33		Not significant	

(Continued on page 92)

(Continued from page 91)
reliable indicator of the P status of highly calcareous soils.

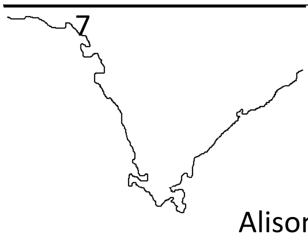
What does this mean?

Grain yield responses to fluid fertilisers depend on both crop type and soil type. In all cases, crops treated with fluids yielded equal to or better than crops treated with granular fertilisers. This was also true for the pea plots sown at Lock. It is possible that the poor performance of durum wheat on the highly calcareous soil at Yandra was due to limitations imposed by other nutrients, particularly micronutrients.

The possibility of root exudates releasing P for later crops will be tested in 2001 when the Karcultaby and Yandra sites will be oversown with wheat.
A similar experiment, exploring the response of different crops to fluid fertilisers will be repeated in 2001.

Acknowledgments

This work was funded by GRDC and would not have been possible without the valuable assistance of Wade Shepperd and Kay Brace (Minnipa Ag. Centre). We also thank the co-operators for their time and provision of trial sites.



Fluid Fertilisers in a Broadcast Seeding System

Alison Frischke and Dr Bob Holloway SARDI, Minnipa Agricultural Centre

Location
Ceduna
Ben and Brenda Hughes
Rainfall
Av. Annual total: 275 mm
Av. GSR: 190 mm
Actual annual total: 307 mm
Actual GSR: 241 mm
Yield
Potential: 2.63 t/ha
Actual: 1.43 t/ha
Paddock History
1999: failed wheat crop
1998: grass-free pasture
1997: pasture
Soil
Red slightly calcareous sandy loam
Diseases
Miild leaf rust
Plot size
26m x 1.5 m
Other factors
Fairly dry start

Why do the trial?

To investigate whether a pre-sowing or sowing application of fluid fertilisers, is as effective as granular fertilisers applied at the same time in a broadcast seeding system.

Aside from economics, another important consideration for adopting any new development into our farming systems is logistics. The broadcast seeding system is a useful tool, which when managed correctly, has repeatedly shown benefits over conventional seeding at Minnipa Agricultural Centre and Mudamuckla. In the broadcast seeding system, the ground is worked up in late-March, early-April, and fertiliser may be drilled at this time, or broadcast with the seed at sowing. To incorporate fluid fertilisers into the broadcast seeding system they would need to be applied at the working up stage.

How was it done?

Trial Details: A site was established at Maltee, on a shallow red slightly calcareous sandy loam. Fertiliser was applied in granular form as MAP (10:22:0), or in fluid form as a phosphoric acid and Agras (18:8:0) mix. Where formulations needed extra N, this amount was made up using urea. The pre-sowing applications of granular and fluid fertiliser were drilled at working up time, 31st March. Near sowing (2nd May), the other two fertiliser treatments were drilled into the remaining plots. All plots received 10 kg/ha of N, and 10 kg/ha of P, applied with the seed. Fluid treatments were applied at a water rate of 400 L/ha, and granular treatments received 400 L/ha of water to ensure all plots received the same water rate. The site was broadcast on 4th May with Excalibur @ 50 kg/ha. The site received a standard in-crop broadleaf herbicide.

What happened?

There was a significant interaction between fertiliser type and application time, where pre-sowing application of fluid fertiliser increased yields by 0.11 t/ha compared with a fluid fertiliser application at seeding time (Table 1). However, this did not happen with granular, and there were no other significant grain yield differences between treatments. This soil type has low soil P (24 mg/kg), but crops have marginal-adequate tissue P concentrations, and did not respond to fluid fertilisers in the way that the grey highly calcareous soils do.

What does this mean?

These are results from one season only—the trial was sown dry, and it was relatively dry until mid-June. However they do indicate that fluid fertiliser technology could quite easily be adapted into a broadcast seeding system on this slightly calcareous red sandy loam soil, *i.e.* yields of fluid fertiliser treatments were as good as those of granular fertilisers. The yields also indicate that fluid fertilisers can be applied at working up time.

For a soil type that immobilises P much more rapidly, such as the highly grey calcareous soils, further research is necessary.

Acknowledgements

This work was funded by the GRDC, and would not have been possible without the valuable assistance of Ben Hughes, and Wade Shepperd (Minnipa Agricultural Centre).

Table 1: Yield of Excalibur grown with fluid or granular fertiliser, drilled 1 month before sowing or at sowing, using broadcast sowing.
(Treatments with the same letter are not significantly different.)

Fertiliser application time	Fluid	Granular
	Grain Yield (t/ha)	
Pre-sowing	1.49 a	1.41 ab
Sowing	1.38 b	1.45 ab
Significance (timing x type)	P<0.05	

Supercharging Wheat Seed

Alison Frischke SARDI, Minnipa Agricultural Centre

Location
Lock
Julian Doudle (Lock IAMA), David Foster, Warren Burrows and Paul Searle

Rainfall
Av. Annual total 344 mm
Av. GSR: 273 mm
Actual annual total: 420 mm
Actual GSR: 353 mm

Yield
Potential: 4.8 t/ha
Actual: 2.6 t/ha

Paddock History
1999: Peas
1998: Oaten Hay
1997: Medic Pasture, spray topped.

Soil
Land System: Dune Swale
Major soil type description: Greyish calcareous sandy loam

Plot size
1.5 wide x 15m long, 4 replicates

Why do the trial?

To evaluate the effects of an application of a foliar nutrient spray at the milky dough stage (supercharging) on grain nutrient concentrations, and to determine how beneficial this is to subsequent crop establishment and wheat yields in a medium rainfall area.

It is well documented that wheat grain containing high nutrient concentrations has improved crop establishment and grain yields on nutrient deficient soils, compared with grain containing low nutrient concentrations. Many of the calcareous soils of Eyre Peninsula have an inherently low status of nutrients such as phosphorus (P), zinc (Zn), manganese (Mn), and copper (Cu). Without fertiliser application of these nutrients (either ground-applied or foliar), concentrations in the plant tissue will inevitably be low, and grain yields will be penalised. Generally, nutrients applied to seed at sowing may increase early trace element concentrations, but can fail to produce consistent or economic yield benefits or increases in grain nutrients. Trace element enhancement of seed at the milky dough stage (grain fill) by means of foliar application, has however shown reliable improvement in concentrations of trace elements in the seed (Mn, Zn and Cu). This can increase both dry matter production and grain yield of subsequent crops grown with that seed on soils deficient in trace elements. While it is relatively easy to increase trace element and nitrogen (protein) concentrations in grain, it is harder to increase grain P concentrations.

How was it done?

Trial Details: In 1999, 3 Lock farmers each treated a wheat crop at grain fill with the Phosyn product PRI-Phos® (liquid fertiliser), using 2 foliar applications of 500mL/ha (approx. $5/ha). This product contains 187 g/L phosphorus, 50 g/L potassium, 20 g/L manganese, 15 g/L copper, 15 g/L zinc and 5 g/L iron, all as phosphates. These seeds were then used in a trial which was direct drilled at Lock on 9th June 2000, into a moderately calcareous sandy loam. All treatments were sown at 70kg/ha and received DAP @ 70kg/ha. The site received standard knockdown and in-crop broadleaf herbicide applications.

Treatments: Stiletto, Silverstar and Frame wheat. Each variety had +/- treatment. Wheat was locally sourced, except the untreated Silverstar which came from a Cummins certified seed producer.
Measurements: Seed analysis, grain yield.

What happened?

The concentrations of nutrients in the product are low compared with standard recommendations of foliar application of nutrients. Phosphorus concentration in the grain did not increase with supercharging, and all P concentrations were within the range (adequate grain P concentration: P >3000 mg/kg) which should produce rapid emergence and vigorous seedlings in the following crop (Table1).

Table 1: Grain nutrient concentrations of wheat (+/- supercharging treatment) grown in 1999 at Lock.

Grain treatment	1999 grain analysis		
	P (mg/kg)	Zn (mg/kg)	Mn (mg/kg)
Stiletto - untreated	3900	15.6	23
Stiletto – treated	3500	16.4	31
Silverstar - untreated	3500	26.0	27
Silverstar – treated	3500	19.9	37
Frame – untreated	2900	34.0	35
Frame - treated	2900	34.0	37

Similarly, zinc levels did not change with the supercharging treatment, and were all above adequate standards (adequate grain Zn concentration: Zn >14 mg/kg). However, manganese was increased as a result of the foliar treatment. Adequate levels of Mn in the grain are considered to be above 20 mg/kg. The concentration of Mn in untreated Stiletto grain was just above the minimum level for adequacy, and was raised by 8 units with the supercharging treatment. For Silverstar, while untreated grain Mn levels were adequate, treatment raised the Mn concentration by 10 mg Mn/kg. In Frame, Mn levels were adequate and remained relatively constant, regardless of whether treated or not.

2000 crop: Plots containing treated seed had stronger growth throughout the season. This was particularly apparent for Stiletto and Silverstar, with the differences in growth continuing right into crop maturation.

Seed treatment significantly increased grain yields for Stiletto and Silverstar by 0.14 t/ha and 0.47 t/ha respectively (Figure 1). Frame grain yields did not change significantly.

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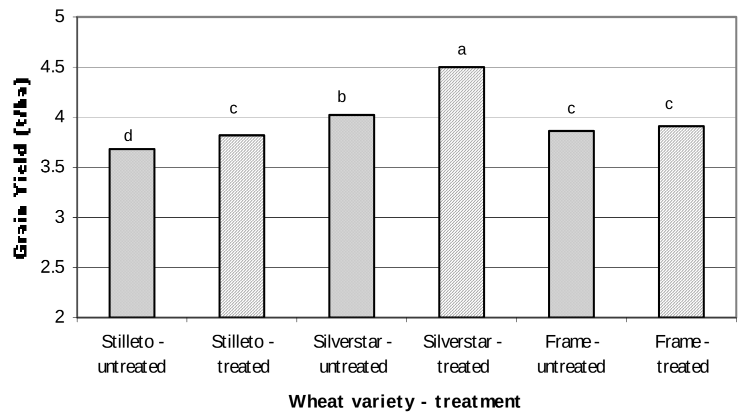

Figure 1: Grain yields of wheat sown at Lock, 2000.
(Treatments with the same letter are not significantly different.)

What does this mean?

- Supercharging is not a new method of treating seed for following crop use but continues to give good results. In this trial, supercharging seed enhanced plant growth, and gave significant yield advantages to the crop sown in the following season for Stiletto and Silverstar. Treatment of seed with the foliar nutrient spray at the milky dough stage raised seed Mn levels in both varieties. The concentration of grain nutrients in Frame did not change with seed treatment (all nutrient concentrations were adequate), nor were any yield advantages recorded.
- Experiments by Nancy Longnecker and Robin Graham (Adelaide University) in 1987 demonstrated the grain yield benefits of sowing seed with high Mn concentrations (0.37 t/ha) compared with seed with low Mn concentrations (0.09 t/ha), on a chronically Mn deficient soil at Wangary. Grain yields were further enhanced when a fertiliser containing Mn was used (from 1.87 t/ha with low Mn content seed, to 2.53 t/ha with high Mn content seed).
- Trials at Kimba in 1998/99 also showed supercharging benefits. Seed was treated with 4 Agrichem multi-element mixes at milky dough stage, (two of which included N and P), and then sown into plots in 1999 at the Kimba CRT Tech Site. The high input treatment (higher levels of N, P, Zn and other trace elements) raised seed zinc levels, and visual assessment during 1999 found this treatment to be more vigorous than other treated seed treatments, which in turn appeared more vigorous than the control. Given that there was a hard, dry finish, there were no statistically significant yield differences. There was a trend in which the high input treatment produced an increased yield and higher protein than the control.
- This research supports previous, although limited, seed supercharging information. If a crop is to be grown on a soil type that is low in a certain trace element, foliar application of that trace element to the seed source at milky dough stage, can increase grain nutrient concentrations, and improve early growth and grain yields of the subsequent crop. This requires patching out the area of the paddock from where seed is to be kept, with a boom spray, mister or plane.
- Experience suggests that two separate foliar applications should be applied during the grain fill period (which lasts 5 weeks) to raise grain trace element concentrations. For Mn, best results have been achieved when both seed supercharged with Mn, and a fertiliser containing Mn has been used.
- Consider carefully which nutrients you are targeting. There are many commercial preparations that will contain all of the trace elements needed, but if you are concerned about a particular trace element, the sulphates, such as zinc sulphate and manganese sulphate, are likely to be just as good and cheaper. However, if you are considering application of sulphates by plane, water rates will be much lower and your crop may suffer scorching. Commercial preparations are useful for multiple element mixes, and for cases where you are trying to boost protein, a slow release form of nitrogen maybe needed.
- This research will be continued in 2001 to further examine the importance of grain nutrient concentrations of seed grown on soil types on upper EP which cause crops to suffer trace element deficiencies.

Acknowledgments

This work was funded by the GRDC. Special thanks go to Julian Doudle (IAMA, Lock), David Foster, Warren Burrows and Paul Searle for their valuable assistance in supplying the product and treated seed for the experiment,

Pushing Protein Quality versus Yield

Nick Booth, Former PIRSA Field Crops Consultant, Cleve

Location
P & K O'Brien & Sons
Kyancutta

Rainfall
Ave Annual Total: 319mm
2000 Annual Total: 358mm
Ave GSR: 235mm
2000 GSR: 279mm

Soil Type
Sandy Loam over calcrete rubble
pH 8.6 (water)
OC%: 0.90%
Avail P 16 mg/kg (Colwell)

Paddock History
1999: Alma peas
1998: Galleon barley
1997: Excalibur wheat

Plot Sizes
3m x 50m

Replicates:
3

Central Eyre Wheat Trials 2000

Why do the trial?

To determine if growing high quality crops such as Tamaroi (durum) and Kukri has advantages over bread wheat varieties like Machete and Frame.

How was it done?

Plots 3 m wide by 50 m long were sown with a double disc seeder on the 25th May. A base rate of 18:20:0 was drilled with the seed @ 60 kg/ha. The plots with additional urea were pre-drilled @ 30kg/ha.
Bread wheats were sown at 65kg/ha, and durum sown at 80 kg/ha.

What happened and what does it mean?

The outcome of this trial highlights the importance of either choosing high yielding bread wheats or regularly achieving the quality required to tap into the premium wheat market. The highest gross margins were achieved by Kukri and Frame with urea added (Table 1). Unfortunately Machete did not make the target grade due to low test weight, and neither did Tamaroi due to low protein, resulting in lower gross margins than expected.

In all situations, the addition of nitrogen paid for itself by increasing grain protein and yield.

If durum wheats were accepted in Pt Lincoln the cost of freight would be reduced. The premium quality market can be very lucrative if the target grade (DR1) is achieved. However special attention to detail with crop management is crucial and the right seasonal conditions are also necessary to achieve the required protein levels. The cost of freight is also greater for the durum wheats, delivered to Kimba as they are then transported to Wallaroo (approx. $40/t). protein levels.
The increased price of AH1, compared to durum, and the 10-15% increase in yield of bread wheats has resulted in greater gross margins of these varieties compared to the durum wheats this year. A premium price and/or acceptance of prime hard and durum wheats in Pt. Lincoln, lowering freight costs, would make these high quality wheats a more profitable option in the future.

Table 1. Grain yield, quality and gross margins of wheat varieties grown with/without additional urea at Kyancutta, 2000.
*Income based on Harvest Payment option, delivered to Kyancutta (bread wheat) and Kimba (durum).

Wheat Variety	Urea	Grain Yield (t/ha)	Protein (%)	Test Weight	Achieved Grade	Target-Grade	Screenings (%)	Gross* Margin ($/ha)
Kukri	-	2.62	10.6	75.9	AH	AH	6.7	338
Kukri	+	2.97	11.2	74.0	AH	AH	7.1	392
Machete	-	2.81	9.9	69.0	GP1	AH	3.9	322
Machete	+	2.90	10.2	70.8	GP1	AH	3.3	346
Tamaroi	-	2.48	10.9	76.7	DR2	DR1	6.8	274
Tamaroi	+	2.54	11.8	75.5	DR2	DR1	7.6	298
Frame	-	2.97	9.4	75.1	APW	APW	5.3	371
Frame	+	3.00	10.2	74.0	APW	APW	5.1	391

Kimba 'Ex-Client' Group (K.E.G. for short)

Why do the trials?

The Kimba Ex-Client Group consists of a small group of farmers who challenge conventional thinking and like to see how far they can push their farming systems. These trials were done by Colin Rayson to determine if manipulating nitrogen rates and seeding rates could benefit the production of wheat on wheat on his farm.

Pre-Drilled Nitrogen Trial

How was it done?

Westonia wheat was sown on the 12th May. All plots had a base rate of 32:10:0 at 30kg/ha except the nil (no fertiliser) plots. Urea was pre-drilled.

What happened and what does this mean?

Yields fluctuated over the trial plots and do not show a strong correlation with applied nitrogen rates (Table 2). However, early vigour caused by the high nitrogen rates would have exhausted sub-soil moisture reserves and the plant could not convert the vegetative growth into yield. Urea rates between 0 – 40kg/ha have provided the best yields and best gross margins over several years of trials.There appears to be a good correlation between nitrogen rates and screenings. As expected, any additional yield advantage was probably lost given the dry finish and the high nitrogen rates resulting in the formed grain not filling properly.

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Nitrogen and Seeding Rate Trial

How was it done?

Westonia sown on the 12th May 2000
Base fertiliser 32:10 @ 30 kg/ha on all plots except nil treatment in Table 1.
Seeding rate ~ 80 kg/ha required to achieve 150 plants/m^2

What happened and what does this mean?

It is interesting to note that the higher seeding rates did not equate to higher screenings, although there may be some connection with the highest urea rates and screening levels (Table 3). It should be remembered that Westonia is a large grained variety and the optimum plant density is around 140 plants /m^2 (or approx 75-80 kg/ha).

In nearly all cases, the highest gross margin was achieved with Nil or 30kg/ha of urea, regardless of the seeding rate. This has been evident in previous years of similar trial work and now makes up part of Colin's standard practise.

Table 2: Grain yield, quality and gross margins of APW wheat grown with different rates of nitrogen.

Urea Rate (kg/ha)	Yield (t/ha)	Protein (%)	Screenings	Test Wt (g/hl)	Gross Margin ($/ha)
Nil	2.70	12.3	2.0	79.6	$413
20 kg	2.79	12.7	2.1	79.4	$430
40 kg	2.74	12.8	2.1	79.2	$414
60kg	2.73	13.2	2.3	78.7	$400
80 kg	2.67	13.5	2.3	78.1	$387
100 kg	2.65	13.5	2.5	77.7	$378
150 kg	2.64	13.8	2.4	76.9	$351

Table 3: Grain yield, quality and gross margins of APW wheat grown with different rates of nitrogen x seeding rate.

Urea Rate	Seeding Rate (kg/ha)	Yield (t/ha)	Protein (%)	Screenings (%)	Test Wt (g/hl)	Gross Margin ($/ha)
Nil	60	2.59	13.7	3.6	76.4	386
30 kg	60	2.76	12.6	2.4	79.4	408
60 kg	60	2.63	13.9	2.9	75.8	384
100 kg	60	2.52	13.5	3.0	78.4	363
Nil	70	2.80	12.0	1.7	79.2	426
30 kg	70	2.60	13.4	2.2	78.6	391
60 kg	70	2.69	13.6	2.6	78.8	395
100 kg	70	2.61	13.8	2.9	77.6	365
Nil	80	2.59	13.1	2.6	78.8	392
30 kg	80	2.78	13.2	2.3	79.4	418
60 kg	80	2.64	13.5	2.0	79.0	389
100 kg	80	2.84	13.3	2.7	79.0	396
Nil	90	2.84	12.0	2.4	79.4	419
30 kg	90	2.82	12.4	2.3	77.8	419
60 kg	90	2.79	13.2	2.4	78.2	409
100 kg	90	2.53	13.7	2.4	78.2	350

Residual Nitrogen Trial

Why do the trial?

This trial was carried out to determine if there is any benefit from residual nitrogen after the poor year in 1999. Janz wheat was simply sown over the 1999 trials to determine if there is any residual benefit from unused fertiliser.

How was it done?

Janz wheat was sown with 18:20:0 at 50 kg/ha.

What happened and what does it mean?

An almost linear relationship occurred between nitrogen rates applied in 1999 and yields obtained in the 2000 growing season (Table 4). Based on these results, it appears that benefits can still be achieved after a poor year with residual nitrogen.

Nitrogen is regarded as fairly mobile and tends not to be 'tied up' by alkaline soils. However, if relying on previous years fertiliser applications to support the crop it may be necessary to provide sufficient phosphorus since it is rapidly tied up in our alkaline soils and is critical in setting potential yield early in the life of the crop.

Table 4. Grain yield and quality of wheat grown with different rates of nitrogen applied in 1999.

Urea Rate	Yield (t/ha)	Protein (%)	Screenings (%)	Test Wt (g/hl)
Nil	1.54	9.0	1.5	83.5
20 kg	1.60	9.0	1.8	83.7
40 kg	1.59	9.4	1.9	83.7
60 kg	1.61	9.6	1.8	82.9
80 kg	1.64	9.9	2.6	82.8
100 kg	1.64	9.9	2.2	84.1
150 kg	1.71	11.4	4.4	81.0

Section Seven

Section Editors: [1]Samantha Doudle & [2]Rachel May

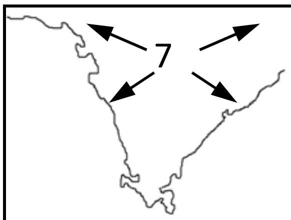
[1]SARDI, Minnipa Agricultural Centre, [2]PIRSA Rural Solutions, Cleve
[1]Eyre Peninsula Farming Systems Project Coordinator, [2]Land Management Consultant

Soils

Soils research has certainly increased on Eyre Peninsula over the last couple of years. In 2000, for the first time, we have the results from a microbial activity and disease survey of Eyre Peninsula soils. These are our first steps towards truly understanding who's living in our soils and whether they are good or bad tenants? Not only that, we have clay spreading, deep ripping and fertiliser placement, farming to soil type, magnesia patches and a survey of the salt and disease levels on the Far West coast.

As we said last year in this section, Eyre Peninsula soils are a non renewable resource. Due to our dry climate we do not have processes occurring that regenerate our soils. We must understand and manage our soils better to ensure they are our gift to the future, not our misunderstood legacy.

AusBulk



Living soils on the Upper EP - are they ????

Penny Day[1], Jon Hancock[2] and Dr Annie McNeill[1]
[1] Department of Agronomy and Farming Systems, Adelaide University Roseworthy Campus, [2] Minnipa Agricultural Centre, Minnipa

Why do the trial ?

Low fertility, poor organic matter status and a lack of structure are characteristics observed for many soils on Eyre Peninsula which has led to the belief that they may be a "microbial graveyard". The greatest concentration of microbes occurs in topsoil where they are responsible for breaking down organic matter, producing and providing vital nutrients for crop growth and sustaining crop production. So, it is timely to survey the relative size and activity of the microbial population in these soils as there is currently little information for EP. By sampling paddocks under continuous cropping and under pasture-wheat rotations we might determine the effect, if any, that cropping practices are having on the soil biota and ultimately soil fertility.

How was it done ?

Farmers from the Western and Upper regions of Eyre Peninsula participated in the survey. During July or August 2000, on each participating farm, top-soil samples (0-10cm depth) were taken from three sites: 1) a paddock that had been continuously cropped; 2) a paddock that had been in a pasture wheat rotation, both for a minimum of 5 years or longer; 3) a region of native bush or relatively undisturbed scrub. A bulk soil sample at each site was obtained from at least a one kilometre transect and three replicate sub-samples taken - so there were nine sub-samples per farm and 27 farms which resulted in a total of 243 samples!!! These were analysed for a range of chemical characters including moisture content, pH, electrical conductivity, texture, carbonate content and total carbon and nitrogen. Measurements of microbial biomass quantity (as microbial carbon) and activity (as soil respiration and production of plant-available N) were made - and this process is still on-going. Soil samples were also sent to the SARDI root disease testing service. All participants were asked to provide information on management practices in the sampled areas dating back at least five years.

What happened?

As mentioned previously, analyses are currently on -going and full results with interpretations will be provided in a booklet for each of the participating farmers later this year. However, the preliminary data may be interesting to those of you contemplating the influence that farming practice has on soil biota.

Microbial biomass and activity

The range in size (microbial biomass) and activity of the microbial population (Table 1) is basically due to the varied soil types and micro-climatic environments of the sample sites. However, initial analysis identifies some general trends with microbial biomass generally being smallest under remnant vegetation (RV) and larger under pasture-wheat (PW) rotation than under continuous cropping (CC). Overall the numbers are comparable to those from lower EP indicating that microbial populations on Upper EP are able to proliferate and maintain activity despite lower rainfall than other areas.

