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Crop Updates 2001 - Grower Booklet

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CROP UPDATES

Unregistered pesticides and uses: This document reports the results of some research where the product, or the use reported for that product, is not currently registered. Any discussion of these uses does not constitute a recommendation for that use. All pesticide use must be in accord with the registered uses for that product.

Introduction

The grains industry in Western Australia is large and grows a significant proportion of the nation's crop. Each year Agriculture Western Australia and the Grains Research and Development Corporation make a large investment in grains research and development activities. The communication of the latest research and development information to grain producers is a vital part of this investment in grain research.

The Western Australian Crop Updates are one mechanism to get this information to the industry. This year a new event was introduced, the State Grower Crop Update was run in Perth, to complement the regional Grower Crop Updates that are being run throughout the grain growing areas of the State in March. By attending these events growers get access to the latest grains research and development information and also the opportunity to interact with the presenters and others within the grains industry.

As part of Crop Updates, researchers summarise and deliver their research results from work conducted last year. Through a magnificent effort, they prepare articles outlining their major research findings and recommendations that are ‘hot off the header’ in a 3-6 week period. This ensures that information is available to growers in a very timely manner ready for use for the coming season.

This booklet contains a compilation of articles that we believe will help you make better decisions for the coming growing season. I urge you to utilise the information in this booklet and please contact Agriculture Western Australia for further information.

Good planning for the coming season!

Dr Graeme Robertson
CHIEF EXECUTIVE OFFICE

GROWER BOOKLET, 2001
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Strategies for leaf disease management in wheat

Jatinderpal Bhathal[1], Cameron Weeks[2], Kith Jayasena[1] and Robert Loughman[1]
[1]Agriculture Western Australia. [2]Mingenew-Irwin Group Inc.

KEY MESSAGES

- Disease management strategies need to be tailored to varieties to achieve optimal crop performance.
- A two spray program (early stem elongation plus flag emergence sprays) was more effective than combining seed treatment or in-furrow fungicide with flag emergence sprays in high leaf rust situations.
- Triazole fungicides have a broad range of activities. Among these, triadimefon provides the most cost-effective control of leaf rust and powdery mildew whereas propiconazole is most effective for yellow spot.

INTRODUCTION

The most important leaf diseases of wheat in Western Australia are yellow spot, septoria blotches, leaf and stem rust and powdery mildew. Fungicide spray experiments in commercial crops have demonstrated up to 40% yield increase (between 5 and 15 per cent are more common). Fungicides can improve grain density and reduce screenings.

The response to fungicide disease control is variable and determined by factors such as varietal resistance, disease spectrum and severity, crop potential, future disease risk (weather) and cost. Opportunities exist for fine-tuning fungicide management by taking these different factors into account.

VARIETY

A range of experiments with leaf rust have shown that highly susceptible varieties like Ajana respond routinely to fungicide disease control, whereas highly resistant varieties like Camm generally are unresponsive (Table 1). With early leaf rust occurrence, fully susceptible varieties (e.g. Ajana) may require more than one spray to achieve their yield potential. Response of varieties with intermediate (e.g. Brookton) and moderate resistance (e.g. Carnamah) vary with disease pressure. In most scenarios varieties with intermediate resistance need only one spray to prevent most yield losses. Losses with moderately resistant varieties are less but these varieties can sometimes benefit from spray treatment.

Table 1. Response of different varieties to fungicide control of leaf rust in 1999 and 2000 at Mingenew

Variety	1999			2000		
	Yield potential (t/ha)	Total yield loss (%)	Preventable yield loss* (%)	Yield potential (t/ha)	Total yield loss (%)	Preventable yield loss* (%)
Ajana	3.76	28	20	3.60	22	10
Brookton	4.08	7	3	3.70	15	12
Cascades	3.34	14	6	2.95	15	9
Westonia	3.64	7	7	4.05	14	8
Carnamah	4.06	7	4	3.67	10	7
Camm	-	-	-	3.41	4	2
Spear	3.90	25	24	-	-	-
Arrino	3.56	20	18	-	-	-
Amery	3.16	19	17	-	-	-

* The per cent yield loss which is prevented with a single spray at flag leaf emergence.