Table 1. Range of microbial biomass and respiration measured for soils on Upper EP and compared to data from

Area	Land use	Microbial biomass (ugC/g dry soil)	Respiration (ugCO_2-C/g dry soil)
Upper	RV	63 - 870	5 - 20
EP	CC	118 - 794	6 - 16
	PW	204 - 929	3 - 11
Lower	RV	79 - 319	1 - 10
EP*	CC or PW	150 - 808	3 - 25

Lower EP
* Data courtesy of V.V.S.R. Gupta and N Wilhelm

Microbial biomass correlated poorly with corresponding respiratory activity (Fig. 1).indicating that activity of the microbes in many of the soils is limited by one or more constraints. It may be due to the lack of sufficient 'energy blocks' in the soil (i.e easily decomposable carbon), a

Fig 1. Microbial size correlated poorly with respiration - data from all sites

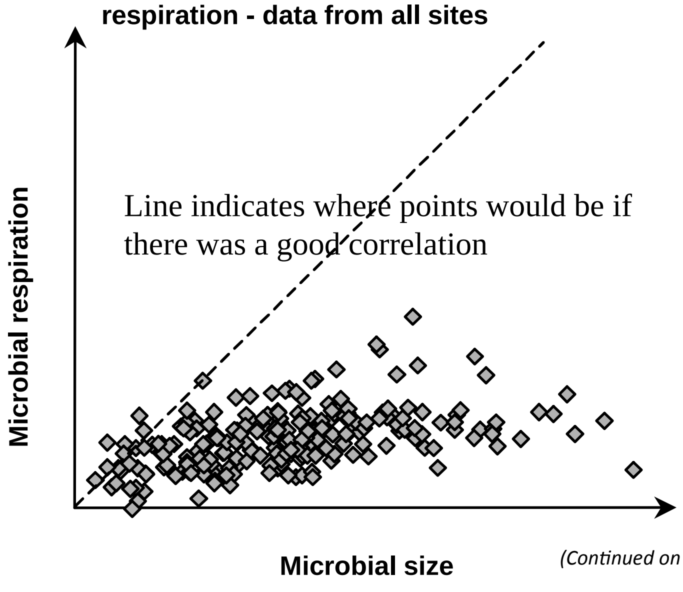


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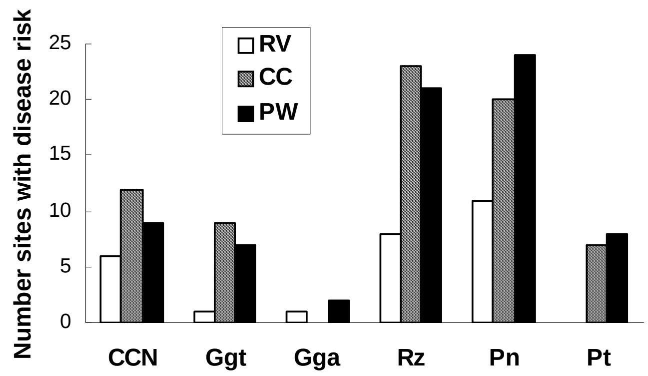
Fig. 2 Root disease test results for all sites



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nutritional deficiency such as low P, or there may be an influence of pH, despite most of the soils being neutral to alkaline which should be optimal for microbial function.

Root-disease causing organisms

A much lower potential for root-disease exists under remnant vegetation (RV) compared to either continuously cropped (CC) land or pasture-wheat (PW) rotation (Fig. 2). There were no large differences in potential for disease occurrence between land management practices with slightly greater amounts of CCN, rhizoctonia (Rz) and take -all (Ggt & Gga) under CC than PW but more pratylenchus (Pn & Pt) under PW than CC.

What does this mean ?

Use of these EP soils for agriculture has increased the size of the soil microbial biomass relative to soils under native vegetation, but there is an (as yet) unknown constraint operating which does not enable the microbes to reach optimum activity. Hopefully we will be able to develop a better understanding of this once we get data for production of plant-available N in relation to organic C and data for extractable and microbial P.

Choice of management practice also seems to have an influence on microbial biomass with greater amounts under a pasture-wheat rotation than under continuous cropping.

Disease risk clearly increases under agricultural practices although it was encouraging that at the majority of sites, risk assessment levels were mainly low or below detection with fewer sites at medium or high risk.

Thanks are due to all the participating farmers and we will be in touch later this year with a detailed summary of the results.

Subsoil Nutrition at Wharminda

[1]Samantha Doudle, [1]Dr Bob Holloway, [2]Dr Nigel Wilhelm
[1] SARDI, Minnipa Agricultural Centre

Location
Wharminda
John, David & Coral Masters
Wharminda Ag. Bureau
Rainfall
Av. Annual total: 296 mm
Av. GSR: 214 mm
Actual annual total: 391 mm
Actual GSR: 291.5 mm
Yield
Potential: 3.63 t/ha
Actual: Control–1.51,
Treatment 11 – 3.54
Paddock History
1999: Barque 1.16 t/ha
1998: Grass Free Pasture
1997: Barunga wheat
Soil
Sand dunes and swales over sodic clay
Diseases
Crown Rot
Plot size
4 Reps
2.8 x 20 m

Why do the trial?

This trial aims to help us understand why we gained a 79% yield increase with subsoil nutrition treatments in the 1999 Wharminda Sodicity Trial (pg 72 of 1999 manual). By using the same products as last year but with different rates and in different combinations we hope to increase our understanding of subsoil nutrition on these sandy soils.

In 1999 crop yield responded to ripping by 20%, surface application of nutrients by 25% (compared to no fertiliser) and subsurface application of nutrients by 79%. It was not clear from these results whether the nutrient response was a result of increased nitrogen, phosphorus or trace elements or a combination of all three.

The Wharminda Ag. Bureau also felt that the rates used in 1999 were unrealistically high. In 2000 we retained the high rate as one treatment, however the majority of treatments contained halved rates of nitrogen (N), phosphorus (P) and trace elements (TE).
Rather than apply all treatments by para plow again (as per 99 trial), in 2000 we used the para plow and the fluid fertiliser plot seeder to apply the same treatments. Exactly the same rates of product were used in each machine giving us a direct comparison between nutrient distributed throughout the soil profile to approx. 40 cm and nutrient banded just below the seed in a single fluid stream.

How was it done?

Trial Details
Ripping and nutrient placement date: 5th May 2000
Sowing date: 22nd May 2000
Variety: Frame Wheat
Base Fertiliser: 50 kg DAP applied at seeding 3 cm below seed
Ripping: 3 tyned para plow
Water Rate: para plow - 4444 litres/ha, fluid fertiliser seeder - 400 l/ha
Treatments—Table 1.

Measurements
Plant counts, tissue tests, dry matter @ harvest, yield, grain nutrients, screening and protein.

(Continued on page 101)

Table 1: Treatments for Subsoil Nutrition Experiment, 2000 (nutrient rates listed kg/ha)

Treatment		Para Plow (Fertiliser distributed through profile to approx. 40 cm, applied 5th May)	Fluid Fertiliser Plot Seeder (Fertiliser banded 3 cm below seed in continuous fluid stream, applied @ seeding, 22nd May)
1.	Cu Deep	Rip + Water + 2 kg Cu	
2.	Cu Shallow	Rip + Water	2 kg Cu
3.	TE Deep	Rip + Water + 2 kg Cu + 5 kg Mn + 5 kg Zn	
4.	TE Shallow	Rip + Water	2 kg Cu + 5 kg Mn + 5 kg Zn
5.	TE/N/P Deep	Rip + Water + 2 kg Cu + 5 kg Mn + 5 kg Zn + 10 P + 17 N	
6	TE/N/P Shallow	Rip + Water	2 kg Cu + 5 kg Mn + 5 kg Zn + 10 kg P + 17kg N
7.	Rip Only	Rip only	
8.	Rip + Water	Rip + Water	
9.	Foliar Spray	Rip + Water	Foliar Spray – 250 g Cu + 2 kg Mn + 1.5 kg Zn
10	Soil Spray	Rip + Water	Soil Spray – 2 kg Cu + 5 kg Mn + 5 kg Zn
11.	High Rate TE/N/P Deep	Rip + Water + 20 kg P, 34 kg N, 10 kg Zn, 10 kg Mn, 4 kg Cu (1999 Super Mix)	
12.	Control	Nil	

Table 2: Results from 2000 Subsoil Nutrition Experiment, Wharminda.

	Treatment	Yield t/ha	Gross Margin $/ha (exc. Ripping)	Cu (mg/kg)	Mn (mg/kg)	Zn (mg/kg)
				Grain Nutrient Analysis		
11	High Rate TE/N/P Deep	3.54	193.56	2.18	23.79	22.64
5	TE/N/P Deep	2.55	185.18	2.12	18.00	21.57
6	TE/N/P Shallow	1.86	18.36	1.99	17.86	22.90
1	Cu Deep	1.59	120.61	2.17	11.12	19.33
4	TE Shallow	1.57	98.26	2.15	17.89	22.95
10	Soil Spray	1.52	124.81	2.25	13.83	20.57
12	Control	1.51	123.11	1.80	14.79	20.18
3	TE Deep	1.49	90.36	2.39	16.35	23.84
7	Rip only	1.49	117.15	1.89	14.02	21.20
8	Rip + Water	1.46	115.63	1.95	11.82	20.63
9	Foliar	1.42	108.28	2.07	13.55	22.54
2	Cu Shallow	1.4	148.23	2.36	12.74	19.27
F		<.001		<.001	<.001	0.02
lsd		0.20		0.23	2.36	2.7

(Continued from page 100)

What happened?

Nutrient Combination

The high rate of nitrogen, phosphorus and trace elements distributed through the profile (treatment 11) produced a 2 t/ha yield increase over the control, the same treatment responsible for the 79% yield increase in 1999. In 2000 a 68% yield increase over the control was gained using the halved rate of N, P and TE placed throughout the profile. This was 71% better than the same amount of trace elements only placed at depth. All treatments without nitrogen and phosphorus had similar yields. All proteins were extremely low, with only a minor increase in the higher yielding treatments.

Nutrient Placement

A large yield increase of 37% was gained by distributing the same amount of N, P and TE nutrient mix throughout the soil profile to 40 cm as compared to placing it just below the seed (Treatment 5 vs 6). This yield increase did not occur with the treatment containing only trace elements. Both Treatments 11 and 5 showed significantly better tillering, plant growth, root growth and nitrogen levels in the grain, but Treatment 11 clearly outperformed the halved rate of nutrients in Treatment 5.

The Effect of Water

Despite the high water rate (4444 l/ha), there were no growth or yield differences between ripping only and ripping plus water (Treatments 7 and 8).

The Effect of Ripping

Unlike the 20% yield increase from ripping in 1999, the 2000 experiment showed no plant growth or yield increases from deep ripping alone.

Gross Margins

It is impractical and uneconomical to use a para plow to place nutrients across a whole paddock so the gross margins were assessed without including the cost of using the para plow to place the nutrients. The control returned a gross margin of $123.11 and the full rate deep placement (Treatment 11) returned $193.56. The direct comparison between the half rate of all nutrients placed deep or shallow (Treatments 5 and 6) showed the deeper placed nutrients gained an extra $166.82 /ha.

What does this mean?

There are enormous yield advantages to be gained by distributing a balanced mix of nutrients throughout the soil profile to a depth of 40 cm on nutrient-deficient sands (although at this site, we believe that it was the nitrogen which caused most of the yield increases). Using the same technique large yield increases were obtained on calcareous soils at Cungena in 1993. However, the para plow technique was abandoned due to the rocky soils. This led to the development of the continuous fluid stream theory and the fluid fertiliser seeder, with excellent results on calcareous soils. Evidence from the Wharminda trials and the original Cungena trials suggest that distributing the nutrients throughout the profile, rather than in a stream below the seed, should produce yet another yield plateau.

There were large yield responses to the high rate of N, P and TE in 1999, a very dry year, and 2000, an above average rainfall year. The response to ripping only occurred in the very dry year, which probably indicates better root penetration and water use in a year when water was one of the most limiting factors.

The gross margins indicate that the nitrogen placed throughout the profile paid dividends. The challenge remains as to how to place these levels of nutrients throughout the profile easily and economically.

Questions for the future

- Can the same yield response be gained using deep placed nitrogen only?
- Can a machine be developed to make the deep distribution of nutrients cheaper and more practical?
- Which soil types will this technique respond to?

We will continue this investigation in 2001, hopefully on a variety of soil types and with the benefit of some serious root measurements by a PhD student from the University of Adelaide.

Acknowledgements

Thank you to the Masters family for once again hosting and assisting with the set up and management of this trial.

Thank you also to Heidi Lynch and Wade Shepperd of Minnipa Agricultural Centre for sampling assistance.

What happened to last year's Wharminda Subsoil trial?

[1]Samantha Doudle, [1]Dr Bob Holloway, [2]Dr Nigel Wilhelm
[1] SARDI, Minnipa Agricultural Centre, [2] SARDI, Sustainable Farming Systems

Location:
Wharminda
John, David & Coral Masters
Wharminda Ag. Bureau

Rainfall
Av. Annual total: 296 mm
Av. GSR: 214 mm
Actual Annual total: 391 mm
Actual GSR: 291.5

Yield
Potential: 4.03 t/ha (barley)
Actual: Paddock Crop of Schooner 1.44 t/ha

Paddock History
1999: trial treatments
1998: grass free pasture
1997: Barunga wheat

Soil
Water repellent sand dunes over sodic clay

Plot size
2.8 x 12 m x 4 reps

Diseases
Crown Rot

Why do the trial?:

This trial simply aimed to determine if the surface applied gypsum and other nutrition treatments applied in 1999 would effect grain yields 12 months later.

Gypsum is composed largely of calcium sulphate. The calcium ions displace excess sodium from clay particles in sodic soils, thereby stopping the clays from dispersing when they get wet. Since there is still no economic method to apply gypsum directly into a sodic subsoil, it was spread on the surface in the 1999 trial. By sowing and reaping this trial again we aim to see whether the gypsum and/or the nutrients from 1999 are still affecting yield.

In an area such as Wharminda the gypsum would only move down the profile approximately 10 cm in a good rainfall year. This trial follows on from page 72 in the 1999 EP Farming Systems Summary.

How was it done?

1999 Details

Ripping: 3 tyned para plow to approx. 40 cm
Gypsum: Lake Malata Gypsum @ approx. 7 t/ha
Fluid Fertilisers: Phosphorus and Nitrogen: 20 kg of P/ha +9 kg N/ha as Tech Grade MAP
Nitrogen Source: 25 kg N/ha as ammonium nitrate
Zinc Source: 10 kg Zn /ha as zinc sulphate heptahydrate
Manganese Source: 10 kg Mn/ha as manganese sulphate tetrahydrate
Copper Source: 4 kg Cu/ha as copper sulphate pentahydrate

Treatments

1. Deep Ripping only
2. Deep Ripping + surface application of gypsum
3. Deep Ripping + subsurface application of fluid fertilisers
4. Deep Ripping + surface application of gypsum + subsurface application of fluid fertilisers
5. Surface application of gypsum
6. Surface application of fluid fertilisers
7. Surface application of gypsum and surface application of fluid fertilisers
8. Nil

2000 Details

Sowing Date: 24th May 2000
Fertiliser: 18:20:0 @ 78 kg/ha
Variety: Schooner Barley @ 63 kg/ha
Sown using farmer air seeder across the plots.
Measurements: grain nutrients, yield and gross margins

What happened?

Yield

There were very few effects of 1999 treatments on the yield of barley in 2000, with treatments 3 and 4, the highest yielding treatments in 1999, only slightly outyielding the other treatments in 2000. Despite a 20% yield increase from deep ripping in 1999, there was no yield increase from the previous ripping this year.

Trace Elements

All grain copper levels were adequate, however the treatments containing trace elements contained significantly higher levels of copper in the grain.
All grain manganese levels were deficient, however the treatments containing trace elements and/or gypsum provided the highest manganese levels.
All grain zinc levels were adequate, with all treatments containing trace elements resulting in increased zinc levels.

Gypsum

Gypsum is composed of calcium sulphate. Grain calcium and sulphur levels were higher in the treatments containing gypsum

What does this mean?

These results suggest that the large yield increases experienced in 1999, were probably due to nitrogen, as has been shown in the 2000 subsoil nutrition trials. Further analysis of the 99 results has revealed that both treatments containing deep placed nutrients (treatments 3 and 4) had significantly higher nitrogen/ha than the same treatments sprayed on the surface (treatments 6 and 7).
From the 2000 yield results, there did not appear to be any nitrogen remaining from the 99 treatments to help boost yield. Yields from this trial were similar to the control treatments in the new 2000 trial (page 98). This also suggests that nitrogen may have played a major role in the large responses because it would be expected that useful residual amounts of other nutrients, such as phosphorus, sulphur and micronutrients, would still be available where they were applied in 1999.

There were, however, increases in concentration of the applied trace elements, despite the fact that no further trace elements were applied in 2000. This is consistent with the immobile nature of trace elements after application (compared with nitrogen) and their residual properties on these soils.

(Continued on page 103)

Table 1: Oversown 1999 Sodicity Trial – 2000 Yield and Grain Analysis Results

Treatment	Yield (t/ha)	Ca (mg/kg)	S (mg/kg)	Cu (mg/kg)	Mn (mg/kg)	Zn (mg/kg)
1. Deep Ripping	1.5	355.0	1210.0	2.7	8.1	21.6
2. Deep Ripping & Gypsum	1.6	422.5	1375.0	2.6	8.8	21.8
3. Deep Ripping & Subsurface Nutrients	1.6	342.5	1167.5	3.6	9.2	25.8
4. Deep Ripping, Gypsum & Sub-surface Nutrients	1.6	405.0	1306.2	3.2	8.7	25.3
5. Gypsum	1.6	378.3	1332.5	2.7	8.5	21.8
6. Surface Nutrients	1.6	372.5	1305.0	3.5	9.5	23.9
7. Gypsum & Surface Nutrients	1.6	422.5	1352.5	3.3	9.7	24.0
8. Control	1.5	375.0	1267.5	2.8	8.1	22.1
Adequate Concentrations				*>2*	*>20*	*>14*
lsd (P=0.05)	0.08	28.83	73.17	0.62	1.08	2.19

(Continued from page 102)

Copper levels in the 1999 grain were marginal, despite the application of 4 kg/ha of copper. Copper levels in the seed in 2000 were all within the adequate range and this would indicate the copper applied in 1999 was still available to the plants in 2000 and perhaps better distributed.

Manganese levels in the grain in 1999 were improved from deficient to adequate by the application of 10 kg of Mn/ha. Manganese levels in the seed in 2000 were all in the deficient range. However, seed from treatments with trace elements added in 1999 did have slightly higher levels of manganese, indicating there was some available manganese remaining.

Zinc concentrations in the 1999 and 2000 grain samples were all "adequate", with the highest levels recorded on the treatments treated with trace elements in 1999.

There was no difference in concentration of trace elements in the grain between those applied down the soil profile and those applied on the surface, although all treatments had only small effects on grain nutrients. Placement of trace elements can be very important under deficient conditions.

It appears that the gypsum applied in 1999 was still within the root zone of the barley plants as indicated by the higher grain calcium and sulphur levels in the treatments containing gypsum.

The major message from this year is that the 1999 treatments had no major carry over effects into 2000. If this proves to be consistent (eg. 2001 results from the 2000 applications) then it will raise serious doubts about techniques developed to place in the profile nutrients deep because the costs will have to be recouped in the year of application.

Acknowledgements

Thank you to the Masters family for hosting, sowing and managing this trial. Especial thanks go to Wade Shepperd, Heidi Lynch and Ian Creeper for sampling and eventually finding last years plots with the metal detector!

Grains Research & Development Corporation

Subsoil nutrition research at Wharminda is funded by GRDC, through the Eyre Peninsula Farming Systems Project

Deep Ripping and Subsoil Nutrients – Wadikkee & LEP

[1]Nick Booth & [2]Mick Broad
[1]PIRSA Rural Solutions, [2]IAMA Cummins

Why do the trial?

Following the successful deep placement of nutrients at the Wharminda site in 1999, several other similar trials were established by the Waddikee Ag Bureau and IAMA Cummins .

Both groups aimed to assess the effectiveness of this technique in their local soil types.

How was it done?

The nutrients were placed into the sub-soil to a depth of about 40cm by using a three tyned paraplough.

Waddikee Ag Bureau
Nutrients: Zn ($ZnS0_4$), Mn ($MnS0_4$) and Cu ($CuS0_4$) and liquid phosphorus (Polyphos) kindly donated by Andrew Lymburn of Agrichem.
Rates equivalent to: 10kg Zn /ha, 10kg Mn /ha, 4 kg Cu /ha
Variety: Site A –Krichauff, Site B –Silverstar
IAMA Cummins
Nutrients: Zn ($ZnS0_4$), Cu ($CuS0_4$) and Tech Grade MAP.
Rates equivalent to: 4 kg Zn /ha, 1 kg Cu /ha, 77 kg MAP / ha
Variety: Coulta Site – Frame, Wangary Site – Camm

Figure 1: Waddikee Subsoil Nutrition Trials

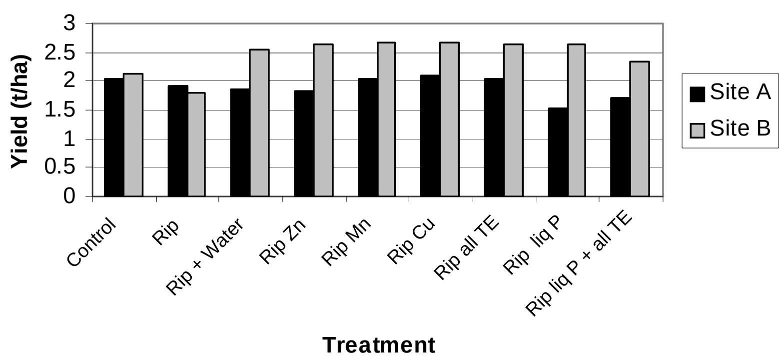
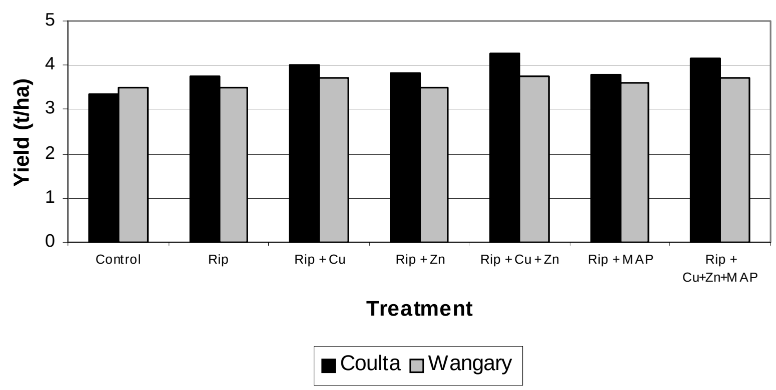


Figure 2: IAMA Subsoil Nutrition Trials



What happened?

Yields were variable from the Waddikee trials, with no clear indication of any treatments outperforming the others. A trend at site B is the increased yield of all treatments containing water through the profile, although this was not the case at site A or anywhere else this work has been conducted. Due to the broadscale, unreplicated nature of these trials, there is no difference between any of the treatments that can be explained with confidence.

The IAMA trials were located on two different soil types and treatments were replicated three times each (Figure 2),
(results from this trial were significant at the 10% level).

The Coulta trial returned a higher yield from all treatments containing copper and visual assessments of this trial during the year also indicated much better growth with the copper treatments. Zinc on its own showed no yield increase over deep ripping. However, combinations of copper and zinc provided the highest yield, indicating there may be an interaction between copper and zinc at this site.

Grain analysis of both Coulta and Wangary sites showed no significant differences in trace element concentrations in the grain.

Whilst not significant, the Coulta trial also returned a slight yield increase from all treatments with deep ripping

What does this mean?

Due to the unreplicated nature of the Waddikee trials and variation between replicates at the Wangary and Coulta trials, no reliable conclusions can be drawn from this data.

The Future

IAMA Cummins intends to conduct further research into ripping and subsoil nutrition on Lower Eyre Peninsula in 2001.

Butler Sodic Soil Trial

David Davenport, PIRSA Rural Solutions, Port Lincoln

Location
Butler
K. Sheperd, I. Charlton, A. Bates, N. Dunn.
Butler Agricultural Bureau
Rainfall
Av. Annual total 375 mm
Av. GSR: 300 mm
Actual Annual total: 435 mm
Actual GSR: 381 mm.

Why do the trial?

To determine and compare the effects of gypsum, deep ripping and subsoil nutrition on grain yields of crops grown on sodic subsoils in the Butler Tanks district.

Landholders in the Butler Tanks district have identified areas of paddocks where in many seasons the crop finishes earlier and often only yields half that of the remainder of the paddock. Soil tests identified a hard setting, highly sodic clay 8-15 cm thick commencing from 2-10 cm depth which was not found on other areas of the paddock. The Butler Ag. Bureau applied for and received some funding support from the Advisory Council of Agriculture to conduct some trials with ripping and gypsum to address the problem. It was also decided to include some subsoil nutrition as part of the trial to see what would happen on heavier soil types.

How was it done?

Four sites were selected only three were monitored and reaped. These were:

Treatments - All sites had the same treatments which were:

Site	Variety	Sowing Date	Fertiliser
Bates	Stilletto Wheat	2/6/00	85 kg/ha 18:20, 50 kg Urea
Charlton	Galleon Barley	7/6/00	75 kg/ha 18:20, 50 kg Urea
Dunn	Sloop Barley	1/6/00	70 kg/ha 18:20, 70 kg Urea

1. Deep Rip, 2. Deep Rip + Gypsum, 3. Deep Rip + Gypsum + Subsoil Trace Elements, 4. Deep Rip + Subsoil Trace Elements, 5. Gypsum, 6. Gypsum + Surface Trace Elements, 7. Surface Trace Elements, 8. Nil

Trace elements: Zinc Sulphate ($ZnSO_4$) =10kg Zn /ha, Manganese Sulphate ($MnSO_4$) = 10kg Mn/ha, Copper Sulphate ($CuSO_4$) = 4 kg Cu/ha

Ripping and subsoil nutrients to approximately 40 cm deep were applied with a three-tyned paraplow. In the surface treatment, nutrients were sprayed onto the surface at the same rate using the same equipment. Both surface and subsoil nutrients were applied prior to sowing.

Gypsum was applied at 5 t/ha to the surface prior to ripping.

Tissue testing was conducted at mid-late tillering at Dunns and Charltons.

What happened?

Tissue tests on Dunn's nil plots showed copper as adequate, manganese as bordering on deficient and zinc as marginal. Surface applied trace elements raised copper concentrations and lifted manganese concentrations to marginal and zinc concentrations to adequate. The subsurface treatments raised all concentrations to adequate levels with large increases in zinc in the tissue.

Table 1: Yield Results (t/ha) from Butler Sodic Soil Trial

	Dunn	Charlton	Bates
Deep Rip	3.7	3.5	3.3
Deep Rip + Gypsum	4.1	3.4	3.0
Subsoil Trace Elements (TE)	3.5	3.5	3.1
Gypsum + Subsoil TE	3.5	3.8	3.2
Surface TE	3.0	2.9	3.1
Gypsum + Surface TE	3.8	3.1	3.5
Gypsum	3.2	3.0	2.8
Nil	3.4	3.00	2.0

Tissue tests at Charlton's indicated adequate copper, deficient zinc and adequate manganese concentrations n the plants on the nil plot. Surface application of trace elements raised the zinc concentration to marginal status, while the subsoil application raised them to adequate.

Yield results were interesting in that observed visual differences on the subsoil trace element sites at Dunns did not result in expected yield increases but did at Charltons. The reason for variations at Charltons are unclear. Yields are summarised in Table 1.

What does this mean?

There were some inconsistencies in this data (which may have been reduced in a replicated trial). Surface application of gypsum may have provided a positive result where the sodic layer has been disturbed either through deep ripping, or on those sites (eg Bates) where the sodic layer is shallow and has been disturbed during seeding. Apart from this, surface application has not provided any significant benefit to date.

Deep ripping alone may also have been beneficial but due to the sodic nature of the soil this benefit may not continue into later crops.

Subsoil trace elements have had mixed results with Charltons the only site with any positive response. There may be several reasons for this:

- The Bates site has high levels of carbonate close to the surface. Manganese and zinc could be expected to be tied up by the carbonate.
- Charlton tissue tests identified a zinc deficiency which was corrected by the subsoil application.

What next?

The sites need to be monitored in the future to:

- assess if surface applications of gypsum improve soil condition as the gypsum dissolves.
- monitor the ripping to determine if the benefits are maintained.
- see if different seasons produce different results (years with drier finishes may see increased benefits from subsoil nutrients).

Edillilie Clay Spreading Trial

David Davenport, PIRSA Rural Solutions, Port Lincoln

Location
Edillilie
Morris Nelligan
Edillilie Landcare Group
Diseases
Spot form of Net Blotch
Plot size
30m x 6m
Unreplicated

Why do the trial?

To evaluate effect on grain yield from a barley crop grown on a clay spread sand dune.

Clay spreading is known to provide benefits in addressing water repellence, reducing wind erosion and raising the pH of acidic sands. However, expected increases in production have not always resulted on Eyre Peninsula. In some areas farmers have observed that crops on clayed ground appeared to show manganese and nitrogen deficiencies, particularly in the first few years after claying. It is known that manganese and zinc availability decreases with higher pH and that manganese assists in nitrogen uptake. If a high pH clay was applied to soils low in manganese and zinc could this cause a problem?

How was it done?

The Edillilie Landcare group supported a trial to look at these issues and a dune site was selected. The pH of the 0-10 cm prior to claying was 5 ($CaCl_2$). A sodic clay with free lime, (pH 8.9) was spread at approx. 150 t/ha. in January 2000. After incorporation pH was raised in 0-10 cm layer to 7.5.

Treatments: 1. Deep ripping only, 2. Subsoil application of trace elements, 3. Subsoil application of nutrients (TE + TGMAP), 4. Surface application of trace elements, 5. Surface application of nutrients (TE + TGMAP), 6. Nil

Ripping and subsoil nutrients to approximately 45 cm deep were applied with a three tyned paraplow prior to sowing. Surface nutrients were sprayed onto the surface at the same rate using the same equipment.

Nutrient Rates : Zinc Sulphate ($ZnSO_4$) =10kg Zn /ha, Manganese Sulphate ($MnSO_4$ =10kg Mn/ha, Copper Sulphate ($CuSO_4$) = 4 kg Cu/ha, Tech Grade MAP (TGMAP) = 20kg of P/ha + 9 kg N/ha

Foliar Spray (early July): Copper Sulphate 250 g/ha, Zinc Sulphate 1 kg/ha, Manganese Sulphate 3 kg/ha

Granular: 90 kg 18:20 at sowing, 30-40 kg urea at early tillering. Tissue tests were taken at mid tillering.

What happened?

Visual differences of the plots became apparent early with the subsoil treatments and to a lesser extent the deep rip plot having greater vigour than the surface treatments and the control (Table 1). These differences became more pronounced as the crop matured. Tissue analysis at mid tillering showed manganese to be bordering on deficient in plants with the nil and surface applied treatments, marginal in the deep rip treatments and adequate in the subsoil treatments. Zinc was adequate on all plots but the subsoil plots gave the highest concentrations. Tissue nitrogen was also higher in the ripped and subsoil plants than in the control and surface applied plants. Differences in crop vigour were highlighted during the dry period in September with the control and surface applied sites haying off. The other plots maintained head development although the ripped site finished earlier than the subsoil nutrient sites.

Table 1: Yield Results – Edillilie Clay Spreading Trial (trace element grain analysis)

TREATMENT	YIELD (t/ha)	Mn (mg/kg)	Zn (mg/kg)	Cu (mg/kg)
Deep Rip	2.6	12.4	24.0	2.4
Subsoil Trace Elements	3.0	16.5	29.0	2.6
Subsoil Nutrients	3.2	16.8	30.0	2.7
Surface Trace Elements	1.7	9.0	22.0	2.8
Surface Nutrients	1.6	10.0	24.0	2.8
Nil	1.6	8.6	23.0	2.7

What does this mean?

Unfortunately the methodology used and lack of replication in this trial make it unclear how much benefit is due to the deep ripping and how much is due to the addition of subsoil nutrition. However it would appear that:

- Deep ripping has provided a major yield increase.
- Manganese deficiency has occurred. This has probably been caused by raising the pH with the addition of calcareous clay, thereby lowering the availability of manganese.
- Placement of manganese below the incorporated clay and to a lesser extent deep ripping resulted in increased manganese in the plant.
- Surface application of trace elements appear to have had no effect on manganese concentrations.
- A single application of manganese foliar spray was not sufficient to overcome manganese deficiency in the tissue.
- Zinc uptake was improved in the subsoil applications but as zinc was already adequate in the plants, we do not know if this was significant.

What now?

This trial site should be monitored further to:

- Determine if manganese deficiency is only short term - other work where clay spreading has appeared to induce manganese deficiency indicates that this problem may only occur in the first 1-2 years following claying.
- Identify the period of benefit achieved by deep ripping.
- Further assess the benefits of subsoil nutrition over and above benefits resulting from deep ripping or correcting the apparent manganese deficiency.
- Another trial site should be developed to determine if it is pH alone or calcium carbonate (lime) or a combination of both which is the major factor causing manganese deficiency.

Take home messages

This trial confirms that soils which are low in manganese are highly susceptible to manganese deficiency if the pH is raised either through clay spreading or liming. It would also appear to be important to incorporate manganese into the soil profile below the zone of raised pH.

Deep ripping is an option to consider on sands (careful timing is required to minimise erosion risk).

Clay Spreading and the Effect on Pastures

[1]Ian Creeper & [2]Rachel May
[1] SARDI, Minnipa Agricultural Centre, [2] PIRSA Rural Solutions, Cleve

Location
Wharminda
Jeff & Jodie Jones
Wharminda Ag Bureau
Rainfall
Av. Annual total: 327 mm
Av. GSR: 302 mm
Actual annual total: 373 mm
Actual GSR: 301 mm
Paddock History
1999: Barley
1998: Grass Free Pasture
1997: Wheat
Soil
Dune Swale
Sand dunes & swales over sodic clay
Disease
Cereal Cyst Nematode – Nil
Take-all – Nil
Rhizoctonia – low
Pratylenchus neglectus - low
Plot size
2.8 m X 20 m, 3 reps

Why do the Trial?

This trial was established in 1999 to determine the most economical combination of clay rate and incorporation depth for water repellent sands in Eyre Peninsula's low rainfall areas. Barley was grown in 1999 with dramatic differences in yield (see Eyre Peninsula's Farming Systems 1999 Summary, page 74). It was decided by the Wharminda Bureau that the next phase of the rotation would be pasture and that the effect of clay spreading has on pasture & especially pasture improvement would be measured.

How was it done?

1999 Treatments
Clay was incorporated at two depths and various rates

1. 0t/ha
2. 50t/ha + shallow incorporation
3. 50t/ha + deep incorporation
4. 100t/ha + shallow incorporation
5. 100t/ha + deep incorporation
6. 150t/ha + shallow incorporation
7. 150t/ha + deep incorporation
8. 250t/ha + shallow incorporation
9. 250 t/ha + deep incorporation

1999: Clay spreading date: 8th April 1999
Clay Incorporation Date: 14th and 15th April 1999
Sown to Sloop Barley 22nd June 1999
2000: Herald 3 kg/ha and Parabinga 4 kg/ha mix sown on 12th April using small seed spreader followed by harrows. Sprayed 13th July with Broadstrike 24 g/ha

What Happened?

Medic suffered severely from powdery mildew throughout the season and which suppressed plant growth. Herald appeared to suffer more from the mildew than Parabinga.

Plant Emergence

Medic: Clay spreading increased medic emergence, although the amount of clay and depth of incorporation appeared to have little impact. Generally medic emergence doubled on clay-spread areas and visual evidence indicated that the medic on these areas was much healthier and grew more vigorously.

Dry Matter: Capeweed was the main weed at the site and contributed a large amount to overall dry matter. Clay spreading at higher rates increased dry matter significantly 150 t/ha shallow produced 2 t/ha compared to the control which produced 0.95 t/ha. This was probably due to the increase in capeweed emergence and growth where clay was spread. Medic competed poorly with the capeweed.Visual dry matter differences between clay spreading treatments were due only to differences between the various treatments and the control.

Soil Water: Soil water measurements were taken on the 14th of March to a depth of 15 cm. The readings indicated that soil water to 15cm increased as the quantity of clay spread increased, eg. control 3.6%, 250t/ha shallow 6.6%. Soil water in the shallow incorporation clay spread sites tended to be greater than the deeper clay spread sites.

What does this mean?

Pasture dry matter was significantly increased with clay spreading. However the overall improvement in pasture species (medic) was lower than expected due to the increase in capeweed emergence and growth. It could be assumed if capeweed could be controlled effectively, a significant improvement in pasture composition could be made. In this trial medic was sown before the break of the season. However it may be necessary to wait until capeweed emerges, gain control and then sow the medic.

Table 1: Results from 2000 Wharminda Clay Spreading

Treatment	Soil Moisture to 15cm March 14th (%)	Medic Plants/m²	Capeweed Plants/m²	Dry Matter t/ha
0t/ha Control	3.6	50.7 c	91.3 cd	0.95 c
50t/ha + shallow inc.	4.2	82.0 b	115.3 b	1.28 bc
50t/ha + deep inc.	4.6	95.7 ab	58.7 e	1.33 bc
100t/ha + shallow inc.	5	84.4 b	122.5 ab	1.50 abc
100t/ha + deep inc.	5.1	114.6 a	64.7 de	1.39 bc
150t/ha + shallow inc.	6.1	97.6 ab	138.7 a	2.00 a
150t/ha + deep inc.	5.3	102.7 ab	82.7 d	1.82 ab
250t/ha + shallow inc.	6.6	93.3 ab	113.0 bc	1.82 ab
250t/ha + deep inc.	5.4	96.6 ab	75.9 de	1.73 ab
Significance		LSD 26.19	LSD 23.18	LSD 0.46

Clay Spreading at Kelly

Rachel May, PIRSA Rural Solutions, Cleve

Location
Kimba
John and Gary Grund
Rainfall
Av. Annual total: 341 mm
Av. GSR: 240 mm
Actual annual total: 384 mm
Actual GSR: 291 mm
Yield
Potential: 3.6 t / ha
Actual: 2.3 t / ha
Paddock History
1999: Excalibur wheat
1998: Merritt lupins
1997: Excalibur wheat (clay spread in April)
Soil
Deep non-wetting sands over heavy red clay
Plot size
Dimensions: 5 plots x 1 ha each, unreplicated
Other factors
A hot, dry October lead to pinched grain, otherwise an ideal growing season

Why do the trial?:

This trial aims to monitor the effect of different clay application rates on non-wetting sands in the Kelly area.

The trial has been monitored since clay was first spread in April 1997. The 1999 trial results can be seen on page 77 of the 1999 Farming Systems Summary Book. The trial compares four application rates of clay against a control of nil; the rates that are included are 150, 200, 250 and 300 tonnes per hectare.

How was it done?

2000 paddock data
Variety: Excalibur wheat
Sowing date: May 18th 2000
Fertiliser: 50 kg 18:20
Trace elements: 1.5 kg Zinc, 3 kg Manganese sulphate, on July 2nd 2000.

This year option D soil tests were carried out to identify whether the clay had had any affect on soil nutrition, particularly to see how the clay had influenced pH, free lime, sodium and boron. Other assessments that were made over the year included, yield, grain test and quality.

What happened?

Yield—The grain yield results for 2000 show that differences between treatments have started to level off, but all plots yielded greater than the nil, (up to 44% of nil). In 1999 results indicated that the lower clay rates gave better yields, whereas this year the results are relatively even.

Gross income—Table 1 shows that the most successful treatment this year was the 200t/ha clay rate, based on gross income. This rate contributed an extra $171.78 per hectare above the nil plot.

Soil Analysis—The soil analysis indicates that the clay had a minimal impact on soil pH, sodium and boron levels on the treated soils, despite the fact that the clay spread on the site was highly sodic (ESP 35.9%, critical level <15%) and high in boron (12.7 ppm, critical level <10 ppm). Even though the clay was high in sodium and boron, it represented only a tiny proportion of the total soil volume, insufficient to alter the soil characteristics.

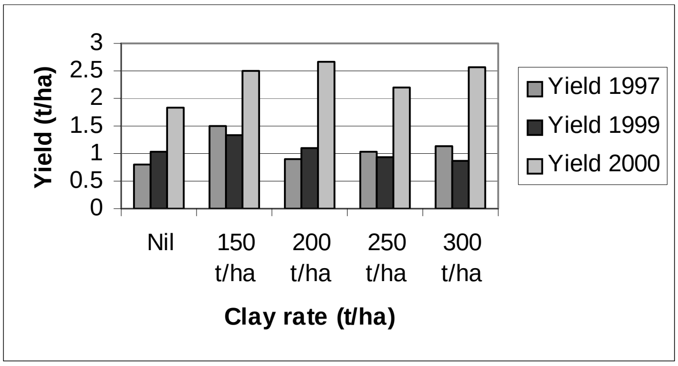


Table 1: Yield and Gross Margin, Kelly Clay Spreading

	Treatment				
Test	Nil	150 t/ha	200 t/ha	250 t/ha	300 t/ha
Screenings %	6.8	5.2	3.3	6.1	10.0
Protein %	9.9	12.2	10.4	10.3	11.5
Yield (t/ha)	1.83	2.50	2.67	2.19	2.57
Gross payment per ha	$305.42	$458.50	$477.20	$377.55	$436.00

Table 2: Soil Analysis, Kelly Clay Spreading Trial

Treatment	Control	200 t	300 t	The Clay
pH (water) pH (CaCl)	7.4 6.4	8.5 7.8	8.9 8.0	10.0 8.6
Free lime	Slight	Mod	High	Very high
Ex Sodium %	1.8	1.5	1.4	35.9
Ext Boron (mg/kg) Ext Chloride (mg/kg)	0.6 6.0	1.1 6.0	1.2 7.0	12.7 360

What does this mean?

On the whole, 2000 was an exceptional year in the Kelly area. The even yields may be attributed to soil water availability during the growing season. Due to the above average growing season rainfall in 2000, there was a decreased affect of water tie-up in the spread clay. On the basis of yield alone, any application of clay should be beneficial in a good year

Based on the soil analysis carried out in 2000, the only factor that may be an issue with spreading of higher rates is the increase in free lime in the soil. This may result in some nutrient tie-up, particularly phosphorus. Care will also be needed when selecting crops, particularly if lupins are to be grown.

Landholder observations—On the whole the Grund's are happy with the way the trial performed in 2000, particularly the fact that overall, yields were seen to be fairly consistent across the treatments. They experienced no wind erosion on any of the clay spread plots this year, and their only disappointment was the lack of rain during October for filling the grain.

2001

The trial will continue to be monitored during 2001 with the main aim of the trial to get long term data on clay

Farming to Soil Type – was it worth it?

Samantha Doudle, Minnipa Agricultural Centre & Mid West Farmers Group

Location
Minnipa
Scott & Jane Forrest
Mid West Farmers Group
Rainfall
Av. Annual total: 322 mm
Av. GSR: 249 mm
Actual annual total: 396 mm
Actual GSR: 300 mm
Yield
Potential: 3.8 t/ha
Actual: 2.52 t/ha (66%)
Paddock History
1999: spraytopped pasture
1998: wheat
1997: pasture
Soil
Dune Swale Land System
Sandy, often water repellent dunes, red sandy loam flats, rocky limestone rises.
Diseases
Crown Rot, Rhizoctonia
Plot size
9 m wide x 170m long, 2 reps
Other factors
Large areas of disease, ryegrass competition on rocky soil

Why do the trial?

This trial continues to gather information about how different soils perform under different seeding and fertiliser rates during different seasons.
Using this information we can then work out if it is worth using variable rate technology (VRT) machinery or adapting your existing machinery to allow these changes to happen quickly and easily. The trial is also providing some interesting information regarding the nutrition levels of the different soil types within a paddock.
The trial continues work begun in 1999 and follows on from the article on page 80 of the 1999 edition of this summary.

How was it done?

The Mid West Farmers Group found a site containing four of the most common soils in the Minnipa district – deep sand over loamy sand (top of dune), sandy loam over sandy clay (side of dune), red sandy loam over light clay (red flat), and red sandy loam between calcrete rubble over calcrete (rocky rise).

Preparation: 400 ml Roundup CT®, 200ml Ester®– 2 weeks prior to sowing + 500ml LVE MCPA® @ sowing
Seeding: direct drilled using a VRT Morris Triple Bin 7130 attached to Gason Bar on 9.2" spacing
Fertiliser: 2l/ha Zincsol ® (+treatments)
Variety: Frame

Table 1: Treatments for Farming to Soil Type Trial

Number	Treatment	Seed (kg/ha)	DAP Fert (kg/ha)
1	District Practice	50	50
2	High fert.	50	70
3	High seed	70	50
4	Low seed	30	50
5	Low fert.	50	30
6	Low all	30	30

Measurements:
The area was intensively sampled and measured to create an accurate soil type map. Emergence counts, tissue tests, harvest cuts and yields were all taken.

What happened?

Yield (Figure 1): The sandy loam soils of the dune slope were the highest yielding soil type this year, followed by the red flats, dune crests and rocks. There was no interaction between any of the treatments and the soil types, ie. none of the treatments made any difference to yield on any of the soil types.

Screenings: The wheat from the red flats had higher screenings than any of the other soil types.

Trace Elements (Table 2): Manganese and copper were both significantly higher in the plants taken from the red flats and rocky soils. Manganese levels were nevertheless adequate on the sands and slopes. Copper levels were marginal on the sand and slopes.
Zinc levels appeared to be unrelated to soil type and levels were generally marginal across all soil types.

Phosphorus: Phosphorus levels were marginal on the red flats and rocky soils, and adequate on the sands and slopes.

Salt: Sodium levels in the plant tissue were significantly higher on the red flats and rocky soils.

Gross Margins (Figure 2):
Gross margins from the 2000 trial were up to three times better than those from the dry year in 1999. The rocky soils still returned the lowest gross margin, however at least it was positive this year!

What does this mean?

Table 2: Tissue Analysis, Farming to Soil Type Trial, 2000

Soil Type	Tissue Analysis (mg/kg)				
	Mn	Cu	Zn	Na	P
Dune	27.0	2.9	21.4	236.5	4375
Slope	29.7	2.3	24.7	233.7	4375
Flat	130.0	9.4	21.0	409.8	3175
Rocks	66.4	7.1	22.9	507.7	2842
Marginal Levels (mg/kg)	15-20	1.5-3	16-24	N/A	3000-3700

Trace Elements: The red flats and rocky soils are inherently higher in manganese and copper than the sandier soils. Once identified, trace element deficiencies can be easily rectified with foliar or soil sprays of the required trace elements.

Yield:
Red Flats - In 1999 flats in the district performed poorly due to drought conditions. In 2000, these same flats became the second highest yielding soil type.
Rocky Soils - Once again the rocky soils proved the lowest yielding soil type in the paddock. Opportunities should be taken to avoid very stony patches if possible, as not only is

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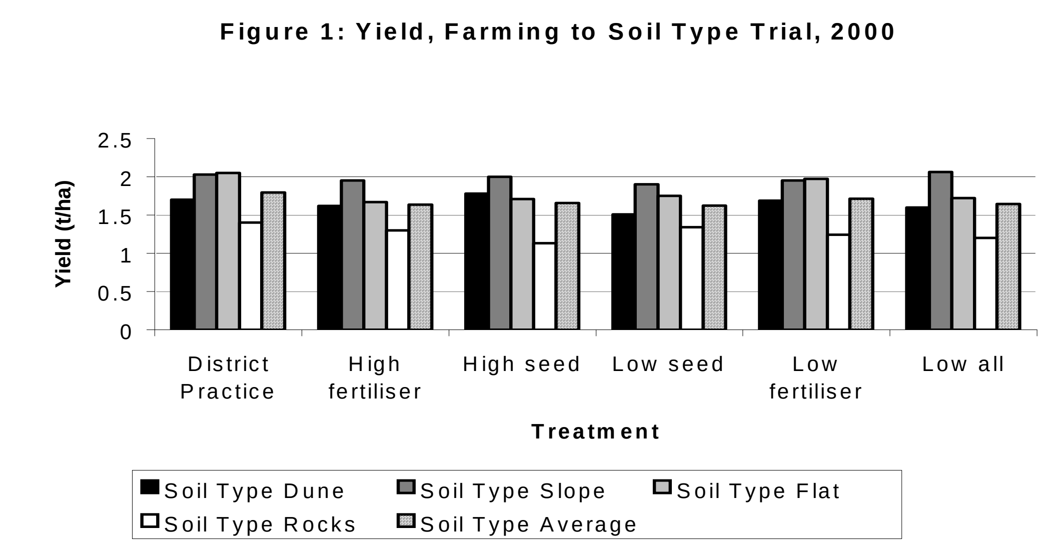
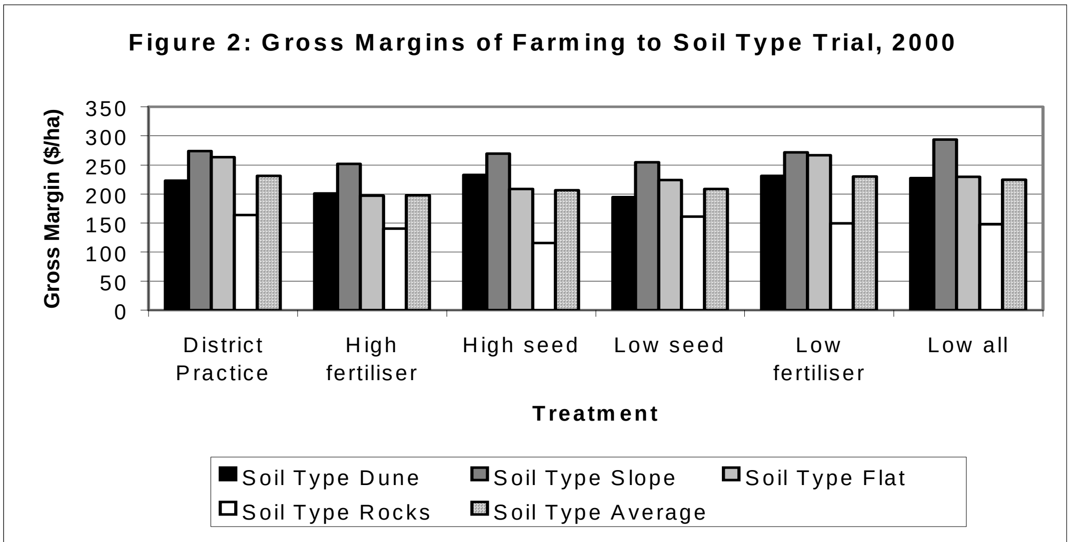
the gross margin questionable, but working them can often bring up even bigger rocks and also damage machinery.

Sand - Despite the fact that none of the treatments showed an increased yield on the sandy rises, the Mid West Farmers Group felt that double seeding and increased fertiliser rates were justified on this soil type. The increased competition and plant vigour supplied by the higher rates improves weed competition and reduces the risk of wind erosion.

Slopes - The sandy loam soils of the dune slopes appear to be the most reliable soil type in the district, year in year out.





VRT Investment?

So, is it worthwhile investing in VRT machinery to allow instantaneous changes in fertiliser and seeding rates? From the two years data gained from this trial, the Mid West Farmers group do not consider buying a new VRT seeder as a high priority. If they really want to change fertiliser or seeding rates on the go, then there are options available to adapt their own machinery with after market modifications.

Best Practice

They believe that the district practice of 50 kg/ha fertiliser and 50 kg/ha seed is a well chosen one and a practice that takes into account not just yield, but also risk management. The group also intends to rethink the way they take their tissue tests, and in future take the tests relative to soil type, not paddock.

Rocky Soils

As for those rocks, more investigation needs to be put into the salt levels on the soils in between, including the red flats. If salt is a problem on these soils it could account to some extent for the delayed germination experienced on the heavier soils in drier years. Wheat breeders are currently investigating the mechanisms of wheat that allow the plant to cope better with saline soils, with a view to breeding varieties more adapted to such situations in the future.