SEED/IN-FURROW TREATMENTS AND FOLIAR SPRAYS

In an average season, single application of fungicide applied at full flag leaf emergence (Z39 growth stage) provides the most economic disease control. However, in seasons when risk of early leaf rust prevails, an earlier fungicide application (early stem elongation) in conjunction with normal timing (around Z39) spray can be advantageous. Experiments in 2000 have shown that early disease can be more effectively managed by an early (Z31 growth stage) foliar spray than seed treatment or in-furrow fungicide (Table 2).

Table 2. Effect of early season fungicide treatment, normal timed fungicide spray and their combination on yield and profit of wheat cultivars affected by leaf rust at Gibson and Mingenew

Early season treatment	Normal timed spray	Stiletto (Gibson)			Ajana (Mingenew)			Carnamah (Mingenew)		
		Yield t/ha	% of Nil	Est. profit $/ha	Yield t/ha	% of Nil	Est. profit $/ha	Yield t/ha	% of Nil	Est. profit $/ha
Untreated seed	Nil	3.7	100	-	2.8	100	-	3.4	100	-
Real @ 150 mL/100 kg seed	Nil	3.8	103	8	-	-	-	-	-	-
Triadimefon-in-furrow 125 gai/ha	Nil	4.0	108	40	-	-	-	-	-	-
Triad 125 EC 1000 mL/ha at Z33	Nil	4.5	122	112	-	-	-	-	-	-
Untreated seed	Z41 spray*	4.5	122	101	3.0	107	21	3.7	106	23
Triadimefon-in-furrow 125 gai/ha	Z41 spray	4.7	127	128	3.3	115	48	3.6	105	7
Real @ 150 mL/100 kg seed	Z41 spray	4.7	127	123	3.2	111	43	3.7	106	28
Triad 125 EC 1000 mL/ha at Z33	Z41 spray	5.0	135	152	3.6	128	94	3.9	113	44
LSD 5%		0.2			0.1			0.1		

* Folicur 430SC 145 mL/ha at Gibson and Tilt250EC 250 mL/ha at Mingenew.

WHICH FUNGICIDE

In a range of experiments with triazole fungicides *propiconazole* provides most effective control of yellow spot. *Triadimefon* has provided highly cost-effective control of leaf rust and powdery mildew.

FUNGICIDE SPRAYING METHOD

Past research has shown that a plane can be just as effective as a ground boom. Grower experiences in 2000 suggest that in high disease pressure situations the higher water volumes available through a boom may allow better disease control. Some in crop comparisons carried out by the Mingenew-Irwin Group in 2000 showed that boom spray wheel damage is minimised when a Rogator is used. Three harvest trials showed an average of 0.7% yield loss associated with wheel tracks when spraying took place at flag leaf emergence.

Because timing of application is critical a grower needs to decide the best method of application based on access to plane or Rogator and whether or not disease pressure warrants rapid control and the flexibility of high water volumes.

CONCLUSIONS

Variability in yield response with fungicide relates partly to varietal resistance, disease spectrum and severity, and seasonal conditions. Number of applications and rates of fungicide needs to be tuned with these factors. Multiple foliar sprays are more cost effective than seed treatment and in-furrow fungicide in controlling early infection of leaf rust on susceptible varieties.

Selecting which fungicide depends on disease spectrum. Commercially available triazole fungicides provide effective control of leaf rust whereas their effectiveness varies against yellow spot. *Propiconazole* is most effective when controlling yellow spot. Aerial and ground sprays are effective in controlling disease. Timing is more important than the method of application. The most timely application method should be used. Severe disease should be controlled earlier with rates appropriate to the duration of control required. Predicting future disease risk using local weather variables will help in further refining of fungicide spray decisions.