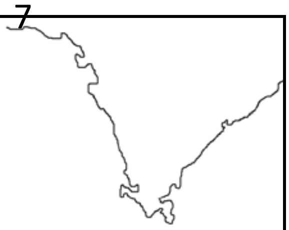
Where to next for the Mid West Farmers Group?

The Mid West Farmers Group's on-farm research work will evolve into long term profitability and sustainability, with a competitive flavour. They have taken on the role of the farmer group in the Minnipa Ag. Centre Farming Systems Competition (refer to page the Rotations Section in this manual). They are also keen to establish some better practices for their sandy soils and believe this can be achieved by visiting and talking to other farmers from sandy areas.

Acknowledgments

Thanks to the farm staff from the Minnipa Ag. Centre for sowing and reaping this trial with their VRT machine and header. Thanks also to the Forrest family for again hosting and managing this trial on their property.

The VRT machinery used in this trial is supported by SAGITF.



Baring it all on the Far West Coast

Samantha Doudle, Minnipa Agricultural Centre

Why do the survey?

Bare patches in your crop?

During the 2000 Charra Sticky Beak Day Dr Tony Rathjen introduced his new friend, a hand held electromagnetic (EM) meter that is able to give the user a reasonably accurate indication of soil salinity levels (in total dissolved salts). We all know that magnesia patches are areas of extremely high salinity, but Tony had a suspicion (based on observation and work from Holloway in the 80's and a paper by Dr Pichu Rengasamy in the Crop Science Newsletter re: salt bulge) that many of the soils in the far west have inherently high salt levels in the root zone area. Tony tested a few soils during the sticky beak day and was surprised that many of the salt levels were not as high as he thought they may be.

So was his theory wrong, or wasn't there enough information to know? A team of intrepid researchers and one trainee took off for the far west coast fully armed with the EM meter, Root Disease Sampling Tests (RDTS) and various other soil testing paraphernalia in search of "the answers to questions unknown!".

How was it done?

The survey was conducted on the 26th of October over twelve farms from Bookabie to Charra. Each farm was visited and the farmers involved took the researchers to poorer areas in their crops. The EM readings were taken in the good and bad areas for both a shallow and deeper reading (to approx. 75cm shallow and 150cm deep). When an obvious salinity reading couldn't explain a bare patch RDTS disease tests were taken separately on both the good and bad areas. Plant samples were also taken from one severely stressed barley crop.

What happened?

Salinity

Of the 11 properties visited, only two did not have some level of salinity in the paddocks assessed. The highly saline areas, or magnesia patches were the only areas that could be visually identified as saline with confidence. The moderate and slightly saline areas appeared as poorer areas in the crop, but further testing was necessary to diagnose the reason for the ill thrift.

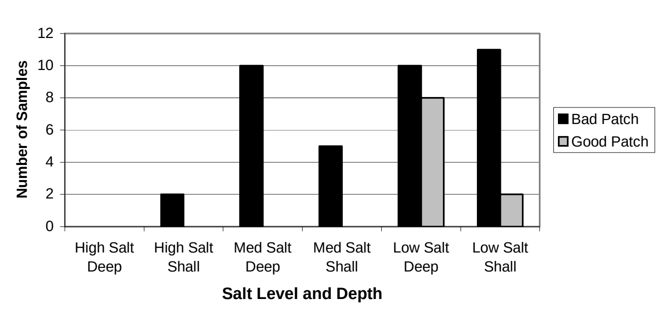
Good vs Bad Patches

Table 1: ***Salinity Results from Far West Coast Survey – number of samples in each category. 61 salinity samples were taken using both the shallow and deep settings. These tests were deliberately taken to compare bad and good areas within a paddock.***

Salt Reading	Depth of Sample	
	Shallow (<75 cm)	Deep (75cm - 150 cm)
Nil	36	25
Slight (40-80ECe)	15	25
Moderate (80-120ECe)	7	11
Severe (120+ ECe)	3	0

Good areas in the crop, as identified by the farmers, occurred generally when the low levels of salinity were deeper in the profile and never when the salinity levels were medium or high anywhere in the soil profile (figure 1). From this survey it appeared that the crop could still have a healthy appearance with a slight salinity rating deep in the profile. Slight levels of salt in the upper soil profile reduced crop emergence and growth. For shallow readings (to 75 cm), the EM meter is not able to distinguish between the salt found in the top 10 cm, where plant germination and establishment occurs, and the remaining 65 cm, where plants spread their root systems later in their growth.

Figure 1: Far West Coast Salt Survey



Disease Levels

Poor root systems and wobbly plants indicated disease activity in several areas and this was later confirmed and quantified using the RDTS. Of the 15 disease tests taken, given that 12 were paired tests (one sample analysed from good patch and one from poor patch), high levels of *Pratylenchus neglectus* and a reasonable amount of *Rhizoctonia* were found. Poor areas in the paddocks were nearly always diagnosed with high *Rhizoctonia* and the corresponding good patches returned a medium *Rhizoctonia* and high *P. Neglectus* recording.

Disease and salt were recorded in the same locations on a number of samples, however not enough samples were taken to establish any interaction between the two.

Other Factors

Also recorded were barley crops that took a sudden dive after the hot weather in September. These crops returned a high Rhizoctonia and medium Pratylenchus recording as well as being diagnosed with severe boron toxicity from the leaf symptoms. The soil salinity was recorded as low at both the shallow and deep level.

What does this mean?

Diseases

Considering the bad patches sampled are high in Rhizoctonia and the good patches sampled have medium levels of *Rhizoctonia* and high *Pratylenchus*, imagine what a patch with a reading of low *Pratylenchus* and *Rhizoctonia*

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would look like! Disease levels on the Far West Coast are high and rotation options are limited due to low rainfall and hostile subsoils. There are however, several "best practice" management tools that can be used to minimise risk of yield loss from disease which are explained in the publication 'Cereal Root and Crown Diseases' available from the PIRSA Farmer Information Centre, Ph. 1800 356 446. This is an excellent publication which illustrates what diseases look like in the paddock and on the plant, and discusses why diseases occur and how to manage them by means of rotation, varietal selection, stubble management, control of host plants etc.

Table 2: Disease Test Results from Far West Coast Survey – number of samples in each category. A total of 15 disease tests were taken. These tests were deliberately taken to compare bad and good areas within a paddock.

Disease Type	Disease Level				Total
	high	medium	low	below detectable limits	
Rhizoctonia	4	6	1	4	15
Pratylenchus neglectus	8	4	2	1	15
Pratylenchus thorneii	0	0	1	14	15
CCN	0	0	10	5	15
Take all	0	1	8	6	15
Black Spot	1	3	1	10	15

Salinity

Rootzone salinity is part of a vicious cycle, causing slower and/or lower emergence. This results in less plant growth and allows soil temperatures to increase quickly in hotter weather at end of season, bringing more salt to the surface in those areas. On the Far West Coast, given other conditions such as lower rainfall and higher temperatures than many agricultural areas, the salinity categories may well be underestimated. Observations from this survey would indicate that even salt levels in the slight category were enough to cause reasonable levels of crop damage, particularly when combined with a dry spell in the weather. Farms on the lighter coastal range soils had much lower salinity levels compared to those on the heavier plains country. Dr Pichu Rengasamy, of the University of Adelaide, says that this trend is most likely caused by the variation in soil texture. The plains country contains shallow sandy loam over clay and calcrete whereas the coastal range is composed mainly of deeper calcareous sand over clay or calcrete. In the plains country the shallow clay acts as a restriction to water flow through the soil, meaning that the salt falling onto this country in the rainfall cannot be rapidly leached out of the soil profile. In contrast, the salt falling onto the lighter textured coastal range soils can be rapidly washed further down the profile until it hits the deeper clay layer. This phenomenon is shown in Figure 2 by relating the heavy plains soils to the restricted drainage graph and the coastal range soil to the free drainage graph.

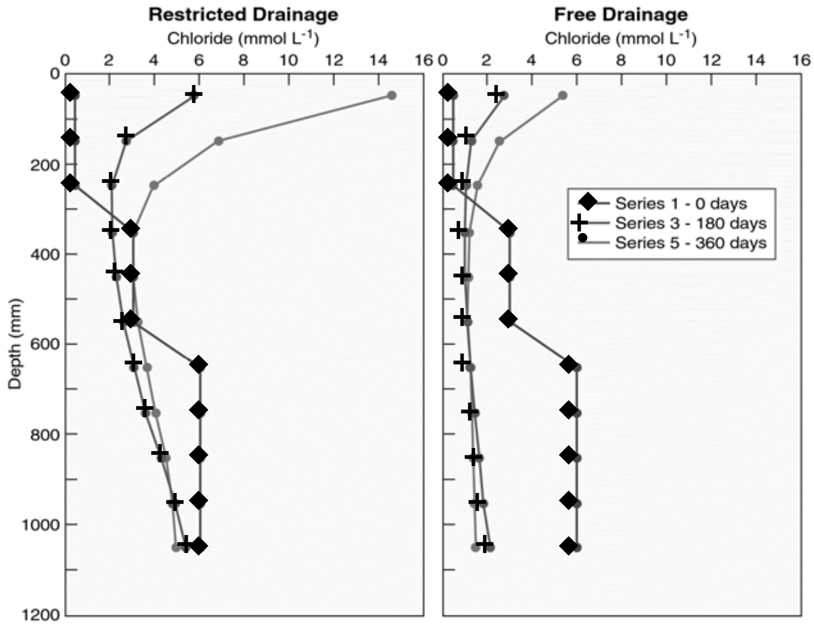


Figure 2: Results of LEACHM model depicting salt (chloride) accumulation in a soil profile in a year of cropping. Salt input is assumed from rainfall only. Graph courtesy of P.Rengasamy and K.Narayan - CSIRO groundwater modeller).

The Future

Stressed plants are less tolerant and less resistant to disease, so it is possible that any salinity reading of slight or higher may exacerbate both the effect of the salinity and the disease. Further research needs to be conducted to verify this theory.

Wheat and barley breeding for salt tolerance and barley breeding for boron tolerance are two of the bright spots on the Far West coast horizon.

Dr Rengasamy ("Renga"), of the University of Adelaide, is now working on modelling the water and salt cycles in many areas, including Ceduna. In the future this work will provide us with estimates of salt loads in our soils and their likely movements and/or accumulation through different soil profiles. Renga is also now working closely with the Wheat Breeders at Waite providing advice regarding salinity issues.

GRDC
Grains Research & Development Corporation

Managing Magnesia with Mulch

Liz Cox, PIRSA Rural Solutions, Streaky Bay

Location 1
Kyancutta
Chris Heath

Rainfall
Av. Annual total: 322 mm
Av. GSR: 236 mm
Actual annual total: 351 mm
Actual GSR: 240 mm

Soil
sandy loam

Location 2
Karcultaby Area School
Tim Coleman

Rainfall
Av. Annual total: 350 mm
Av. GSR: 263 mm

Location 3
Penong
Roger Freeman

Rainfall
Av. Annual total: 306 mm
Actual annual total: 286 mm
Actual GSR: 202 mm

Soil
Red clay loam

Other factors
early finish

Experiment 1: Kyancutta and Karcultaby Area School

Why do the trial?:

To determine which surface treatment was the most effective at reducing soil salinity levels.

Applications of surface mulches have long been touted as the "answer" to reducing the occurrence and severity of magnesia patches. By reducing the amount of bare soil exposed, evaporation is decreased and hence the concentrations of salts drawn upwards in the soil solution is reduced.

How was it done?

Kyancutta

A large magnesia patch of approximately 15 m, diameter with relatively consistent salt levels throughout, was divided into three equal strips. The salt levels were measured in late March prior to the commencement of the trial.

Three treatments were applied to the soil surface. They were selected due to conflicting and anecdotal evidence regarding the success or otherwise of these treatments. They were a mixture of straw and pig manure, gypsum and drift sand and were applied at a rate of approximately 1t/ha. The gypsum was applied to the soil surface and worked in with an off-set disk.

Following application of each treatment, the magnesia patch was treated the same as the remainder of the paddock, and sown with wheat.

Soil samples were randomly taken across each of the three treatments and measured for salinity by electrical conductivity of 1:5 soil:water extract (by weight), measured in dS/m. These measurements were compared to salinity measurements randomly taken prior to the application of the treatment strips.

Karcultaby Area School

Three salt affected areas were chosen including sections within remnant scrub, pasture and crop. The magnesia patches were identified prior to sowing. Samples were taken from each of the affected and neighbouring non-affected areas. The patches were halved, with treatments being applied to one half and the other half remaining as a control.

Two treatments were applied – sand at a depth of 25-50 mm, and oaten hay at 15 t/ha (depth of 15-20 cm).
Soil samples were taken every week for a four week period in August at depths of 0-5 cm, 5-10 cm and 10-15 cm.

Samples were taken from the treatment and control plots at each of the sites. These samples were measured for electrical conductivity by means of a 1:5 soil:water extract (by weight). Comparisons were then made to the controls to determine whether the surface mulches had any effect on salinity at different depths.

What happened?

Kyancutta

Despite no apparent differences in the growth of wheat on any of the three treatments, Table 1 indicates that each of the treatments influenced the salinity levels present in the magnesia patch. The mulch of pig manure and straw was the most effective in reducing the salinity levels in the top 40 cm of soil. This would be expected as the addition of organic matter has the effect of increasing water infiltration and reducing evaporation.

The sand mulch was the next most effective. While salinity levels were marginally increased in the top 10 cm, levels lower in the profile were reduced by up to 36%. Possible explanations for why the sand may not have been as effective, particularly in the topsoil, could be that cultivation would have mixed the sand reducing the mulching effect and wind may have blown fine surface particles away to expose the more saline soil beneath.

The least effective treatment was gypsum. This is because the addition of the salts in the gypsum to the soil can have the short term effect of increasing salinity.

Table 1: Salinity readings under different mulch treatments at Kyancutta

DEPTH	SALINTY READINGS PER TREATMENT EC (1:5)			
	Initial (dS/m)	Gypsum (dS/m)	Pig manure and straw (dS/m)	Sand (dS/m)
0-10 cm	2.6	3.9	1.1	2.7
10-20 cm	3.0	4.4	1.5	1.9
20-30 cm	1.7	2.7	1.7	1.5
30-40 cm	2.5	1.6	1.3	1.7

(Continued on page 114)

(Continued from page 113)

Karcultaby Area School

Over the four weeks of testing, the students noted that the salt concentration in every treatment (and the controls) had decreased. 50 mm of rain fell in the middle of the trial period which would be responsible for leaching the salts down the profile. Of the mulch treatments applied, sand appeared to be the most effective. However, both the sand and the straw treatments were successful in reducing the concentrations of salt at all measured depths.

What does this mean?

Salinity levels are generally highest during January and February. Mulch needs to be applied prior to this to prevent salt from moving to the surface and inhibiting germination and plant growth. Mulch treatments can reduce surface soil salinity below levels that would limit cereal crop yields. Mulch treatments may need to be in place for more than one season to effectively reduce surface soil salinities for cereal crop production. Mulches high in organic matter lead to increased infiltration and reduced evaporation resulting in maximised leaching of salts from the topsoil.

Magnesia patches often have sodic subsoils. Gypsum can address sodicity problems, however saline conditions in the soil surface over-ride any other problems and need to be addressed first. Applications of gypsum in past trials did not appear to substantially improve emergence, establishment or total yield.

Experiment 2: Penong

Why do the trial?:

To determine the amounts and movement of salt in the soil profile throughout the year and investigate ways in which salt concentrations in the topsoil can be minimised.

Up to 60% of some paddocks in the Far West Coast are affected by magnesia patches. Finding ways to achieve production form these patches has the potential to increase the profitability of this region.

How was it done?

A transect along the length of the magnesia trial site was selected. Along this transect 6 holes were dug and lined with PVC pipe was inserted, surrounded by a bentonite slurry. The transect covered areas both affected and unaffected by magnesia. The holes were capped to prevent moisture and rainfall from entering. Moisture levels were recorded using a neutron probe at different depths at two-monthly intervals. The entire paddock was sown with Spear wheat at a rate of 55 kg/ha with 18:20 fertiliser applied at a rate of 55 kg/ha.

What happened?

Soil water levels were measured with the neutron probe at different depths in the soil profile three times during the year (data not presented in this paper, but is available from the author). Results show that on both the affected and unaffected sites the greatest moisture and hence salinity fluctuations occur in the top 50 cm. This is supported by the findings of previous studies. The shape of the moisture/ salt curve for the following 75 cm is relatively uniform regardless of whether they are showing visual signs of being affected by magnesia. This data supports our knowledge of commonly high salt concentrations in the subsoils. Mechanisms to decrease salt concentrations in the top 25 cm are therefore very critical .

What does this mean?

The results represent only one year of measurements. It is expected that the cover provided by full stubble retention would not be sufficient in some areas of the far west to provide adequate cover and to reduce evaporation rates, ie. stubbles aren't bulky enough, rainfall isn't high enough, inherent quantities of salt in the soil profile are too high. The costs of applying mulches to all magnesia patches in terms of materials, time and labour would be prohibitive. However, by capitalising on years where there is good winter rainfall, productive growth can be achieved from these patches. It is planned to try sweepings from SACBH as a mulch on patches in the far west this year.

This work was sponsored by Eyre Peninsula Soil Conservation Boards

Section Eight

Section Editor: Liz Cox
PIRSA Rural Solutions, Streaky Bay

Tillage

For land to continue to sustain agricultural production in both the long, and the short term, farmers need to adopt sustainable cropping systems which prevent land degradation.

Conservation farming practices ensures sustainability as they improve soil structure, increase organic matter and soil biology and make the best use of available soil moisture.

Weeds, wind erosion, fuel prices, machinery and time all play a part in deciding which tillage system fits the best into your farming system. Given these issues and the variable soil types across Eyre Peninsula not every tillage option will suit every soil type or farming system.

The more tillage research carried out the better equipped we will be to capitalise on the advantages of conservation farming practices whilst overcoming some of the present limitations and adapt them to our farming systems.

AusBulk

Broadcasting – who tried it and what happened?

Samantha Doudle, Mark Bennie, SARDI, Minnipa Agricultural Centre
EP Farmers - Justin Bamman, Graeme Baldock, Allen Sampson, Ben Hughes, Phil McKenna, Wayne Woolford

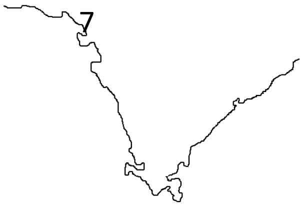
Why do it? - You've all heard this story a dozen times over! Early seeding using the broadcasting technique has been the highest yielding and highest gross margin crop on the Minnipa Agricultural Centre every time it has been sown for the last 17 years. Despite this, you could count on one hand the number of farmers who have tried it and use one finger to count those who've adopted the technique. In 2000, MAC staff and PIRSA Agronomists made a concerted effort to raise the issue of early seeding and broadcasting with farmer discussion groups. Two groups of farmers, one at Tuckey and one at Streaky Bay, decided to set up their own broadscale trials comparing broadcasting, direct drilling and conventional cultivation. Several other farmers went one step further and set themselves up to broadcast an entire paddock on their property. Once again, the Minnipa Ag. Centre used broadcasting as a method of getting a fair percentage of their crop sown on minimal moisture. The following is a run down on what happened with the broadcast crops versus comparable conventionally sown crops at MAC and across the Peninsula.

	Farm Name	
	Minnipa Agricultural Centre	
Farmer Name	Mark Bennie, Brett McEvoy, Ted McEvoy	
Location	Minnipa - the scenic spot amidst the rocks!	
2000 Total Rainfall	389 mm	
Growing Season Rainfall	298 mm	
Crop Information	*Broadcast*	*Conventional*
Preparation	Chemical fallows in 1999. Summer weed control if required. Fertiliser pre-drilled early April.	Sprayseed & Treflan mix applied prior to the seeding operation
Variety	Frame, Bt Schomburgk & Camm	Excalibur
Sowing Rate	110 kg/ha	55 kg/ha
Sowing Date	1st Date- 14th May (1 paddock of Frame on 12mm of rain over a 72 hours. Not ideal but thought we would test our friendship with what moisture we had received!). 2nd Sowing Date - 28th May - Bt Schomburgk & Camm.	2nd June
Machinery	Gason Bar with narrow tungsten tip cultivator point on 9.2" spacings for pre-drilling fertilizer and Marshall single spinner 3.5 ton spreader for the seeding operation.	Gason Bar with a narrow tungsten tip cultivator point on 9.2" spacings with Morris Air Cart
Comments - growth	Slow in patches that were not moist enough to germinate initially, but generally looked very healthy once established and was best looking crop on the farm until late rains in the season.	Once established the crop did look healthy all season and tillered well.
Yield	average 2.13 t/ha,	2.18 t/ha
Screenings %	average 4.3%	4.40%
Protein %	average 10.9%	13.10%
Comments - yield	Frame yield was lower than expected, given how the paddock looked, but the rest of the broadcast crops all did well.	Yields were up on what I expected. The crop looked 1.8 t/ha. Quality was excellent with small grains pushing the screenings level up.
General Information	The season evened out with good rains which helped all crops establish and yield well. Protein was down in one broadcast paddock, which dragged overall average down.	
Do it again?	Absolutely	
What would you change?	Not a lot, but maybe get a bigger broadcaster so we don't have to fill up so #!#! often. It would be good to have it as a one pass operation, but at present our spread pattern isn't wide enough to incorporate in the same pass as spreading.	
Message to other farmers	Try it yourself on a small scale. The most important component of the system is not the method itself, but very effective weed control (especially barley and rye grass) the previous season or two seasons. You struggle to control ryegrass in a broadcasting system, as you cannot spray and incorporate treflan.	

	Farm Name		*Farm Name*	
	Broadview			
Farmer Name	Wayne & Pam Woolford		Phil & Mick McKenna	
Location	Buckleboo		Mamblin/Kyancutta	
2000 Total Rainfall	387 mm		385 mm	
Growing Season Rainfall	206 mm		300 mm	
Major Events	Locusts after crop emerged, perimeter sprayed twice, whole crop sprayed for locusts when sprayed broadleaves.			
Crop Information	*Broadcast*	*Conventional*	*Broadcast*	*Conventional*
Preparation	Aug 24th 99 - 400 mls Glyphosate, Dec 99 - 500 ml Gramoxone + 500 ml Amine. 20th Feb - 47.2 mm rain, 25th Feb - melon control, 500 ml Ester + 800 ml Glyphosate, 80 ml Garlon. End March - melon control, Ester. 5th May - ripped up and pre drilled with 65 kg of 18:20 using points.	Spraytopped twice (400 ml Roundup & 500 ml Gramoxone). Ripped up December and cultivated twice after that.	98 wheat, 99 Targa (good job). 2000, April - 12th 23mm rain, 14th, workued up + 70 kg/ha 10:22, 30th 17 mm rain	99 Targa. 2000, April 16th worked up, May 2nd sprayed Nuqat/Treflan
Variety	Carnamah	Janz	Excalibur	Excalibur
Sowing Rate	110 kg/ha	50 Kg/ha	75 kg/ha	60 kg/ha
Sowing Date	14th May	7th May	31st April	May 2nd
Machinery	Gason 5100 bar with points, contract broadcaster & prickle chain	Gason 5100 bar, sowing 7" spacing, using 8" shares.	Spreader and harrows	Full cut, 15 cm spacings
Comments - growth	Growth was ahead of other crops	Growth was good, had some trouble with locusts.		
Yield	2.26 t/ha	2.26 t/ha	2 t/ha	2.1 t/ha
Screenings %	1.9 - 3.5 %	4.4 - 8.7 %	2.8 - 4.3 %	1.8 - 3.4 %
Protein %	10.60%	10.30%	9.2 - 12.2 %	9.1 - 10.7 %
Comments - yield	Crop had the most potential out of all of our crops but the 26 days without rain in Sept/early Oct. took its toll. Grain size very good.	Yield was affected by dry spell in September.		
General Information	Broadcasting gave us a break in our chemical cycle.			
Do it again?	Yes - we plan to broadcast 360 ha this year.		I will have another go.	
What would you change?	Maybe a little cultivation in Jan - Feb to stop the hit and miss of chemicals.		I need to get my paddocks clean the year before.	
Message to other farmers				

	Farm Name		*Farm Name*	
	Wangabina		Kanbarra	
Farmer Name	Ben Hughes (Wangabina)		Allen & Coralie Sampson	
Location	Maltee, north east of Ceduna		Cortlinye- Section 32, west of Kimba	
2000 Total Rainfall	307 mm		335 mm	
Growing Season Rainfall	241 mm		251 mm	
Major Events	Very little rain before August		A hot dry week with north winds first week in October. Early locust damage to emerging crop	
Crop Information	*Broadcast*	*Conventional*	*Broadcast*	*Conventional*
Preparation	Some fallow, some stubble worked up once.	None	Cultivated Feb. April 22nd - sprayed 25g Logran + 2 kg Zn soil spray. Worked & sowed 80 kg 22:15 with cultivator	Ploughed March. April 25th - sprayed 850 ml Treflan 480 + 2 kg Zn soil spray, worked back & cultivated.
Variety	Excalibur, Sunbrook, Bt Schomburgk & Yitpi	None	Stilleto	Stilleto
Sowing Rate	60 kg/ha	None	110 kg/ha	65 kg/ha
Sowing Date	20/04/2000 - 4/05/2000	None	1/05/2000	8/05/2000
Machinery	Speader towing a prickle chain	None	Broadcaster & heavy harrows that were weighted	Connershea Scari Seeder
Comments - growth	Good germination - slow until August	None	Emergence was observed in four days. This crop lodged more than conventional but not a problem.	Emergence at eight days and uneven wild oats in part of paddock
Yield	Average 1.2 t/ha	None	2.1 t/ha	1.8 t/ha
Screenings %		None	Average 4 %	7.50%
Protein %		None	11%	13%
Comments - yield	Had nil to poor germination on uneven ground due to poor seed coverage - good protein.	None	None	None
General Information	We broadcast the entire farm.		Both paddocks were the first year on a new property, so we had no chance to treat weeds in previous year. Broadcasting was done on three other paddocks with magnesia areas. Improved emergence and yield was observed on the magnesia areas.	
Do it again?	Yes		Yes	
What would you change?	With uneven ground I will try trailing harrows instead of a prickle chain this year.		Make sure of sufficient even furrows. Use prickle chain instead of harrows for incorporation	
Message to other farmers	Get your weed control right and go for it		Be ready when it rains. Good previous paddock preparation is essential, especially for early weed control	

	Farm Name		*Farm Name*	
	Coondappa		Karinya	
Farmer Name	Justin & Karen Bammann		Graeme & Heather Baldock	
Location	Yadnarie - Section 33 & 34, near Cleve		Section 17 Hundred of Buckleboo, north of Kimba	
2000 Total Rainfall	416 mm		321 mm	
Growing Season Rainfall	309 mm		257 mm	
Major Events	None		Rye Grass	
Crop Information	*Broadcast*	*Conventional*	*Broadcast*	*Conventional*
Preparation	Off-set disk in Feb. with no more workings till sowing date	Worked up with cultivator, worked back cultivator. Sown with same machine, except used narrow points	Aug 99 - Chemical Fallow, Nov 99 - Work Up, Jan 00 - Work Back, 18/04/2000 - Pre-drill fertilizer & work back	Canola stubble, No-Till
Variety	Janz & Excalibur	Janz	Janz	Janz
Sowing Rate	95 kg/ha	65 kg/ha	110 kg/ha	52 kg/ha
Sowing Date	31/04/2000	10/5/2000 - 13/05/2000	30/04/2000	8/05/2000
Machinery	300 Chamberlain Bar, sweep shares prickle chain	9 " spacing, Harrington points	Marshall super spreader and heavy harrows.	Air Seeder with knife points
Comments - growth	Looked excellent all year. Due to dry finish, plus hot windy 5th October it matured prematurely.	Excellent	Initial germination was not as it should have been as wind and rain on 29/04/2000 left ground flat & firm, and harrows did not bury grain well enough. Dry July - set back. Dry Sept - too hot	Dry July thinned out things. Dry/hot September - a bit much.
Yield	2.5 t/ha	3.5 t/ha	2 t/ha	2.4 t/ha
Screenings %	Excalibur 5 – 10%, Janz 10 – 25%	5 –10 %	7%	3%
Protein %	10.5	10.5	11.90%	9.50%
Comments - yield	Yielded quite well. Crop was even in germination but too dense to finish well given the end of season conditions.	None	Rye grass sneaked up on me. Incorporation not good enough. I should have sown paddock when I pre-drilled as it was wet enough to germinate seeds.	Should have applied more N
General Information				
Do it again?	Doubtful ?		Sort of.	
What would you change?	If sowing early I would reduce seeding rate if conditions were ideal		Would use a different variety *ie*. Frame or Excalibur. Better paddock selection and/or use of SU's. Incorporate seed better. Prickle chain may have been better.	
Message to other farmers	Try a percentage of crop and see how it compares		Give it a go with good paddock selection and vigourous seed variety. Be ready to go as soon as it rains.	



Economic Evaluation Of Seeding Systems

(Broadcasting, Direct Drilling and Conventional Tillage)

Authors: Andy Bates, AWB Ltd Area Service Manager, (Formerly PIRSA Rural Solutions, Streaky Bay), Liz Cox, PIRSA Rural Solutions, Streaky Bay & Jon Hancock, SARDI, Minnipa Ag. Centre

Location:
Streaky Bay
Cactus Feltus
Streaky Bay & Cungena Ag Bureau, Western EP Soil Board
Rainfall
Av. Annual total 330 mm
Av. GSR: 260 mm
Actual annual total: 360 mm
Actual GSR: 270 mm
Yield
Potential: 3.2t/ha
Actual: 1.98t/ha
Paddock History
1999: pasture
Soil
Major soil type description: Grey calcareous loam, heavier flats
Land Value
Approx 200-250/ha
Diseases
Rhizoctonia most evident on direct drill and broadcast areas
Plot size
20ac
Other factors
Poor moisture at seeding

Why do the trial?

The aim of this demonstration was to economically evaluate the relative benefits of;

- direct drilling with a modified combine fitted with narrow points and press wheels (referred to as the "Cungena machine");
- full cut direct drilling with a conventional seeding unit;
- broadcast seeding over predrilled fertiliser, and sowing after two soil cultivations.

Seeding systems on EP have changed significantly over the past decade. Reduced tillage regimes when combined with optimum disease, nutrition and weed management have demonstrated similar yields and gross margins to the more intensively cultivated soil preparation/seeding techniques. More recently the spotlight has focussed on broadcasting seed and incorporating with harrows to achieve timely seeding on minimal moisture and minimise the soils exposure to wind erosion. The challenge is to determine the place and opportunity for utilising all the available seeding techniques in your system, where large areas are sown annually often on insufficient soil moisture. This demonstration compliments the aims of the Western EP Soil Conservation Board's chapter to promote sustainable land management practices. Other tillage research is summarised on pages 84-87 of the 1999 EP Farming Systems Summary Book.

How was it done?

- Broad acre plots were chosen to reflect paddock variability in soil type and depth.
- A late chemical fallow (700ml/ha Glyphosate CT® plus Liase®) was applied to approximately 25 ha on September 15th 1999. The rest of the pasture paddock was spray topped at the appropriate timing to restrict grass seed set. Lincoln weed was controlled on Nov 2nd with 4.5g/ha Ally® plus wetter.
- 65 kg/ha 10:22:0 was used on all plots. The variety sown was Excalibur at 56 kg/ha by all tyned machines and 100 kg/ha by the broadcaster.
- The broadcaster and the direct drilled plots were sown after 40 points of rain over two days. No further rainfall was received prior to sowing the conventional plot.

What happened?

The broadcast crop emerged first due to shallow seeding depth and covered faster with the higher seeding rate,

(Continued on page 121)

TREATMENT	Broadcast	Direct Drill-Narrow point	Direct Drill-Full Cut	Conventional
Machine	Marshall Broadcaster, harrowed	Cungena Ag Bureau machine, narrow points+presswheels	Forward Engineering airseeder full cut	Forwood Engineering Airseeder, full cut
Early Sept				Spray top 350ml/ha Glyphosate CT®
Sept 15th	Glyphosate CT® 700mls+liase	Glyphosate CT® 700mls+liase	Glyphosate CT® 700mls+liase	
March 19th				Worked up
May 4th	Pre drilled fertiliser at 5cm with narrow points			
May 15th	Sprayed Cedit+Bonus® @ 340ml/ha	Sprayed Cedit+Bonus® @ 340ml/ha	Sprayed Cedit+Bonus® @ 340ml/ha	Worked back
May 27th	Sown with Marshall Broadcaster, harrowed once.	Trifluralin® @800ml/ha Sown	Trifluralin® @800ml/ha Sown	
June 4th				Sown
July 4th	Post emergent weed spray	Post emergent weed spray	Post emergent weed spray	Post emergent weed spray

(Continued from page 120)
however both of the direct drilled plots rapidly caught up. By 20 days after emergence,

seedlings in the plot direct drilled with the full cut Forward bar were clearly more advanced and healthier than the broadcasting and "Cungena machine" plots. The sowing of seed and fertiliser together under low soil moisture conditions is the most likely cause of this difference in performance. Seed and fertiliser in the broadcast and "Cungena machine" direct drilled plots were separated by upwards of 4cm.

Rhizoctonia was most evident in the direct drilled and broadcast plots, and damage increased visually after the post emergent application of Ally®.

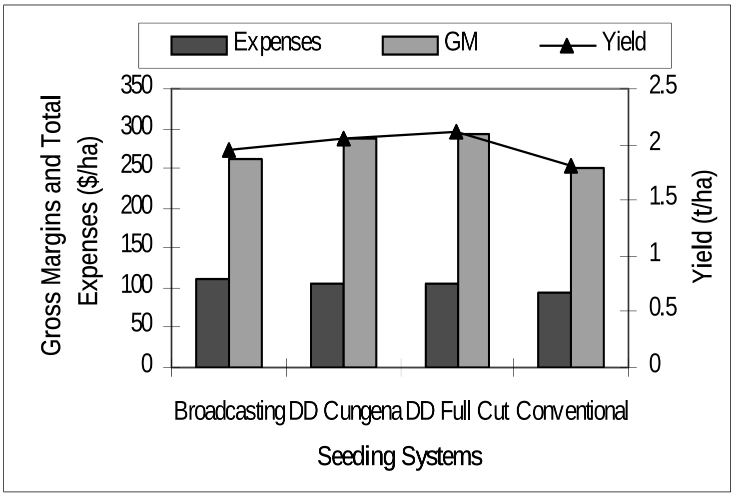


Figure 1: Gross Margins, Total Expenses and Yield of Seeding systems

The direct drilled and broadcast plots had significantly higher populations of grassy weeds than the later sown conventional area. The high plant density in the broadcast plots did compete well with the weeds present, however, sufficient grassy weeds set seed to cause problems with the management of subsequent crops in the rotation.

Total costs of production for each crop were similar (Figure 1). The crop direct drilled with full cut sweeps on the Forward Airseeder achieved the best yield and gross margin (Figure 1) , closely followed by the crop sown with the Cungena Direct Drill Machine.

What does this mean?

- Regardless of sowing method, the benefits of early sowing towards maximising grain yield have been demonstrated.
- No one sowing method will consistently provide yield advantages over your whole farm. Leave your options open by controlling weeds and disease so that the most appropriate seeding technique can be chosen to suit the seasonal conditions at the optimum sowing time.
- Remember to have a valid reason for selecting a sowing method – broadcasting may allow you to sow large areas quickly with little capital investment in equipment. Conventional cultivation systems may leave your soil exposed to wind erosion for extended periods of time if you are sowing large areas. Direct drilling also has advantages and disadvantages. No system is right or wrong.
- Sowing successful cereal crops on Eyre Peninsula's sandy soils is nine tenths agronomy and timing, and the remaining one tenth depends on how you actually place the seed in the ground.

Acknowlegments

Financial and other support was given by various Ag Bureaus, Western Eyre Peninsula Soil Conservation Board, Western Eyre Peninsula Community Land Care and PIRSA. Thanks to Malcolm Baldock, Howard Feltus, and Greg Moroney for the use of their machinery.

Tillage System Comparison

Nick Booth, PIRSA Field Crop Consultant

Why do the trial?

With the on-going debate of 'which tillage is best' further complicated by the broadcasting results coming from Minnipa, several farmers tried 'tillage comparison' trials. The trials were made up of unreplicated paddock strips using a number of different techniques.

How was it done?

Noel and Ben Hampel - Rudall
1999 – Pasture (grass free)
2000 – Frame Wheat sown @ 70 kg/ha with 80 kg 18:20
Treatments (unreplicated)
Conventional – One working, Treflan and Sprayseed
Direct Drill – No workings, sown with conventional shares, Treflan & Sprayseed
Broadcast – One working (super sown), no chemicals pre-seeding (sown @ 110 kg/ha)

Rex and Adam Crosby – Tuckey
1999 – Pasture (Grass free and spraytopped)
2000 – Excalibur Wheat @ 75 kg/ha with 80 kg 24:16
Sowing date May 15th
Treatments (unreplicated)
Conventional – Two workings (60 kg/ha seed with 70 kg 24:16 super)
Deep Ripped - Chisel plough (approx. 20 cm deep), two workings (seed & super same as conventional)
Broadcast - Seed @ 110 kg/ha (super 70 kg 24:16 pre-sown on May 1st)

What happened?

The key to an alternative tillage system is having the ground prepared the year before and hence being able to capitalise on early sowing. This was not the case in these trials. The trial site at Rudall had a lot of grass weeds and these were particularly evident in the broadcast plot. Another mistake made in the broadcast plot was not leaving the ground ridged. When the super was pre-drilled, the covering devices should have been raised to leave the ground rough. As it was, when the seed was dropped on the seed bed and harrowed in, there was not enough 'free' soil to cover the seed and a fair portion of seed was left uncovered.

Table 1: Yield results from Rudall Tillage Trials

Method	Yield (t/ha)	Protein (%)	Screenings (%)
Conventional	2.43	9.5	6.9
Direct Drill	1.90	8.6	6.4
Broadcast	1.73	9.9	9.4

Table 2: Yield results from Tuckey Tillage Trials

Method	Yield (t/ha)	Protein (%)	Screenings (%)
Conventional	2.72**	8.6	11.5
Direct Drill	2.16	8.6	13.7
Broadcast	2.16	9.2	8.4

*** Yields were significantly higher than the rest of the conventionally sown paddock.*

Broadcasting capitalises on early sowing and sowing into a moist seedbed. The trial at Rudall was sown near the end of the sowing program and into a drying seedbed. As a result, the broadcast strip never looked as good as the other treatments.

The direct drill versus the conventionally sown crop was more even. All year the direct drill plot was a deeper green and had a healthier appearance, however this did not translate into yield (Table 1).

The reason for the yield difference between conventional and other methods at Tuckey may be related to soil type or may be a tillage response – these are the questions that remain unanswered in unreplicated trials. However, the general consensus of the farmers involved in this trial is that the conventional site had better seed bed and improved root system compared to the direct drill especially after a pasture year.

What does this mean?

In the case of deep ripping, the work done over the years has suggested that the results are unpredictable and transitory. Unless the ripping is being done to bring clay to the surface or place nutrients or gypsum at depth, ripping by itself can be expensive and risky.

Broadcasting has a place which trials at Minnipa Agricultural Centre have proven. However, the potential for error is high when corners are cut. Hopefully, a few more farmers will continue to try broadcasting as a cheap and quick method of seeding, but will make sure paddocks and machinery are fully prepared. See the broadcasting article in this section for details on preparation.

The debate between the chemical abusers (no-till) and the diesel burners (conventional tillers) will probably never be resolved. My feeling on the matter is that whatever tillage technique is used has a relatively minor effect on yield. Last year certainly demonstrated the benefits of early sowing. This could be where no-till has an advantage over conventional till, but this will only occur where the ground has been set up properly and has adequate nutrition and a low weed/disease burden.

Why do the trial?

The trial was initiated by the Franklin Harbour Ag Bureau after much discussion (err arguments) over the sustainability of current farming techniques in the Mitchelville areas, north of Cowell. The areas of Mitchelville and Midgee are characterised by very fragile,

Table 3: Tillage Treatments and Yields at Mitchelville

Paddock Name	Treatment	Yield (t/ha)	Protein (%)
Goose	Chemical Fallow – no till	1.19	12.4
Norwest	Spray topped '99 – no till	1.11	12.8
Dump	Wheat on Wheat – no till	1.08	12.2
South West	Spray topped '99 – working early	0.91	13.3
Stumpy Gully	Spray topped '99 – working early	0.88	12.9
Long Gully	Spray topped '99 – working early + worked back	0.80	13.6
Old Tank	Tynes Late	0.80	13.2
DT Gully	Tynes early, sprayed late	0.76	13.4

Location
Mitchelville
Steve Edwards
Franklin Harbour Ag Bureau

Rainfall
Ave Annual: 290mm
2000 Total: 246mm
Ave Growing Season: 210mm
2000 Growing Season: 185mm

Paddock History
1997: Fallow
1998: Wheat
1999: Pasture

Soil Type
Sandy Loam over rubble
pH: 8.5% (water)
OC %: 1.2%
Avail P: 14 mg/kg (Colwell)

Other
Moisture stress at flowering
Crown Rot in Wheat on Wheat

light sandy soils over a calcrete rubble or sheet limestone base that is very prone to wind erosion. The land type is predominantly dune/swale.

Several farmers in the area are adopting a no-till or very much reduced tillage system to preserve their soil and improve fertility.

How was it done?

Different paddocks were set up and worked differently in an attempt to determine if any yield advantages could be gained from the different tillage systems.

What happened?

Observations

- No-till paddocks had areas that did not emerge due to shallow sowing on undulating ground across the width of the machine. The soil profile was shallow due to previous continuous disc ploughing and prickle chain usage.
- Worked back paddock looked to be the thicker and more vigorous crop mid-season.
- Disc ploughs gave greater long-term control of Bindii, saltbush and Fuzz weed (Fluffy Daisy).
- Spraying was better on disc ploughed ground rather than tyned working due to less dust and no furrows.
- No-till paddock was best to work and spray because of less dust and wheel slip whilst seeding.
- Press wheels gave good seed-soil contact, especially where soil was dry on top and moist 3-4 cm down. This ensured good early germination.
- No post-emergent broad leaf control was necessary where Ester + Ally® were applied pre-sowing.
- Spray-Seed® gave poor control of large turnip weed in no-till paddock.
- There were high populations of grasses in the paddock that was worked back, even though it had Spray-Seed® and Trifluralin prior to sowing.

What does it mean?

There are a number of variables that can confuse the issues in a trial like this. Sowing date, variety, soil type and weed control can all affect the final result.

The observation that more weeds germinated in the paddock that had been worked back confirms the theory on weed seed populations. Weed seeds buried by cultivation will have a staggered germination, with the time of emergence depending on the depth of burial.

Another problem encountered is with the type of weeds present – in particular onion weed. Control of this biennial in the pasture year prior to cropping is vitally important to permit ease of seeding with conventional seeding equipment.

With an issue like tillage and the emotions it seems to stir up, there is no real right or wrong answer. What is obvious from these results, is the adoption of no-till does not provide any huge jump in yield although it does allow the paddock to be sown earlier and therefore capitalise on a longer growing season and potentially higher yields. It also provides a much less tangible result – peace of mind. Peace of mind in the sense that you know your paddock is not blowing away, fertility and organic carbon will increase and what little moisture is in the soil is not being evaporated by excessive tillage.

In a low rainfall, low input system like this, a very careful approach to herbicides is required. The break crop options are severely limited and the highly alkaline soils will cause most SU's to persist too long for any medic pasture to thrive. As mentioned earlier, a flexible approach to whatever farming system you adopt will be of most benefit to your farm as the seasons and situations dictate.

Sowing into Stony Soils

How does seeding technology affect performance ?

Jack Desbiolles[1] and Dan Hill[2]
[1]Agricultural Machinery Research & Design Centre, University of SA
[2]Mallee Research Station, Walpeup Vic

Location
Werrimull Victoria
Tony Robbins
Group: Mallee Sustainable Farming Project
Site yield
Potential: 2.5 t/ha
Actual: 2.29 t/ha
Paddock History
1999: Frame wheat, conventional (2.0 t/ha)
1998: Spray fallow
1997: Volunteer pasture
Soil
Sandy-loam top soil (pH water 8.6)
over alkaline clay subsoil below 60 cm (pH water 9.5-10)
Land Value
$200-250/ha
Diseases
- Root disease risk levels pre-sowing:
Rhizoctonia (medium) and P/ Neglectus (low/medium)
- Yellow leaf spot outbreak early on
Plot size
40 m x 6 rows x 0.25 m spacing
Other factors
Dry post seeding period
Significant rye grass problem until late tillering
Above average rainfall during September-October

Why do the trial ?

Stony soil conditions represent a significant farming area in the Mallee region. The ability of seeding systems to maintain seed placement accuracy under rough conditions was investigated. The average seeding depth and its variability are important factors dictated by:
i) the physical placement of seeds within the furrow and
ii) the subsequent addition of soil cover, in particular through the effects of lateral soil throw from adjacent rows. The objectives of the trial were:
1. To demonstrate the abilities of various seeding system designs to achieve and maintain accurate and uniform seed placement under intense stump jumping actions and,
2. To evaluate the associated crop responses (establishment and yield).

How was it done?

A range of machinery factors were investigated as part of two sub-trials which comprised:
i) tine break-out rating (280 lb and 550 lb),
ii) rigid versus coil tine designs,
iii) hydraulic versus spring release systems,
iv) parallelogram versus 'trailing pivot arm' seed boot systems,
vi) ribbon and paired row units,
vii) rigid mounted versus flexible-contour following seed boot design's and,
viii) tine versus discs units.

All systems featured deep tillage below seed depth with the ability to deep band fertiliser to the bottom of the furrow. A single shoot control (tilling at sowing depth) was also included as a reference. Two tillage depth settings (90-95 mm and 125-130 mm) were used with a selection of treatments to provide two levels of stump jumping intensities.

A sandy-loam top soil with 25% stones of a 50 mm median stone size was used. All treatments were sown at 9-10 km/hr, included a press-wheel action and were set at 0.25m (10") row spacing. The site was direct drilled to *Frame* wheat at 65 kg/ha into drying soil conditions and with a target seeding depth of 40 mm. Fertiliser rates were 90 kg/ha of DAP + 3% Zn deep banded at 70 mm where applicable. Sowing was conducted past the optimum date (on 20th May) into drying top soil but with adequate moisture below, and was followed by a serious water deficit period until July. A rye grass problem additionally held the crop back until August, but this was followed by above average rainfall during September-October which drastically boosted the crop potential.

What happened?

Seed placement: seeding depth was greatly influenced by the ability of each seeding systems to effectively backfill over the deeper part of the furrow prior to seeds landing, and by the effect of lateral soil throw across adjacent seed rows (i.e. front rank mounted openers ended with up to 40-45 mm more soil cover). Seeding depths typically increased by 10-15 mm (up to 25-30 mm) with deeper working treatments, due to greater surface disturbance associated with the more intense stump jumping actions. Seeding depth variations across sowing rows (i.e. between front and rear rank openers) were also worsened by deeper tillage settings and by systems creating greater soil surface disturbance (eg. ribbon sowing and paired row systems). Seeding depth differences across sowing rows can be minimised with adjustable sowing boots, but differences are still likely to remain significant under rough soil conditions when seeking to secure enough soil cover over seeds.

Seeding uniformity is measured by the extent of the vertical seed spread. Seed spread was typically worse for front rank openers due to the irregularity of added soil throw under intermittent stump jumping conditions. Vertical seed spread was minimised by shallower tillage depth, but not significantly for front rank openers due to the above reasons. More accurate seed placement was obtained with systems which did not rely on backfilling the bottom of the deep furrow for placement accuracy. These better systems included the side banding Treatment C (ie. sowing on a ledge), the disc Treatment D (independent sowing unit), the single shoot control Treatment K (ie. seeding at tillage depth), and the flexible seeding boot Treatment E which operates as a furrow re-opener rather than a furrow closer plate due to its positioning further behind the point.

Overall, seed spread values across the range of treatments varied from ±15 mm for the better treatments to ±30 mm for the less performing treatments.

(Continued on page 126)

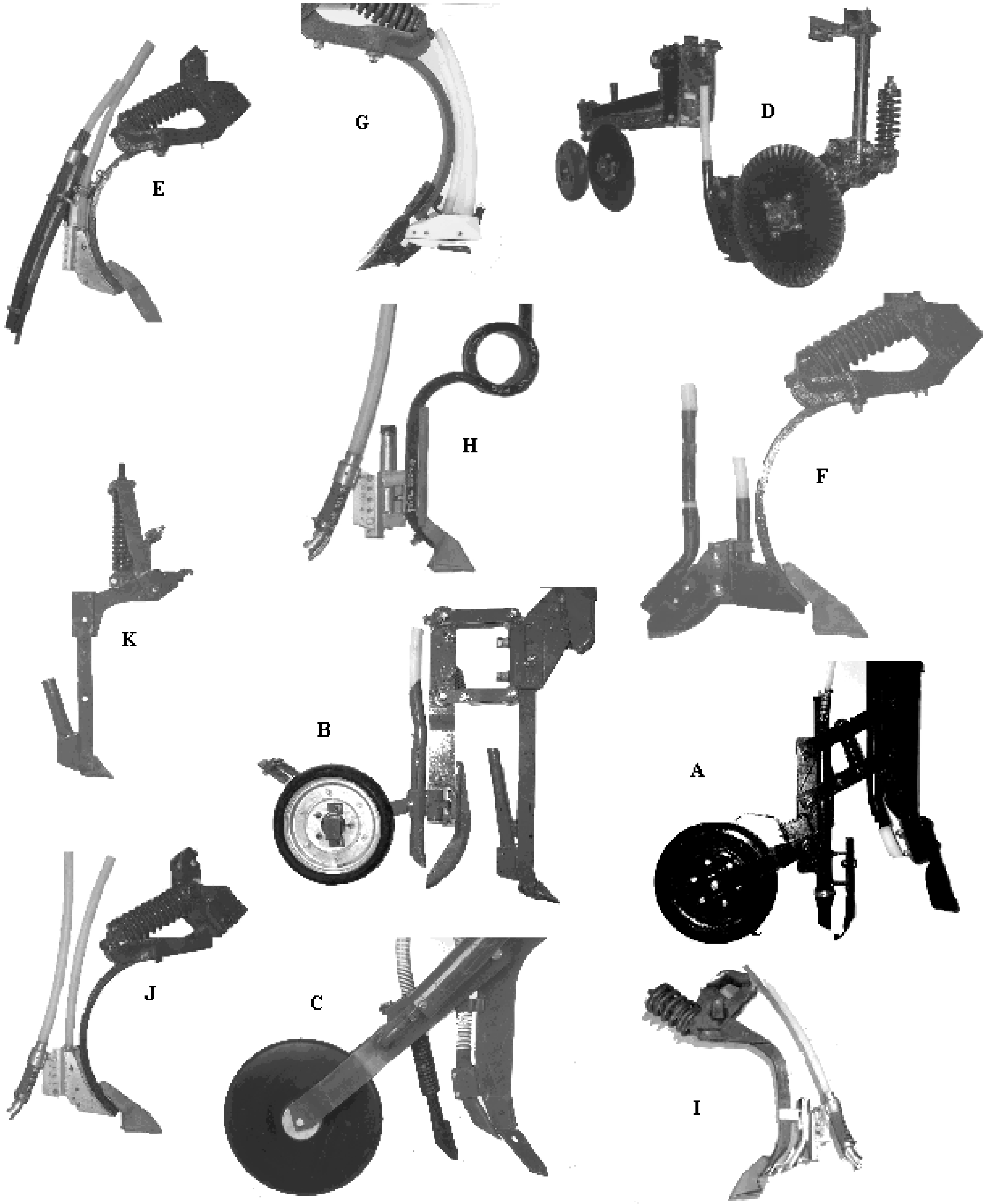
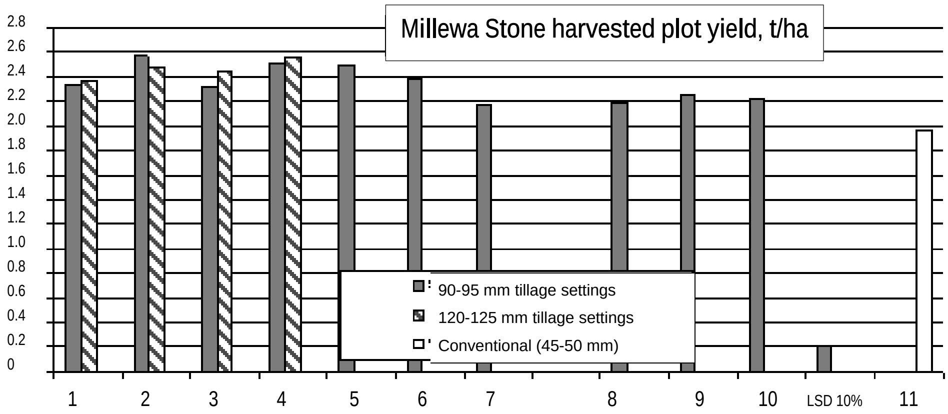


Figure 1: seeding technologies investigated in the trial (NB: parallelogram mounted seed boot on hydraulic (A) and spring (B) stump-jump systems, trailing pivot arm system (C), Deep coulter +V seeding disc unit (D), flexible seeding boot (E), paired-row (F) and ribbon (G) sowing systems, spring coil tine (H), low break-out – 280lbf (I) and high break-out – 550lbf (J) spring release ratings, single shoot control technology (K).