AGWEST research is supported with financial assistance provided by GRDC. The provision of samples by fungicide manufacturers and cooperation of growers is gratefully acknowledged.

GRDC Project No.: DAW 488, DAW 589

Paper reviewed by: Dominie Wright

Burn stubble windrows: to diagnose soil fertility problems

Bill Bowden, Chris Gazey and Ross Brennan, Agriculture Western Australia

KEY MESSAGES

Changing farming conditions over the last couple of decades have meant that traditional methods of assessing soil fertility are not as reliable as they used to be. Crop nutrition in WA has always operated on a knife edge and our soils are very susceptible to the inevitable acidification processes of farming.

Burning stubble windrows provides a means of observing and diagnosing otherwise subclinical fertility problems.

Burn windrows and if variation in growth is obvious in the following crop, take paired soil and plant samples and access an expert to interpret the results and offer remedial advice.

INTRODUCTION

Marked yield responses to the burning of canola stubble in windrows have been observed in following crops. Much of the response is due to the accumulation of high levels of nutrients (K, S, Cu, Mo, P, Zn) on the windrows (Bowden *et al*. 1999 and 2000 crop updates). In some cases there has been an apparent response to the liming impact of the burnt stubble. As can be seen in the table below, many of these responses have been greater than 1t/ha with possible returns to remedial treatments of over $150/ha.

				Stubble treatment		
2000 observations				**Removed**		**Burnt/spread**
Location	**Crop**	**GY on kg/ha**	**GY off kg/ha**	**Loss kg/ha**	**Loss $/ha**	**Loss pad. 4:1 $/ha**
Cadoux	Wheat	1,978	534	1,444	173	139
Tenindewa	Wheat	1,914	1,505	409	49	39
Goomalling	Wheat	4,644	3,395	1,249	150	120
Bejording, hill	Wheat	5,371	3,714	1,657	199	159
Bejording, track	Wheat	4,771	2,829	1,943	233	187
Bejording, Sheen	Wheat	4,071	3,143	929	111	89
Kononngorring E	Wheat	2,143	1,200	943	113	91
Wongan Hills	Barley	1,984	1,323	661	79	63
Konongorring S	Wheat	3,200	2,057	1,143	137	110
Varley 'uniform'	Wheat	2,454	1,894	560	67	54
Varley 'contrast'	Wheat	2,813	1,886	927	111	89
Mean		3,157	1,987	1,170	140	112

Assume 4:1 off/on ratio and $120/t.

While the observation of waves in crops following canola was originally seen as a negative to growing canola, it subsequently has been recognised that the same effects are possible from the heterogeneous distribution of the stubbles from other crops, and that the effect can be exploited by growers.

Importantly, these responses have given us a wake up call to the fact that much of the crop nutrition in WA is sub-optimal. Further, our soil test critical levels for P and K may well be too low in these days of minimum tillage and where soils are now more acid and contain more root pruning organisms and herbicide residuals than were present in the '70s and '80s when the tests were calibrated. Despite our reliance on soil tests for P and K in WA, it is extremely difficult to make appropriate adjustments to the calibration curves without making a large investment in obtaining better diagnostic information.

An opportunity exists to diagnose and then implement a quick fix to what appears to be widespread and expensive (as high as $200/ha), sub-clinical fertility problems in WA. By encouraging farmers to burn stubbles concentrated on windrows (not between the windrows) and then to collect paired, plant and soil samples in the subsequent crops if windrow effects are obvious, it should be possible to diagnose problems which have otherwise gone undetected. The diagnostic power of paired samples

from adjacent areas in a crop, is an order of magnitude greater than picking up the causes of the problems from the normal soil and tissue testing methods. In these methods, measured nutrient levels are compared with time and tissue dependent standards, with wide errors on critical levels, and often calibrated in another era under quite different growing conditions