(Continued from page 124)



1. Hydraulic release boot, 2. Spring release boot, 3. Flexible boot, 4. Paired row, 5. Ribbon seeding, 6. Trailing pivot arm boot, 7. Coulter + v disc, 8. Coil tine low 260 lb, 9. Spring release 280 lb, 10. Spring release 550 lb, 11. Control, single shoot

Figure 2: Millewa Stone harvested plot yield (t/ha)

Crop establishment: An average 145 plants/m² was established on the site overall. A better crop establishment (150-160 plants/m² or +10-14%) was typically achieved at the shallower tillage depth setting (90-95 mm). The control system K without tillage below seeding did not benefit from mixing subsoil moisture with the seeds under the experimental conditions and resulted in lower plant densities (119 plants/m²). The higher break -out Treatment J established 23% more plants/m² than its lower break-out equivalent (Treatment I). Plant weights taken at stem elongation stage confirmed a lower potential for the control system K and coulter/disc system D.

Harvested grain yields (see Figure 2): Wheat yield values reached an average 2.29t/ha (ranging from 1.92t/ha to 2.50t/ha), despite late sowing, dry follow up period and serious rye grass infestation early on, but benefiting from late rain during September-October. The data indicate a significant yield benefit from tillage below seed depth (i.e. +10% to +30%) with, however, no apparent further gain from deeper tillage depth (i.e.. 125 mm versus 90 mm). The anticipated benefits of higher break-out settings could not be confirmed despite the superior crop establishment.

Various treatment differences are also observed with variable levels of significance: paired row/ribbon systems achieved yields 7.5% higher than the site average. Independently mounted seed boot systems (eg. parallelogram and pivot trailing arm) also tended to yield above average (+3.5%) and significantly better than rigid boot systems (eg. +10%). The spring break-out system (B) under the experimental conditions yielded 7% higher than its hydraulic counterpart (A) which may be due to design differences of the backfilling device (NB: the hydraulic break-out treatment A performed a lot more smoothly during the seeding operation). No treatment effects on % protein or screenings could be detected.

What does this mean?

The trial has shown that the technology of seeding systems can drastically affect i) the quality of seed placement obtained under rough ground conditions and ii) the resulting yield performance of the crop. The context of this trial also showed that seasonal effects (ie. dry top soil at seeding followed by a dry post seeding period) can compromise the potential of more accurate seeding systems such as those without deep tillage action. The following summarises the main outcomes of the trial:

SEED PLACEMENT and CROP ESTABLISHMENT

- Under rough conditions, seeding depth variation is particularly influenced by both the physical placement of seeds within the furrow and the uniformity of added soil cover.
- Seed placement accuracy under rough conditions can be improved with:
  1) shallower tillage depth,
  2) sowing at tillage depth,
  3) no reliance on backfilling action from a closer plate where deeper tillage is used,
  4) seed delivery angles set away from the vertical direction where furrow backfilling is required,
  5) low disturbance openers and,
  6) individually adjusted (per row) seed boot systems.
- Tillage below seeding depth can optimise crop establishment results under dry top soil conditions followed by dry post seeding period.
- Greater stump-jumping intensities worsen seed placement accuracy and reduce plant establishment (eg. higher break-out ratings achieved superior crop establishment).

GRAIN YIELD

- A significant grain yield variation (0.58t/ha or 25% of site average yield) was measured between the 11 seeding systems at harvest.
- A positive yield response (i.e. +10% to +30%) to deep tillage below seeding (90-95 mm) was measured under the experimental conditions. The yield benefits did not increase with deeper depth setting (120-125 mm).
- A superior performance was observed with paired row/ ribbon sowing systems (+7.5% above site average) and with independently mounted seed boots (eg. parallelogram) with +9% yield benefit compared with rigid mounted boot systems.
- The superior crop establishment achieved with the higher break-out treatment did not translate into yield benefits.

The above information can assist farmers with decision making on seeding machinery selection, but need to be considered alongside issues of investment cost and product durability, in the context of stony-soil relative area specific to each farm.

Section Nine

Section Editor: Amanda Cook

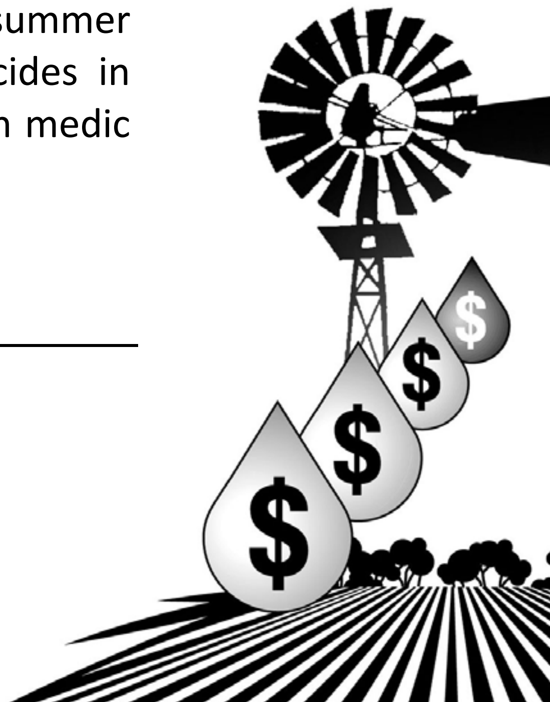
Minnipa Agricultural Centre

Weeds

The cost of controlling weeds on Upper Eyre Peninsula is almost a quarter of the total cash cost involved in growing a crop. The opportunity to control weeds by methods other than herbicides within our low rainfall systems has been reduced due to the move towards minimum tillage and conservation farming practices.

Weed management practices and the impact on crop profitability are important for both farm productivity and sustainability.

Current research involves the control of summer weeds, the persistence of sulfonylurea herbicides in our alkaline soils and controlling grass weeds in medic pastures.



AusBulk

Is Summer Weed Control

Andy Bates[1], Jon Hancock[2] & Samantha Doudle[2]—[1]AWB Limited and [2]Minnipa Ag. Centre

Locations
Elliston, Koongawa, Tuckey
Elliston: Nigel May
Elliston Landcare Group
Kyancutta: Jeff Frischke
Rudall: Jason Burton
Tuckey Ag. Bureau
Rainfall
Elliston
Av. Annual total: 419 mm
Actual annual total: 418 mm
Actual GSR: 343 mm
Koongawa
Av. Annual total: 346 mm
Av. Growing season: 254 mm
Actual annual total: 327 mm
Actual GSR: 208 mm
Tuckey
Av. Annual total: 335 mm
Av. Growing season: 250 mm
Actual annual total: 378 mm
Actual GSR: 288 mm
Yield
Elliston
Potential: 5.06t/ha
Actual: 2.65t/ha
Complete: 2.79t/ha
Koongawa
Potential: 2.88t/ha
Actual: 1.72t/ha
Complete: 2.84t/ha
Tuckey
Potential: 3.76t/ha
Actual: 2.71t/ha
Complete: 3.60t/ha

Why do the trial?

Trials were set up to investigate the impact of various methods and timings of summer weed control on soil moisture, nutrition, disease, yield and profit. These trials will continue for the next three seasons. Currently, little data exists to quantify the economic impact of summer weed control on subsequent cereal crops. This series of trials compliments a similar program in the Mallee of South Australia, Victoria and New South Wales and aims to provide producers with a decision support framework to enable the adoption of cost -effective summer weed management programs.

How was it done?

Summer weed control trials were set up at Elliston, Piednippie, Koongawa and Tuckey. All sites were pasture in 1999. Lincoln Weed was the main weed present at Elliston and Piednippie, while heliotrope and melons dominated the weed spectrum at Koongawa and Tuckey. Four different categories of weed control methods were applied over the 1999/2000 summer at each site. These are generalised as complete control, early weed control, late weed control and a dry working control. The complete control plots were sprayed three times in order to maintain zero weed growth over summer. At Elliston and Piednippie, this was achieved through an initial application of metsulfuron-methyl (Associate®) followed by two subsequent applications of a 2,4-D ester and glyphosate mix to ensure the results would not be confounded by any residual sulfonylurea problems. At the other sites, complete weed control was achieved through three 2,4-D ester and glyphosate applications. The early weed control treatments were sprayed in mid November and the late weed control treatments were sprayed in late February. All working treatments were cultivated with full cut shares on the 3rd of March. Chemicals used in the different treatments and treatment costs including the cost of application are shown in Tables 1, 2 and 3.

Soil moisture probes were used to regularly monitor the relative soil moisture of the different treatments throughout summer and the growing season. Elliston was sown to Sloop barley while Koongawa and Tuckey were sown to Frame wheat to establish if there was a correlation between summer weed control, grain yield and grain quality of the following crop. Plots were monitored for disease and nitrate early in the season and gross margins were calculated following harvest to determine the profitability of each treatment.

What Happened?

The lack of rain at Piednippie over the 1998/1999 summer caused desiccation of Lincoln weed in all treatments. Early weed control was therefore to no avail. There were no significant differences in soil moisture retention or wheat yield and so these results are not included in this section. Elliston, Koongawa and Tuckey received 93mm, 71.8mm and 111mm respectively from November to March. These substantial amounts of rainfall caused summer weeds to proliferate when not controlled.

At Elliston, Koongawa and Tuckey, the relative water content at seeding time was greatest with complete weed control. An account of the actual amount of water stored within the top metre of soil will be available following calibration of the soil moisture probe.

Soil samples were taken from selected treatments at Elliston and Tuckey before and after sowing. These were DNA disease tested to investigate the impact of weed control on *Pratylenchus neglectus*, *Pratylenchus thornei* and rhizoctonia levels. While there were no significant differences in disease levels between any treatments tested at either site, their risk categories are shown in Table 4.

The sap nitrate concentration in wheat plants from selected treatments at Koongawa and Tuckey was determined on the 31st July. Nitrate levels were highest in the complete control plots at both sites (Table 5).

At Elliston, complete summer weed control led to a

Table 4: Risk of disease incidence at Elliston and Tuckey.

	Elliston	Tuckey
Prat neglectus	High	Low
Prat thornei	Below detection	Below detection
Rhizoctonia	Low	Low

Table 5: Sap nitrate concentrations (ppm) in the basal stems of wheat plants (cv Frame) at Koongawa and Tuckey.

	Koongawa	Tuckey
Complete Control	3795	3200
Early Spray (2,4-D)	3400	2525
Dry Working (late)	2675	1725
Late Spray (Gly+Ester)	3300	1450
Nil Control	1950	1350

(Continued on page 129)

Table 1. Weed control methods and treatment costs used at Elliston

Treatment	Treatment cost ($/ha)
Complete – 1. Associate® @ 5g/ha + wetter, 2. Glyphosate 450 @ 1l/ha + Estercide 800® @ 400ml/ha + wetter 3. Glyphosate 450 @ 1l/ha + Estercide 800® @ 400ml/ha + wetter	25.30
Associate®@ 5g/ha + wetter (early)	4.06
Associate® @ 3g/ha + MCPA 500 @ 500ml/ha + wetter (early)	11.10
Surpass® @ 2.2l/ha + Glyphosate 450 @ 800ml/ha (early)	16.60
MCPA 500 @ 1.5 l/ha + LI700 (early)	10.16
Associate® @ 5 g/ha + wetter (late)	4.06
Surpass® @ 2.2l/ha + Glyphosate 450 @ 800ml/ha (late)	10.34
MCPA 500 @ 1.5l/ha + LI700 (late)	4.83
Working Dry (late)	3.97
Nil/Control	0

Table 2. Weed control methods and treatment costs used at Koongawa.

Treatment	Treatment cost ($/ha)
Complete – 3 applications of; Glyphosate 450 @ 1l/ha + Estercide 800® @ 400ml/ha + wetter	32.26
2,4-D Amine 500 @ 1.5l/ha + wetter (early)	9.69
Estercide 800® @ 750ml/ha + oil (early)	9.47
Invader® @ 80ml/ha + oil (early)	7.75
Invader® @ 50ml/ha + 2,4-D Amine @ 1l/ha (early)	10.76
Estercide 800® @ 450ml/ha + Glyphosate @ 900ml/ha + wetter (early)	10.68
Paraquat @ 750ml/ha + 2,4-D Amine 500 @ 1l/ha + wetter (early)	13.64
Invader® @ 80ml/ha + Glyphosate @ 1l/ha + oil (late)	13.83
Estercide 800® @ 400ml/ha + Glyphosate @ 1l/ha + oil (late)	11.57
Working Dry (late)	3.97
Nil/Control	0

Table 3: Weed control methods and treatment costs used at Tuckey.

Treatment	Treatment cost ($/ha)
Complete – 3 applications of; Glyphosate @ 1l/ha + Estercide 800ò @ 400ml/ha + wetter	32.26
2,4-D Amine 500 @ 1.5l/ha + wetter (early)	9.69
Estercide 800® @ 800ml/ha + oil (early)	9.92
Invader® @ 120ml/ha + Paraquat @ 1l/ha + wetter (early)	19.45
Invader® @ 120ml/ha + 2,4-D Amine @ 1l/ha (early)	15.92
Estercide 800® @ 600ml/ha + Glyphosate 450 @ 1.2l/ha + wetter (early)	10.68
Invader® @ 120ml/ha + oil (early)	11.51
Paraquat @ 750ml/ha + 2,4-D Amine 500 @ 1l/ha + wetter (early)	13.64
Invader® @ 80ml/ha + Glyphosate 450 @ 1l/ha + oil (late)	13.83
Estercide 800® @ 400ml/ha + Glyphosate 450 @ 1l/ha + oil (late)	11.57
Working Dry (late)	3.97
Nil/Control	0

(Continued from page 128)

significant increase in grain protein. Grain protein in the complete treatment was 17% greater than the nil treatment. There were no significant differences in the grain protein between treatments at Koongawa or Tuckey, although complete control plots had the highest levels at both sites.

At Elliston four treatments, including the complete and all three early treatments provided the highest yields (Table 6). At Piednippie, there was no significant difference in yield between any of the treatments. As a result of little summer rain, weed control options resulted in a net cost. A distinct increase in plant vigour throughout the season was evident in the complete control treatments at Koongawa and Tuckey. This culminated in a significant yield advantage of the complete weed control treatment over all other treatments at these two sites (Tables 7 and 8).

Gross margins were calculated for each treatment at each site. These included the cost of summer weed control and all other variable inputs required to grow last seasons crop. Last year's prices were used for all commodities and grain prices were estimated pool returns using the harvest payment method. Actual protein and screening data was used for determining grain prices according to the current sliding scales for wheat and malting barley. All calculated figures are given in Tables 6 to 9 and are exclusive of GST. To compare treatments, marginal return (extra dollars of gain per extra dollar of input for summer weed control) was calculated.

What does this mean?

Data has been obtained from three sites which had exceptional conditions for weed growth over last summer. This has allowed the observation of some startling differences in last years crops at Elliston, Koongawa and Tuckey.

After one year of the trial, the Elliston site has shown there are effective and economic options available for Lincoln weed control

(Continued on page 130)

Table 6: Yield, gross margin and marginal return of summer weed control treatments at Elliston.

Treatment	Yield (t/ha)	Gross Margin ($/ha)	Marginal Return ($/$)
Associate® (early)	2.83	428	29
MCPA 500 + LI700 (early)	2.84	426	11
Associate® + MCPA 500 + wetter (early)	2.84	420	10
Associate® + wetter (late)	2.75	411	25
Complete	2.79	404	4
2,4-D Amine + Glyphosate 450 (early)	2.74	400	5
Working Dry (late)	2.61	389	20
2,4-D Amine @ + Glyphosate 450 (late)	2.51	362	5
MCPA 500 + LI700 (late)	2.39	344	7
Nil/Control	2.16	311	0
Least significant difference (P<0.05)	0.30	54	

Table 7: Yield, gross margin and marginal return of summer weed control treatments at Koongawa.

Treatment	Yield (t/ha)	Gross Margin ($/ha)	Marginal Return ($/$)
Complete	2.84	353	6
2,4-D Amine + wetter (early)	2.04	235	9
Estercide 800® + Glyphosate + oil (late)	1.85	199	4
Invader® + Glyphosate + oil (late)	1.76	195	3
Estercide 800® + Glyphosate + wetter (early)	1.60	166	2
Invader® + 2,4-D Amine (early)	1.55	161	1
Paraquat + 2,4-D Amine + wetter (early)	1.53	151	0
Nil/Control	1.43	150	0
Working Dry (late)	1.45	142	-2
Invader® + oil (early)	1.43	137	-2
Estercide 800® + oil (early)	1.44	133	-2
Least significant difference (P<0.05)	0.43	74	

Table 8: Yield, gross margin and marginal return of summer weed control treatments at Tuckey.

Treatment	Yield (t/ha)	Gross Margin ($/ha)	Marginal Return ($/$)
Complete	3.60	458	5
Working Dry (late)	2.92	364	21
Invader® + Paraquat + wetter (early)	2.95	342	3
Estercide 800 ® + oil (early)	2.76	327	4
2,4-D Amine + wetter (early)	2.77	323	4
Invader® + 2,4-D Amine (early)	2.81	320	2
Paraquat + 2,4-D Amine + wetter (early)	2.57	291	1
Estercide 800® + Glyphosate 450 + oil (late)	2.54	288	0
Invader® + oil (early)	2.52	285	0
Nil/Control	2.41	282	0
Invade® r + Glyphosate 450 + oil (late)	2.45	270	-1
Least significant difference (P<0.05)	0.53	93	

(Continued from page 129)

other than the traditional wind erosion prone practice of cultivation. These include chemical weed control options that do not necessarily rely on sulfonylurea herbicides.

The Piednippie site demonstrated that summer weed control may not always be economically viable. Due to Lincoln weed desiccation in all treatments through lack of rain, weed control measures at this site did not benefit the following crop. While summer weed control at this site was not cost-effective, the data will be used in the development of guidelines for economic summer weed management on Eyre Peninsula.

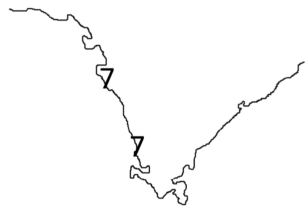
At Koongawa and Tuckey, control of summer weeds nearly always paid off with improved gross margins. The complete summer weed control treatment led to significantly increased yield over all other treatments last year. This was probably due to increased moisture retention and early vigour in these crops to aid with in-crop weed competition. In particular, the presence of brome grass in the trial at Koongawa was a noticeably lower in the complete control plots. All other weed control treatments led to similar yields and there were no significant differences between them.

There has not yet been enough rain this summer to warrant summer weed control at any site. The sites will be either cropped by the farmer or left as pasture according to the rotation practice of the paddock. Control of summer weeds this summer will be dependent upon rainfall over the next couple of months. An accurate calibration of relative water measurements to actual water available within the soil profile will provide useful guide of water conservation between treatments.

Acknowledgements

Nufarm
Eyre Peninsula Soil Boards
E P Community Landcare
Advisory Board of Agriculture
GRDC, SARDI

Using Sulfonylurea Herbicides on Eyre Peninsula



Terry Bertozzi and Nigel Wilhelm, Sustainable Farming Systems, SARDI, Adelaide

Location:
Pt Kenny: S. Guerin
Mt Hope: T. Vigar
Rainfall
Av. Annual totals:
Pt Kenny: 355mm
Mt Hope: 416mm
2000 Totals:
Pt Kenny: 345mm
Mt Hope: 579mm
Soil
Grey highly calcareous soils
Plot size
10m x 8 rows
Replicates
4
Other factors
Snails at Mt Hope

Why do the trial?

The trials were established to investigate the persistence and movement of several ALS (Group B) herbicides in alkaline soils. The ALS group contains the sulfonylurea (SU) herbicides (Glean®, Logran® etc) and also related herbicides such as Spinnaker® and Broadstrike®.

The SU group of herbicides are very important because of their low cost, their effectiveness against a large number of weeds (mostly broadleaf), operator safety and activity at low application rates. However, there have been increasing problems with recropping on alkaline soils after the use of SU herbicides, as many crops grown in rotation are very sensitive to SU residues. The article in the 1999 Eyre Peninsula Farming Systems Summary (pg. 92) outlines the importance of soil pH, rainfall and gave an overall summary of the project so far. This article will focus on the results from plant-back trials conducted at sites on Eyre Peninsula.

How was it done?

Plots were sprayed with one of the treatments shown in Table 1 in either 1997, 1998 or 1999, so that by sowing in 2000, we had plots with residues between 1 and 3 years old for each herbicide. Each plot was sown with either a mixture of medic (Harbinger AR, Herald and Caliph) @ 10kg/ha, Alma peas @ 90 kg/ha or Karoo canola @ 5 kg/ha on 4 June 2000. Due to poor establishment, the canola was resown at both sites on 21 July 2000. Dry matter cuts were collected from each crop in late September and pea and canola plots harvested on 14 November 2000 and 4 December 2000 for Pt Kenny and Mt Hope, respectively. Soil cores to a depth of 60 cm were taken in August and October 2000 from each plot to determine the movement and persistence of the herbicides into the soil profile.

What happened?

At Port Kenny, pea and medic sown in plots where either Glean® or Logran® had been applied in 1999 produced much less dry matter than untreated plots (Figures 1 & 2). Not surprisingly, pea yield was also significantly less in the same Glean® and Logran® plots as compared to the untreated plots (Figure 3). Pea yield was also depressed by application of Glean® and Logran® in 1998. Growth in the canola plots was slow due to resowing and large variation in the plots across the trial made it difficult to determine any treatment effects in either dry matter or yield. There was no evidence of damage in sensitive crops following use of Ally® or Broadstrike® in any prior year, or following application of Glean® in years prior to 1999.

Table 1. ***Herbicide treatments and rates applied at Pt Kenny (PK) and Mt Hope (MH) trial sites.***

Treatment	Site	Rate
Ally®	PK, MH	7 g/ha
Glean®	PK, MH	20 g/ha
Logran®	PK, MH	35 g/ha
Broadstrike®	PK	25 g/ha
Spinnaker®	MH	300ml/ha

At Mt Hope, there were no differences in dry matter between any treatments for any of the crops. Pea yield was higher than at Pt Kenny but again there were no differences between any of the treatments. The canola plots were as variable as the Pt Kenny site but were only partially harvested due to very high snail numbers.

Why were the sites so different? Pre-sowing estimates of herbicide residues at each site indicated that the residues at Pt Kenny were concentrated in the top 20cm of the soil profile and decreased with depth, while at Mt Hope less herbicide residue was in the surface layers and more had moved down into the profile to at least 40cm. SU herbicides are very mobile in alkaline soils and the higher rainfall at the Mt Hope site may account for these observations. Soil samples collected at harvest last year have not yet been processed but should prove interesting as the Mt Hope site had 232mm more rainfall than the Pt Kenny site in 2000 and may explain why the large dry matter and yield differences observed at Pt Kenny were not present at Mt Hope. The amount of rainfall between herbicide application and sowing of the susceptible crop is very important and is usually included in the plant-back guidelines on the product label.

What does this mean?

SU herbicides persist in alkaline soils for long periods of time and are very toxic to sensitive crops and pastures. Therefore:

- Read the plantback guidelines on the product label carefully as they will point out the factors that should be taken into consideration before using the product.
- Know the pH of your soil across the paddock and in the subsoil as this will guide you in your selection of herbicides.
- Be aware of how much rainfall the paddock has received between herbicide application and sowing of the susceptible crop. If conditions have been very dry, then be extra cautious as the herbicide may not have broken down to non damaging levels.

(Continued on page 132)

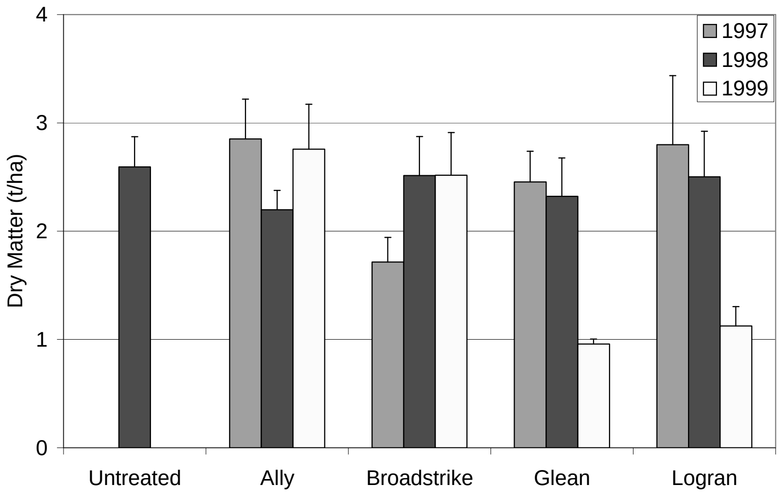


Figure 1: Pea dry matter production in 2000 after application o f ALS herbicides in 1997, 98 or 99 at Pt Kenny.

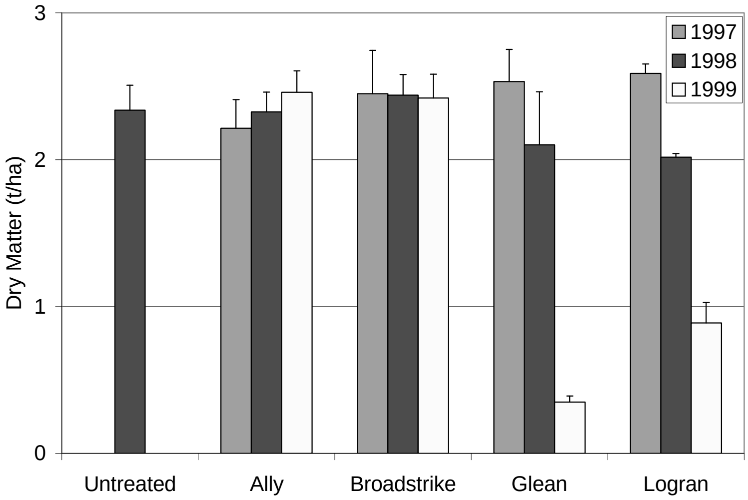


Figure 2: Medic dry matter production in 2000 after ALS herbicides in 1997, 98 or 99 at Pt Kenny

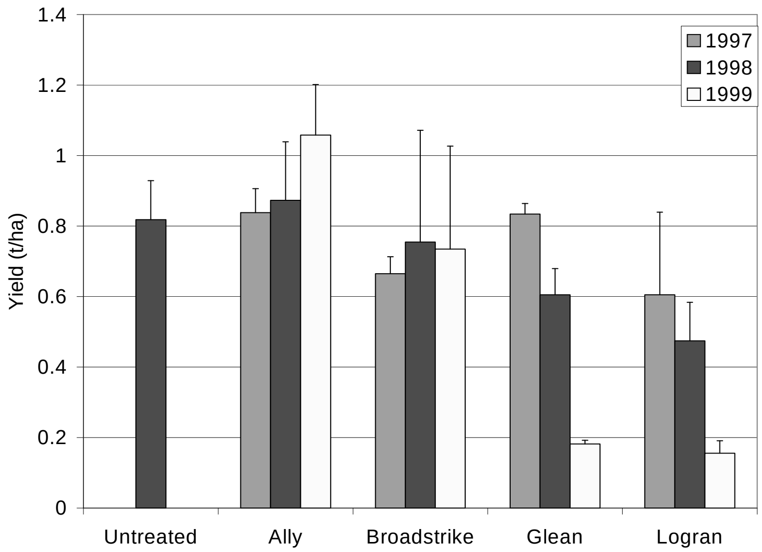


Figure 3: Pea grain yield in 2000 after application o f ALS herbicides in 1997, 98 or 99 at Pt Kenny

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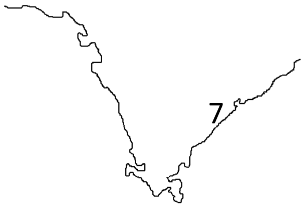
If the label says do not plant back a sensitive crop for 24 months, then that means exactly 24 months following application, not that if it is about 2 years since the herbicide was applied it should be OK. For instance, in the Pt Kenny trial (surface soil pH 8.6), pea yields were reduced by an application of Logran® 25 months previously but only 584 mm of rain had fallen. The label says that on a soil with such a high pH, peas should not be sown before 24 months from application AND 700 mm of rain has fallen. This example highlights the importance of pH, time interval and rainfall in determining plant back intervals.

Despite continuing reports of damage from SU herbicides occurring in sensitive crops in situations when the label recommendations suggest the paddock should be safe, the patterns of damage which occurred in these trials suggest that the labels are conservative in their plant back intervals. For instance, the label recommendation for medic is 24 months (and 700 mm of rain) following Logran® application and yet at both sites, medic production was similar to the control when planted only 11 months after application.



Grass Weed Control in Medic Pastures

By Nick Booth, PIRSA Field Crop Consultant & Arno Bay Ag Bureau

Why do the trial?

To determine if the use of glyphosate will give satisfactory grass control results in medic pasture when compared to low rates (below recommended label rate) of grass selective herbicides.

How was it done?

Boomspray widths of the treatments were applied along the length of the paddock. Pasture samples were collected in the middle of August to determine mid season productivity and pasture composition.

The chemicals were applied on 3rd June in ideal conditions. Weed species present included annual ryegrass, barley grass, capeweed, mustard and turnip. Medics had established well after mid February rains and were actively growing.

The treatments applied were;

1 – Glyphosate (450) @ 300ml + 0.2% Wetter
2 – Glyphosate (450) @ 600ml + 0.2% Wetter
3 – Glyphosate (450) @ 300ml + 0.5% Hasten®
4 - Control
5 – Glyphosate (450) @ 500ml + 0.5% Hasten®
6 – Targa® @ 125ml + 0.1% Wetter + 0.5% Hasten®
7 – Targa® @ 125ml + Glyphosate @ 300ml + 0.1% Wetter + 0.5% Hasten®
8 – Targa® @ 250ml + 0.1% Wetter + 0.5% Hasten®
9 - Control
10 – Correct® @ 100ml + Glyphosate @ 300ml + 0.1% Wetter + 0.5% Hasten®

What happened?

This season was unique due to early season rains, which allowed the medic to establish and sustain growth until the break of the season on the 4th May. The dense medic canopy may have obstructed the chemical and compromised the efficacy of the spray, therefore some grasses may have escaped control. Considering grasses seemed to germinate later (late April – May) the total amount of grass above the medic canopy may have only been a small total of what was actually present.

From Figure 1, it can be seen that any treatment containing glyphosate had an adverse effect on pasture dry matter production.

Similarly, treatments containing glyphosate were observed to delay flowering and subsequent seed development in medics. This was also noted in the grasses where some barley grass and ryegrass were out in head and flowering in the controls only.

While the glyphosate treated plots appeared relatively clean of grasses*, the yield penalty and reduced podding of the medics would constitute unacceptable damage to the medics in an 'average' year.

* Note – ryegrass plants in the glyphosate treated plots were smaller and finer, therefore less visible – even when the ryegrass plant counts were higher. See Figure 2.

Take home messages

- The least amount of ryegrass was recorded in the Targa® treated strips. Low rates of grass selective herbicide might be better than none.
- Glyphosate treated strips, still had ryegrass present, but they were smaller and finer.
- Flowering and podding of medic was delayed considerably with all glyphosate treated strips.
- Low rates of grass selective herbicides may be a better option, but a spraytopping option must take into consideration the grasses (mainly ryegrass) that escape or germinate late.

In short, the take home message is the same as in the article, Grass Weed Management in Medic Pastures, Farming Systems Summary, 1999. Where all else fails, read the label.

This **double hit** approach in itself may be a good management to prevent or

Location
Cleve – Ben and Kathy Ranford
Arno Bay Ag Bureau

Rainfall
Ave Annual Total: 327mm
Ave GSR: 234 mm
2000 Total: 340 mm
2000 GSR: 252 mm

Carrying Capacity
~ 7 DSE

Paddock History
1997: Bettong Oats
1998: Caliph Medic Pasture
1999: Kite Wheat

Soil Type
Sandy Loam
pH: 8.5
OC%: 1. 5%
Avail P: 15-20mg/kg (Colwell)

Plot Size
20 ha

Other Comments
Stresses: No
Grazed: No
Pests/diseases: Aphids visible on the glyphosate treated plots only.

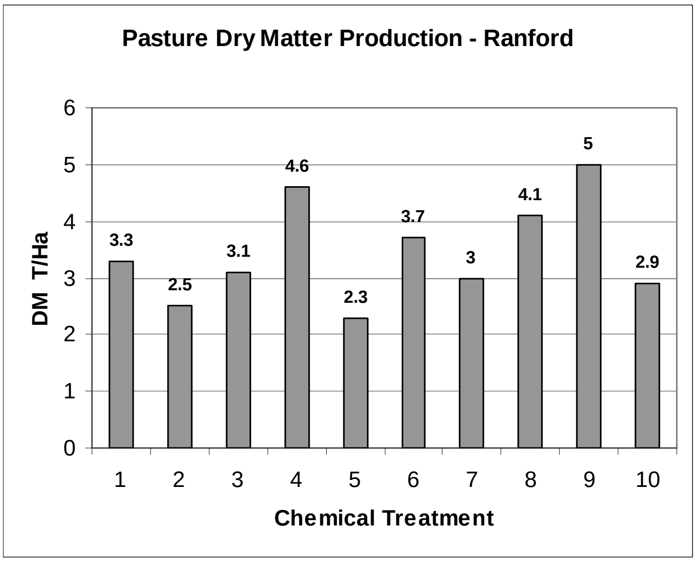


Figure 1: Effect of chemical treatment on dry matter production

(Continued on page 134)

(Continued from page 133)
delay the onset of Group A herbicide resistance. By 'mopping up' any escapes with a non-selective herbicide, the risk of inducing a herbicide resistant grass population is almost rated at zero.

Members of the Arno Bay Ag Bureau involved in the Farming Systems project initiated this demonstration. The interest was aroused after anecdotal evidence in the district. The farmers bought all chemicals used in the demonstration, as they were being used in that current year. PIRSA or SARDI do not advocate the use of non-label recommendations.

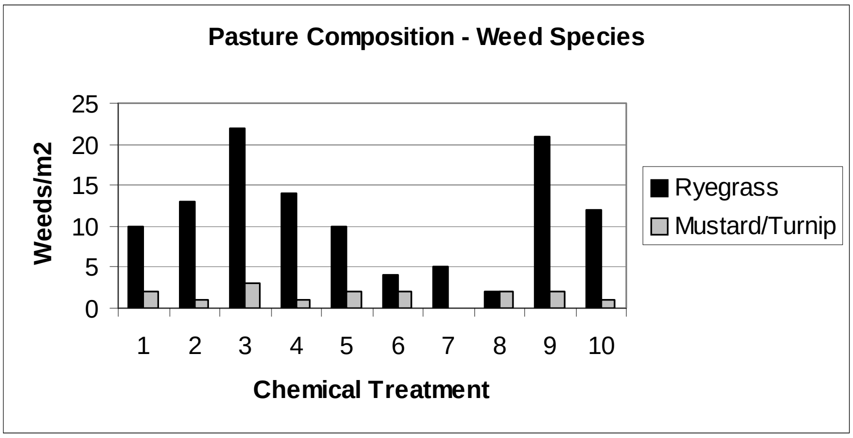
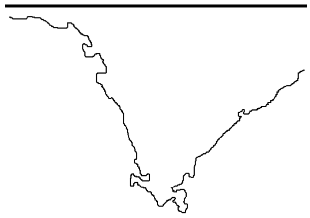


Figure 2: Effect of Chemical Treatment on Pasture Species Composition

Weed Management Workshops



Graham Fromm, PIRSA Rural Solutions, Murray Bridge

Why do the workshop?

Weed management is one the fastest changing technologies of a modern farming system. Knowing what weeds you have and how to best manage them within your system is crucial for both productivity and sustainability. Many farmer groups on Eyre Peninsula have participated in a series of workshops designed to give farmers the knowledge and confidence to better manage their weeds.

How is it done?

The workshops are conducted by PIRSA Rural Solutions under Challenge 2020. There are three workshops in the weed management series:

- Understanding weeds in farming systems
- Developing a weed management plan
- Herbicides and their use in weed management

Participants in workshop three have the opportunity , at the conclusion of the workshop, to update their Chemcert certificates. This is a separate activity and needs to be arranged with the workshop co-ordinators.

Who's doing it?

At this stage the following groups on EP have requested Workshop two and are now following that up with workshop three.
Wangary Ag Bureau

- Coomunga PMP Group/ Koppio Ag. Bureau/ Big Swamp PMP Group
- Kapinnie PMP/Top Crop Groups
- Arno Bay and Butler Tanks Ag Bureaus
- Crossville Ag Bureau
- Tuckey Ag Bureau
- Wadikkee Ag Bureau
- Mt Cooper Ag Bureau

New groups at Buckleboo and Franklin Harbour have requested to do workshop 2 which will be held after seeding.

What's in a workshop?

In workshop one, participants improve their ability to recognise and understand both current and potential weed problems in their farming systems. Participants learn how weeds are introduced and what favours their build up and conversely their effective management under different farming systems. They will receive information and develop skills that will help them to plan and implement effective strategies for both the prevention and management of weeds in local situations. The workshop will focus on weeds of local farming systems drawing on both local and outside experience and knowledge to shed light on these and potential new weeds.

Workshop two reviews the weed management techniques used by participants and others both within the group and outside that group and/or district. The presence and/or threat of herbicide resistance is addressed and influences discussion and presentation. Participants visit four or five nearby paddocks and these are used as case studies. The benefits and limitations of different weed management techniques are considered in light of both local and external information and experience. The group works through the preparation of weed management plans based on local conditions, realistic goals and practical techniques, both current and potential.

This workshop also has a bonus that IF a weed management plan was documented that it could be accredited as components for assessment towards AQF level's IV and level V (many C2020 workshops have this level of delivery built in).

In workshop three participants learn how herbicides work and the need to consider a wide range of factors including soil type, soil pH, risk of herbicide resistance, growth stage of plants, weed type and density. The application of herbicides and equipment is discussed. Participants can to update their Chemcert certificates at the conclusion of this workshop. This will involve some extra time and assessments on label reading, calibrating and relevant legislation

Further Information

If you wish to coordinate a workshop further information can be obtained from:
Local agronomists
PIRSA District Offices
Farmbi$ officers
PMP consultants

Challenge 2020
MEETING TOMORROW'S CHALLENGES TODAY

Section Ten

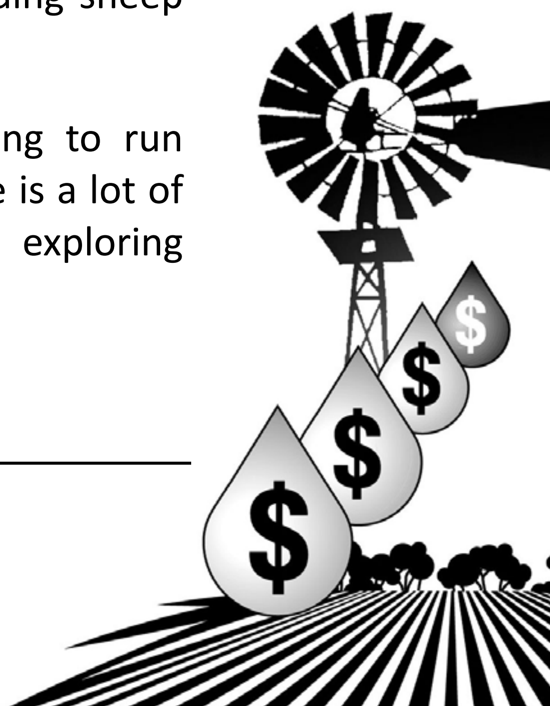
Section Editor: Brian Ashton
PIRSA Rural Solutions, Pt. Lincoln
Senior Sheep Consultant

Livestock

The drought of 1999 saw many sheep trucked off Eyre Peninsula, especially in the Far West. Despite sheep prices being low this was particularly useful income at the time considering crop yields were much lower (or in some cases – non existent).

Good seasonal rains in most areas in 2000 brought pastures back into production and large quantities of stubble feed meant that farmers started building sheep numbers up again.

Most farmers consider, that if they are going to run livestock, they need to be good quality. There is a lot of potential to increase returns and many are exploring options to increase their profits.



AusBulk

Damara Fat Tail Sheep Crosses

Wool contamination and lamb production

Malcolm Fleet[1] and Mark Bennie[2]

[1]Turretfield Research Centre and Integrated Livestock Management Alliance (Roseworthy Campus), [2]Minnipa Agricultural Centre.

Location
Minnipa Ag. Centre

Number of Merino ewes
194

Number of Merino rams
2

Number of Damara rams
2

Key issues
Wool contamination
Lamb production
Lamb growth

Why do the trial?

To assess the wool contamination and lamb production arising from the crossbreeding of Damara rams with Merino ewes.

Low wool prices have influenced some Merino breeders to try the Damara fat tail sheep – a breed recently imported from South Africa. The Damara breeding program ultimately leads to a sheep that does not need to be shorn or crutched, may have other reduced costs (eg. less fly strike), may eat less palatable forage, may have a lower water requirement and may reproduce and survive better in harsher environments than Merinos.

Diversification from Merinos towards wool-less sheep relies on the prices from lambs, surplus sheep, increased meat production, and reduced production costs to more than off-set the loss of income from wool. However, there is very little information available on the relative performance of Merino and Damara sheep or their crossbreds.

A risk for the Australian wool industry from crossbreeding of Merinos with coloured breeds is dark fibre contamination of Merino wool. The importation of such exotic sheep breeds has involved considerable debate and controversy over the potential wool contamination issue.

How was the trial done ?

The trial was conducted by SARDI, with support of PIRSA's Wool Industry Development Board, rams loaned by the Damara Breeders' Group of SA and other inputs from G.H. Michell and Sons, Regency Park TAFE and the Agricultural University of Norway.

The wool contamination study required a mob of Merino ewes rearing only Damara crossbred lambs. For the lamb growth study it was essential to have Merino and Damara crossbred lambs reared together. The trial design and lambing results to weaning were described in the 1999 Farming Systems Summary, on page 97.

What happened?

1. Wool contamination

Merino ewe fleeces were sampled after mating (with Merino or Damara rams), after weaning of Damara crossbred lambs, and 3.5 months after weaning. Figure 1 shows the counts of pigmented fibres (with lengths greater than 10mm) in scoured fleece samples or carded sliver from composite samples.

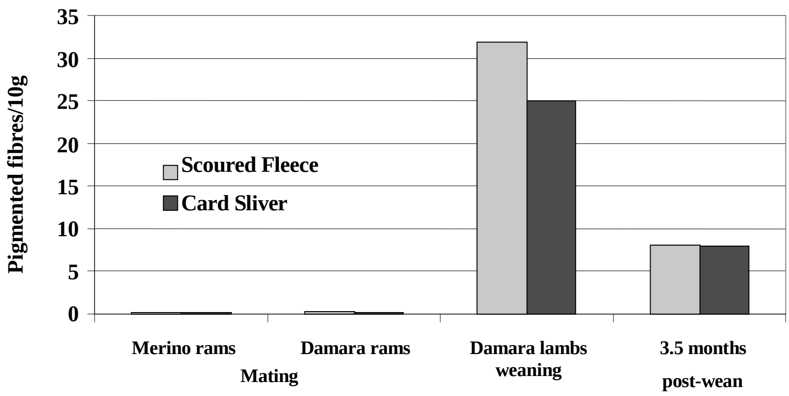
Pigmented and heavily medullated fibres transferred from crossbred lambs to their Merino mothers led to contamination at weaning far in excess of acceptable levels for Merino wool. The extent of fibre transfer arising from ram mating was small compared to lamb rearing effects. There were around 8 pigmented fibres remaining per 10g of carded sliver wool at 3.5 months after weaning of the crossbred lambs. These results support the need for identification of potential contaminated lots and development of a practical pre-sale test for greasy wool bale lots.

The extent of contaminant fibre transfer, and degree of fibre loss following exposure, will depend on several factors. For example, the proportion of coloured and/or heavily medullated animals present, the period of exposure and the delay in shearing. In this trial most of the ewes reared twin lambs which were mainly extensively coloured. Fleece shedding, stocking rates, handling in yards, vegetable matter on Merino fleeces and bush in paddocks are some other possible influencing factors.

2. Lamb growth and carcass evaluations

The Merinos mated to two Damara rams reared more lambs (1.40 and 1.45 lambs per ewe pregnant) than the Merino

Figure 1: Transfer of pigmented fibres from Damara rams or crossbred lambs to Merino ewes



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ewes mated to two Merino rams (0.86 and 1.09 lambs per ewe pregnant); though lambing occurred in separate paddocks. Damara crossbred lambs run with Merino lambs after marking (5 weeks after the start of lambing) had higher live weight increases between birth and 5 to 6 months of age (32.4 kg vs 27.3 kg).

When the ram lambs were slaughtered at age 6 to 7 months, the chilled carcasses of the crossbred lambs were 4.5 kg heavier than the adjusted Merino lamb weights (21.6 kg vs 17.1 kg). Damara crossbred fat tail weights (including the residue left on skins) averaged 0.46 kg. Greasy wool production from the crossbred lambs (1.09 kg) was approximately half that of the Merino lambs (2.23 kg) and was also less valuable due to the pigmentation or heavily medullated fibres present.

Carcass evaluations at the Regency Park TAFE showed that the Damara crossbred lambs had similar lean meat yield (8.70 kg vs 8.95 kg) but higher fat trimmings (2.64 kg - excluding fat tail) than the Merino ram lambs (2.14 kg) with adjustments including chilled carcass weight.

What does this mean?

This project represents only two rams of each breed and it only provides preliminary evidence for discussions and further investigations.

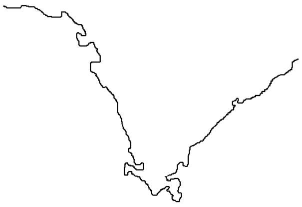
The two Damara rams produced more lambs that grew faster; perhaps involving hybrid vigour. There was no significant difference in lean meat yield but the crossbred lambs carried more fat.

Fibre transfer between lambs and ewes was evident at weaning and 3.5 months after weaning but effect of mating was small in this case. The results support concerns about Merino wool contamination arising from crossbreeding with coloured or heavily medullated breeds. The requirement to identify potentially contaminated greasy wool pre-sale is supported together with the need to develop pre-sale measurement for guidance testing of the level of contamination risk present.

Acknowledgements

Several other people assisted the above trial outputs including for the field work at Minnipa (Kym and Brett McEvoy), the wool measurements at Turretfield and ILMA (Wendy Fulwood, Tony Fotheringham and Meridith Treloar) and G.H. Michell and Sons (Judy Turk, Debbie Peat and Michell Warner), carcass assessments (Gordon Cook, Geoff Dunsford and Bruce Hancock), administration support and publicity (Mike Cottell, Geoff Keynes, Bob Holloway, Peter Speck, Andrew Curtis, Cheryl Pope and Brian Ashton) and Tom Ashby provided the Damara rams.

Figure 2: Damara x Merino ram lambs and carcasses showing fat tail development



BETTER BREEDING

Just do it!

Brian Ashton, Livestock Consultant, PIRSA Rural Solutions, Port Lincoln

Location
Around Eyre Peninsula and SA (over 50 trial sites and increasing all the time)

Bloodlines
Many and varied (see 1999 Farming Systems summary)

Why do the trial?

All farmers with Merino sheep want to increase their income but most find it very difficult to change their ram source. Yet choice of bloodline is critical to the success of the Merino enterprise.

Why is the decision so difficult?

- A change of bloodline is not something farmers regularly do - many have been on the same bloodline for decades. Cereal varieties, for example, are changed regularly so we are familiar with the process.
- Objective information on rams is lacking. Compared to cereal varieties we have very little information comparing bloodlines.
- It is easy to see if a new cereal variety goes well, but it is not so easy with a new bloodline.

The BETTER BREEDING project is helping woolgrowers through this difficult process.

The project has helped woolgrowers access and understand the objective information that we do have. The "Merino Bloodlines" fact sheet, produced by NSW Agriculture, gives very good information on some bloodlines. It clearly shows that income can increase by over $10 a sheep by choice of bloodline.

BETTER BREEDING workshops have been held around Eyre Peninsula discussing this information. Contact your Bureau.

How were the BETTER BREEDING trials done?

The project makes the steps in changing bloodline easy. We suggest farmers buy five rams from the new source and mate them to a random draft of ewes. The offspring need to be identified and run together, then evaluated as hoggets.

This is a simple, step-by-step, process that farmers find interesting and worthwhile.

What happened?

The 1999 Farm Systems article gave the results of six ram evaluation trials. More are coming in and all the information will be collated into a booklet.

One lot of results has just come in from Wanilla. This farmer has changed bloodlines twice before and so the process was not at all scary to him. He considered he had found a pretty good bloodline but he wanted more!

The new bloodline was a leader in the "Merino Bloodlines" fact sheet and this is why it was chosen by the farmer. The hogget offspring were shorn in January 2001.

The results so far (wool is still in the store) are in Figure 1.

Figure 1: Recent results from a change in bloodline by a Wanilla farmer.

	Home Bloodline (pure)	New bloodline (first cross)
Visual culls	17 %	1 %
Fibre diameter	22.7 microns	22.1 microns
Greasy fleece weights Ewe hoggets Wether hoggets	 6.4 kg 6.9 kg	 6.9 kg 7.5 kg

Note: The farmer culled the sheep visually for obvious faults only. The home bloodline had a problem with water stain (as did the rest of his flock this year) and this was the major reason for culling. At shearing the new bloodline was more wrinkly and in future more of these sheep will be culled for wrinkle.

The farmer was ecstatic with his results - but he is now looking around for <u>further</u> improvements !

Take home messages:

- Improved bloodline selection is an opportunity to make more money from your sheep.
- It is the profits from the offspring of a ram that is important - not just the looks of the ram himself.
- To make real progress your breeder must be measuring the important characters rather than just relying on looks (a ram has to be visually OK as well).

Contact

Brian Ashton, ph 8688 3403, for the simple guidelines on how to run a trial, the BETTER BREEDING Newsletter, or the "Merino Bloodlines" fact sheet. A meeting can be arranged to discuss the issues.

BETTER BREEDING

BETTER BREEDING is a PIRSA and Advisory Board of Agriculture project with funding from the Woolmark Company under the RAMPOWER program

Section Eleven

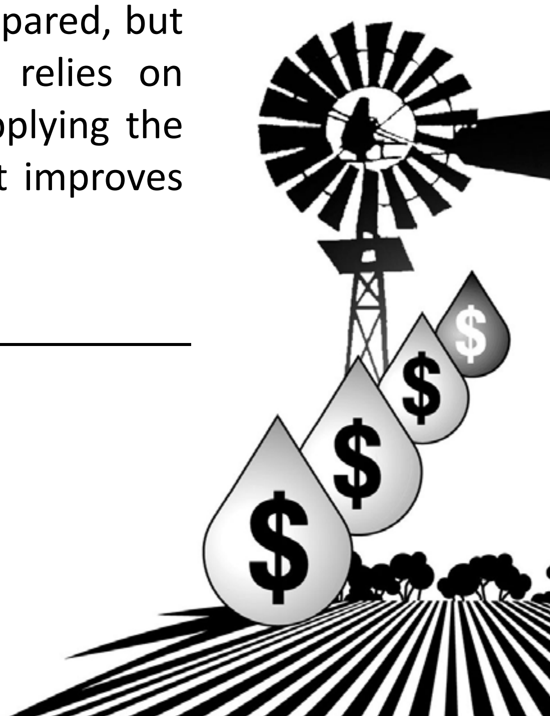
Section Editor: Samantha Doudle
SARDI, Minnipa Agricultural Centre
Eyre Peninsula Farming Systems Project Coordinator

Economics

This is a new section for the Farming Systems Summary, specifically requested by Eyre Peninsula farmers in last years survey.

Successful planning and goal setting can promote the viability of farm businesses into the future. Machinery replacement and lifestyle issues form part of this process.

Benchmarking is one tool which can be used to improve farm business performance. Benchmarks are standards or measures against which something can be compared, but it is not just the numbers. Benchmarking relies on questioning and learning from others, then applying the information to our farms in such a way that it improves performance.



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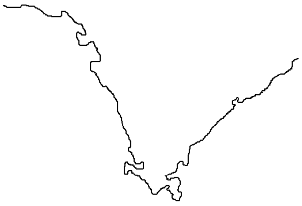


The Costs of Machinery Ownership

Chris McDonough and Mark Stanley, PIRSA Rural Solutions

The high cost of machinery makes replacement decisions amongst the most crucial in the farming business.

Determining how often machinery should be replaced, what is affordable, and how the new machine will fit an individual farming system now and into the future can be a daunting task.

Farm profitability is influenced by decisions on the number, size and type of machines to operate, the timing of replacement, and the type of ownership.
In deciding on machinery purchases, consider the costs involved of the various options; the optimum size of machinery; ownership options (buy, hire, contractors, contract, syndicate); when replacement of different items is required; and the tax implications of machinery sales and purchases.

Questions often asked include; are farmers who invest in large, expensive machinery really moving forward in their business, or is it better economics to persist with older machinery. Unfortunately, the answers are often hidden from those wanting to make informed decisions on machinery replacement.

Machinery Replacement workshop

The Machinery Replacement workshop developed by PIRSA Rural Solutions consultant Chris McDonough can assist in answering some of these questions. The workshop is one of the Challenge 2020 series of interactive, hands - on workshops, which give practical answers to the real problems faced by farmers today.

The workshop allows participants to explore "what if" scenarios from the safety of their own desk!

In the workshop participants are able to assess their current machinery ownership, and their ability to keep up with their intended or required level of machinery for their cropping enterprise. The workshop allows participants to take into account interest repayments, and match costs against the productivity level of their cropping enterprise.

In the workshop, a number of machinery capitalisation indicators are calculated, and these can be compared with industry benchmarks and between workshop participants to see how they compare, and where adjustments may need to be made.

Linking Machinery Ownership with Cropping Returns

The Machinery Replacement workshop allows you to calculate the cost of machinery ownership, then subtract this from your total cropping gross margin, so that you have a better understanding of the effect of machinery ownership on overall cropping profitability.

For example, over the next ten years a farmer may require $40/ha cropped/year to keep up with capital replacement. If the average gross margins for this farmer's cropping operation averages $100/ha, then after taking the capital costs into account, realistically he is only making $60/ha.

This amounts to 40% of the farmers gross margin paying for machinery, not leaving a huge amount for living expenses, fixed costs and loan repayments.

If you are spending too much on machinery, you need to consider the following:

- Examine your more expensive items and consider less costly options
- Crop more land
- Improve crop profitability
- Re-think timing of replacement
- Explore other ownership options (leasing, sharing, contracting)

The Machinery Replacement workshop shows you how to test different scenarios to help work out your best options.

Chris has already run a number of these workshops, with excellent feedback regarding their content and value in assessing key factors for decisions on machinery replacement and the development of action plans for machinery replacement.

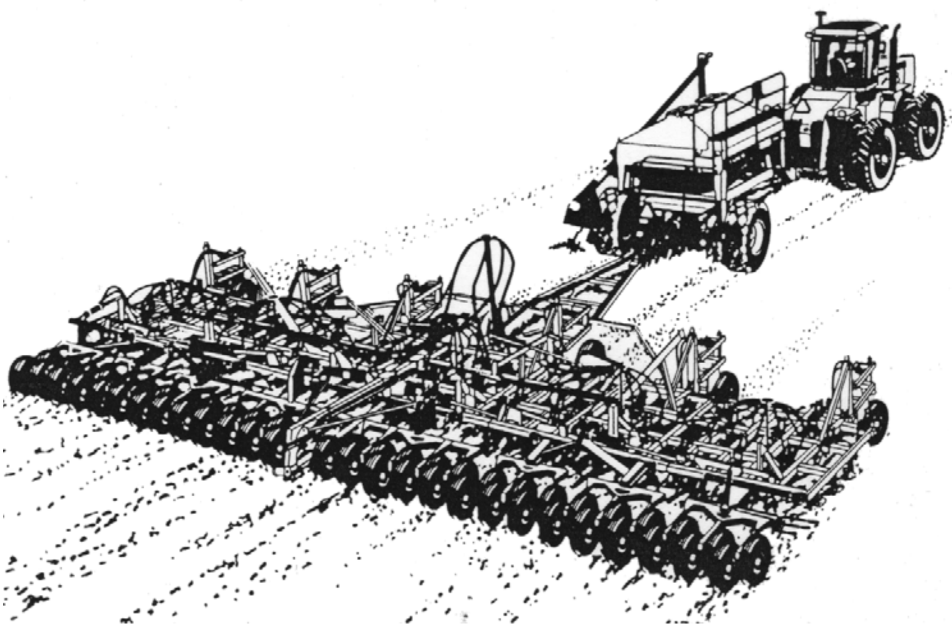
The workshop runs for approximately 4 hours, and is best conducted with farmer groups of between 8 and 15 people. The workshop attracts a FARMBIS subsidy, making the cost only $35 per participant.

For further information on this workshop, and other workshops in the Challenge 2020 program, please contact a PIRSA Rural Solutions consultant or Erica Hancock on 85686400.

Challenge 2020
MEETING TOMORROW'S CHALLENGES TODAY

FLOW CHART FOR MACHINERY DECISION MAKING

- **Now**
  - Keep as is
  - Recondition
    - Cash
    - Cash and loan
    - Overdraft
  - Replace
    - Sole ownership and usage
      - New
        - Cash
        - Cash and Loan
        - Cash and hire purchase
        - Lease
      - Second hand
        - Cash
        - Cash and loan
        - Cash and hire purchase
        - Lease (newer plant items only)
    - Alternatives to ownership
      - Syndicate new (Finance as above)
      - Machinery Rings (coordinated hire)
      - Contracting/Rental



Benchmarking your farm on Eyre Peninsula

Brenton Lynch – Lynch Farm Monitoring, Wudinna

The benefits of benchmarking farm business and their performance have been well documented. Rather than take farmers through what can become an involved and potentially confusing process, in the past I have chosen to benchmark our clients on the basis of their cost of production per tonne of grain. To me this makes sense as wheat growing and grain growing forms the majority of income for EP farmers.

Some of the best and most useful things in life are the simplest, and it is this approach we have used in benchmarking cost of production per tonne of grain. Many other indicators can be used but it is very easy for the process to become unreliable, especially if participants are not exactly sure what they are measuring, and why.

In my experience, benchmarking production indicators is fairly straightforward (yields, water use efficiency, grain protein). Financial benchmarking can be a little more complex depending on the accuracy of financial information kept.

Over a numbers of years, our clients have compared their cost of production per tonne and used this to compare their business characteristics and cost structure with other farms. This can help us in future decisions on investment in different areas of their business.
The process is more useful when farms of similar rainfall areas are compared. For example comparison of lower rainfall farms on Western EP (west of Minnipa), central EP (north of Lock) and lower EP (south of Lock) would make for more valid comparison if compared with in their own area. This does not prevent the group being treated as a whole.

COST OF PRODUCTION PER TONNE OF WHEAT (CENTRAL EP)

Cost Centre	**Indicative figure (per tonne)**	**Comment**
CASH COSTS		
Seed treatment	$14.00	Depends on grain price, seeding rate and pickle used
Fertilizer	$25.00	Depends on fertilizer price/rate and trace element used
Chemical	$20.00	Inc. pasture treatment, but not summer weed control
Fuel	$12.00	Gross figure. Depends on the tillage system
Repairs and maintenance on machinery	$12.00	Depends on machinery condition
OVERHEAD COSTS		
Machinery dep.	$12.00	Depends on machinery condition & total tonnages
Debt servicing (interest, principal, HP)	$20.00	Depends on loan structure & total tonnages
Wages/Drawings/Tax	$18.00	Very variable between businesses
Other business o/heads	$18.00	Depends on business size and tonnage
TOTAL	$ 159/tonne	

Note:

- The above costs are per tonne, not per hectare.
- Comparison to figures above is only valid if you use the same process to derive them as has been used here.
- Figures above are guideline figures only and vary widely within businesses.
- With wheat at 2000 prices, there is around $11/T margin.
- All costs met in cash each year except for machinery depreciation which occurs in ‘lumps’ when machinery is changed over.
- Figures above are for a central EP farm (lower EP and western EP would differ).

Once you have all the figures, it is how you use them to make your business more efficient and profitable, that really matters.

Section Twelve

Section Editor: Brett Bartel
PIRSA Rural Solutions
Revegetation Consultant

Revegetation

The PIRSA Revegetation program on Eyre Peninsula is involved in a range of state funded activities and consultancies relating to on-farm revegetation which enhances farm economics and environmental benefits. These include:

- Layout and design of windbreaks, shelter belts and alley farming.
- Land rehabilitation (dryland salinity, wind and water erosion).
- Native grassland management
- Fodder shrubs
- Farm forestry
- Species selection for projects.

In the future the revegetation team on Eyre Peninsula will be available for support of funded projects and are available as consultants for on-farm planning and implementation of revegetation.

AusBulk

Sandalwood for Farm Forestry on Upper EP

Brett Bartel, PIRSA Rural Solutions

Location
Minnipa
Minnipa Agricultural Centre
Group:
Rainfall
Av. Annual total: 325 mm
Av. Growing season: 250 mm
Actual annual total: 390mm
Actual growing season: 299mm
Soil
Land System:
Major soil type description:
Red sandy loam
Plot size
0.63 ha

Why do the trial?

To determine if sandalwood (*Santalum spicatum*) is a viable, low rainfall farm forestry option for upper Eyre Peninsula. To determine which provenance of sandalwood and host species will be most suitable and produce best growth rates for Upper Eyre Peninsula.

Landholders on Eyre Peninsula are looking for revegetation options which may provide additional farm income. Sandalwood is a species which is showing potential in other areas of Australia. The market for this species appears to be relatively stable with all of the wood currently being harvested coming from native stands. Global demand for sandalwood is higher than annual supply and the current range of prices ($6500 - $10,000 per tonne) is expected to remain high for the median term. The wood is mainly used for aromatic oil or in the making of incense for religious ceremonies. There is a small niche market for craft wood due its fine grain and unique properties. Potential also exists for the seed kernels to be harvested which have shown to have similar characteristics to other commonly used nuts such as walnuts and Brazil nuts.

There have been very few plantations established in Australia and to date no wood has been harvested from plantations. It is therefore difficult to determine growth rates and harvest times. From information gathered from wild stands it is expected that harvests may occur between 23 years in high rainfall areas (500 mm/year) to 100 years in low rainfall areas (300mm). Irrigation may be utilised to increase growth rates and it is envisaged that a small amount of irrigation in summer may shorten harvesting time. Long term trials will assist in determining this information.

How was it done?

Three different provenances of the same species of sandalwood (*Santalum spicatum*) were propagated and planted. These included:

- Gawler Ranges, South Australia.
- Eucla, Western Australia.
- Nectarbrook plantation, Port Augusta.

These were planted in separate rows so that growth and survival rates could be monitored over the years.

Sandalwood require a host species to which they can attach in order to survive and grow. A ground cover (*Myoporum parvifolium*) was propagated with the seedlings to provide a host in the initial stages. Rows of shrubs or trees are required within approximately 10 metres of the sandalwood plants for successful growth. A range of different host species were planted in separate rows between the sandalwood to determine if host species affected growth rates of sandalwood.

Host planted included:

- Wattle mix – A mixture of *Acacia notabilis, A. sclerophylla, A. iteaphylla and A. ligulata.*
- *Eucalyptus gracilis*
- *Allocasuarina cristata* (Black oak)

Host seedlings were planted in winter 1999 to enable establishment. Sandalwood were planted in winter 2000 to ensure connection.

Host species were planted using a mechanical tree planter. Sandalwood were propagated in biodegradable pots and entire pot was hand planted. These pots were used to minimise disturbance to the roots of seedlings. A shade cloth tree guard was erected around each sandalwood plant as 50–80% shade cover is desirable to optimise seedling survival.

Hosts were planted using a combination of tube stock seedlings and speedlings. Both hosts and sandalwood were planted at four meter row spacing with three to four metres between each seedling. All seedlings were watered at the time of planting and twice throughout the first year to optimise survival rates.

What happened?

Approximately 80% of sandalwood seedlings have survived to date (February 2001). Survival and growth rates will be monitored in the future. This is however a very long term trial due to slow growth rates of sandalwood.

What does this mean?

Information gained from this trial may give indications of which provenance of sandalwood is most suitable for upper Eyre Peninsula. In addition, an indication of which host species will produce best sandalwood growth rates may be obtained.

Sandalwood appears to be a productive revegetation option. This is a long term investment and should be viewed as Landcare forestry. The land management benefits and potential additional farm income should be viewed in combination. Sandalwood plantations can be established in strategic locations to act as wind breaks, protect soils from wind erosion, minimise recharge assisting in salinity management and increase the biodiversity of the area. In the longer term there is potential for the plantation to provide additional farm income.

More broad acre, long term trials are required on a range of soil types to determine the suitability of sandalwood to farming systems on upper Eyre Peninsula.

Tree species for deep sandy soils on Eastern Eyre Peninsula

Brett Bartel, PIRSA Rural Solutions

Location
Rudall
Mel and Cynthia Wagner

Rainfall
Av. Annual total: 339 mm
Av. Growing season: 247 mm
Actual annual total: 409 mm
Actual growing season: 301mm

Soil
Land System: Dune swale
Major soil type description: Deep Sandy

Plot size
1 ha

Why do the trial?

To determine which tree species are most suitable for establishment on deep sands on Eastern Eyre Peninsula.

Perennial native vegetation on deep sandy sites provides the opportunity for landholders to permanently stabilise these traditionally erosion prone areas of their properties. Alley farming on these areas is being promoted as a design option as it allows landholders to establish perennial vegetation to protect their crops, livestock and soils, whilst maintaining agricultural production between vegetation belts. Block plantings on these soils are also being encouraged to promote soil stabilisation, salinity management, biodiversity benefits and shelter for stock. With the exception of oldman saltbush (*Atriplex nummularia*) little is known about which species will be most suitable for these areas.

Desirable characteristics of species for these areas include:

- Fast growing so they establish rapidly and provide shelter.
- Tall growing with good form to create ideal windbreaks.
- Roots which do not compete with crops.
- Easy to establish.
- Long lived.
- Not prone to insect invasion.

How was it done?

A variety of tree and shrub species which have previously shown potential or been recommended for planting on sandy sites were planted on a sandy site near Rudall.

Tree lines were sprayed with Roundup® one week prior to seedling planting. Tubestock seedlings were planted on the 29th of June 1999. 10 seedlings of 29 different species were planted using a mechanical tree planter (refer table one for species planted). Seedlings were planted at five metre row spacing with four metres between each plant. Seedling were watered at time of planting only. Survival and growth rates were monitored.

<u>Definition of growth rates</u>

V. High: Very high growth rate with plants over 120 cm high.
High: High growth rate with plants between 80 – 120 cm high
Med: Medium growth rate with plants between 50 – 80 cm high.
Low: Plants which survived but were lower than 50 cm high.

What has happened?

Overall in this trial there has been a high mortality rate. There are several possible explanations for this:

- **Planting technique utilised** – An unfamiliar mechanical tree planter was utilised and could have damaged seedlings and created poor root soil contact at time of planting.
- **Poor seedling quality** – Desert cassia (*Senna artemisioides*), native pine (*Callitris verrucosa*) and sugar wood (*Myoporum platycarpum*) seedlings were identified as being of poor quality at time of planting.
- **Grazing by rabbits** – Signs of rabbits were observed at one end of the trial. This was mainly observed around ridge-fruited mallee (*Eucalyptus incrassata*), Flinders Range Wattle (*Acacia iteaphylla*) and Broughton wattle (*A. salicina*) and may have been responsible for high mortality rates of these species.
- **Weed competition** – Despite spraying prior to sowing weed control in this trial has been poor.

EP blue gum, Silverton and Mt. Wedge red gum and flat topped yate have been planted widely across Eyre Peninsula, but are not generally considered sandy soil species. Their suitability to these soils requires further investigation and monitoring to determine their long term suitability.

Golden grey wattle has done extremely well in this trial, but has not previously been utilised on Eyre Peninsula. This species is mainly found in the Flinders and Mount Lofty ranges and warrants further investigation.

What does this mean?

The best performers in this trial were golden reef wattle, golden grey wattle, EP blue gum, red gum and flat topped yate and all show potential for sandy soils. It should be noted that golden reef wattle is only a short lived species and is considered a weed in many areas as it out competes local native vegetation.

There were many poor performers, but this trial was not conclusive due to limitations such as weed control, rabbits and lack of replication. Species should not be excluded as potential species for this region due to their performance in this trial.

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(Continued from page 147)

A project undertaken by the Central and Eastern Eyre Peninsula Soil Conservation Board (C&EEPSCB) titled "Stabilising Fragile Sands" (1990 – 1994) trialed several tree and shrub species for deep sandy soils. This project found that native pine (*Callitris preissii*) and dry-land tea tree (*Melaleuca lanceolata*) had good survival rates and high growth rates. These species had poor survival rates in this project.

Silver mulga was also trialed in the stabilising fragile sand project. Medium level survival rates were recorded with very high growth rates.

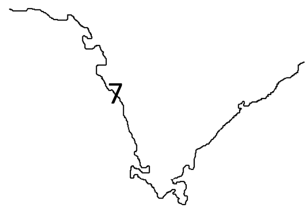
The C&EEPSCB project found that S.A. mallee box (*Eucalyptus porosa*) and drooping sheoak (*Allocasuarina verticillata*) had good survival rates and very high growth rates. These species were not trialed in this project.

To prevent the introduction of weed species and maximise biodiversity values, local species should be favoured over those of introduced species.

Table 1: Survival and growth rates at 6th September 2000.

Species	Common Name	No. of plants	Growth Rates				% survival
		Survived	V. High	High	Med.	Low	
Acacia argyrophylla	Golden grey mulga	9	1	7	1		90
A. iteaphylla	Flinders range wattle	0					0
A. ligulata	Umbrella bush	7		4	3		70
A. notabilis	Notable wattle	10			9	1	100
A. pycnantha	Golden wattle	7			5	2	70
A. rigens	Needle bush wattle	7			6	1	70
A. salicina	Broughton wattle	0					0
A. saligna	Golden reef wattle	9	8		1		90
A. sclerophylla	Hard leaf wattle	0					0
A. stenophylla	River cooba	5		1	4		50
Atriplex amnicola	River saltbush	1				1	10
A. nummularia	Oldman saltbush	2			2		20
Callitris verrucosa	Native Pine	2				2	20
Corymbia maculata	Spotted gum (formerly Euc.)	1				1	10
Eucalyptus calamldulensis	Red gum – Mt Wedge	9		8	1		90
E. calamldulensis	Red Gum – Silverton	9		8	1		90
E. cladocalyx	Sugar gum – Flinders ranges	2			2		20
E. cladocalyx	Sugar gum – EP variety	0					0
E. gracilis	Yorrell	7			7		70
E. incrassata	Ridge fruited mallee	5		1	4		50
E. lansdowneana ssp albopurpurea	Port Lincoln gum	7			7		70
E. occidentalis	Flat topped yate	10	3	7			100
E. petiolaris	EP Blue gum	10	4	6			100
E. sideroxylon	Red ironbark	4			4		40
M. lanceolata	Dryland tea tree	0					0
M. pauperiflora	EP tea tree	0					0
Myoporum platycarpum	Sugar wood	0					0
Pinus helepensis	Alleppo pine	0					0
Senna artemisioides notho spp. artemisioides	Desert cassia	0					0
TOTAL		123					42%

Native Grassland Grazing Demonstration Sites



Brett Bartel, PIRSA Rural Solutions

Why do the trial?

To demonstrate that appropriate grazing management can allow native pastures to be grazed for production, and result in improved biodiversity values of native grasslands.

Set stocking (continuous grazing) of livestock on native pastures has resulted in native grassland pastures becoming degraded, with a loss of desirable perennial grasses. Those surviving perennial grasses exhibit evidence of extreme grazing pressure through prostrate growth. In many cases these native perennial grasses have been replaced by annuals such as wild oats, barley grass and saffron thistles. This has resulted in a decline in productivity and biodiversity.

Native grasslands are one of the most threatened native ecosystems in Australia. This project aims to demonstrate that conservation of these systems is possible without compromising productivity. With appropriate rotational grazing systems it may be possible to improve productivity from these areas, while increasing the biodiversity values.

These demonstrations sites are being set up in early 2001 and monitoring will begin in winter 2001.

How is it to be done?

Three sites have been selected in the Elliston area to demonstrate best practice grazing strategies. These demonstrations will involve subdividing paddocks to enable grazing to be controlled more effectively. The aim is to graze the paddock at high stocking rates (approx. 100 to 150 DSE per ha) for short periods of time. The perennial species will be allowed to recover before being re-grazed. It is envisaged that the total carrying capacity of the area will not be lowered, simply concentrated into a shorter period of time. This will allow perennial native grasses time to recover and reproduce.

Each site will be monitored for changes in pasture composition over time. Within each paddock at least one 100 metre long transect will be established and the following monitored:

- **Presence/absence** - of plant species will give an indication of the frequency and diversity within the paddock and monitoring will determine if this is changing with modified grazing strategies.
- Number of native perennial grass plants per quadrat - will give an indication of the condition of the pasture as perennial grasses provide stability to the grassland.
- **Available pasture mass -** pasture cuts will be undertaken to determine pasture height/weight relationship. This will be used determine appropriate stocking rates.
- **Contribution of dominant species to total dry weight of pasture -** the dry weight rank of the dominant plant species will be visually assessed to give a measure of species contribution to total pasture dry weight relative to other species in the pasture.
- **Photo points -** will be established at each site to monitor visual changes in composition of the pasture.

Monitoring will be undertaken during winter (June/July) and late spring/early summer (November/December). Monitoring times will depend on seasonal variations.

Demonstrations similar to these are being undertaken in the Mid North and Eastern Mount Lofty ranges.

Location
Elliston
Steve McCracken, Arthur Robinson, Bruce Agars.
Elliston Landcare Group

Soil
Land System: Undulating calcrete plains
Major soil type description: Shallow soils over sheet calcrete

What will this mean?

It is envisaged that with improved grazing strategies the number of perennial native grasses can be increased and annual weeds decreased. This will result in improved productivity as perennial grasses are capable of taking advantage of any summer rainfall and producing valuable green pasture all year round. In contrast annuals such as wild oats provide an abundance of feed in the winter and are inactive throughout the remainder of the year.

Improved grazing management has many land management benefits. The increased number of perennials in the pasture result in better water use efficiency and water holding capacity of soils. This results in a more sustainable system and positive benefits for dryland salinity control. The permanent cover provided by perennial grasses also protects soils from erosion.

Improved grazing management will also have positive biodiversity outcomes as native grasses, herb and forb species will be allowed to regenerate and reproduce.

The methodology utilised in this project has been adapted from Agricultural Information and Montoring Services.