PROPOSED ACTION AND COSTINGS

It is proposed, that in the 2001 season, growers be encouraged to burn windrows and observe the effect on the subsequent crops. If variation in early crop growth reflects the burnt windrow pattern of the preceding stubble, paired soil and plant samples will be taken from adjacent good and poor areas of the crop. These samples will be chemically analysed and experienced agronomists/nutritionists will be rostered to provide an interpretation/diagnosis of the problems causing the poor crop performance. Examples of the sort of results from paired sampling in the 2000 season are shown in the table below. Obviously other chemical assays are made. The interpretations are not necessarily simple.

	0-10 cm soil samples				Early tops samples					
	pH		K mg/kg		K%		Wt/plant		K update	
Location	**On**	**Off**	**On**	**Off**	**On**	**Off**	**On**	**Off**	**On**	**Off**
Cadoux	5.1	4.3	33	23	3.7	1.4	0.8	0.2	3.0	0.3
Tenindewa	6.1	4.9	110	44	5.3	4.5	0.1	0.1	0.6	0.4
Walebing	4.9	4.4	111	81	5.1	1.5	0.8	0.2	4.2	0.3
Goomalling	5.1	4.5	146	78	5.2	5.4	0.9	0.3	4.5	1.9
Bejording, hill	5.1	4.5	67	35	3.6	2.9	4.8	1.2	17.4	3.4
Bejording, track	4.9	4.7	23	14	2.2	0.9	5.0	1.1	10.9	1.0
Bejording, Sheen	5.2	4.3	132	21	1.7	0.9	10.3	3.6	17.5	3.2
Kononngorring E	6.2	5.5	57	26	3.4	1.1	0.9	0.6	3.0	0.6
Kononngorring S	5.2	4.6	45	35	3.1	1.8	0.8	0.3	2.4	0.5

Remedial measures (lime, tillage, fertilisers, rotations?) will be examined with the participating growers. For example, the application of potassium to some crops immediately after diagnosis in 1999 gave highly profitable responses. The dry season in 2000 prevented such immediate responses. Most often the remediation will be in the following year.

Funding for this exercise is currently being canvassed. It is estimated that the chemical analyses should cost about $180 per set of paired soil (0-10 and 10-20 cm deep) and plant samples. The diagnosis and recommendations should double these costs. Thus a stand alone project of 100 sites would cost about $30,000 to $40,000

From an individual grower's point of view, a $360 expenditure representing, 100 hectares ($3.60/ha) of affected crop could net $100/ha ($10,000 total) in the first year and further returns in future years, as a result of remedial fertilising or liming. One hundred such growers would return $1,000,000 for an investment of $36,000 in diagnostics and between $350,000 and $700,000 (say) in remedial action.

CONCLUSIONS

Burn some stubble windrows in your cropping paddocks. If you see major systematic growth and yield differences in you crops in 2001, take paired soil and plant samples. Enlist an expert to help you interpret the chemical analyses of those samples and discuss remedial action for next year. You may improve your returns by hundreds of dollars per hectare next year and some of the treatments have large residual effects.

KEY WORDS

diagnosis, burnt windrows, nutrition, soil fertility

Project No.: DAW 635

Paper reviewed by: John Blake

Rainfall - What happened in 2000 and the prospects for 2001

Ian Foster, Agriculture Western Australia, South Perth

KEY MESSAGE

Last year's poor season was characterised by extreme summer rain, a late start to winter, and an early spring finish. An experimental long-lead forecasting scheme developed at AGWEST predicts that that a weak to moderate El Nino event will develop in the Pacific Ocean during 2001. Historically this has meant that a wet winter is less likely over most of the agricultural region. However, a trend of decreasing rainfall over the past three decades has made statistical rainfall forecasting schemes of less value, and suggests that we revise downward our expectations of winter rainfall.

AIMS

This paper aims to put last year in historical perspective and to provide some guidance for the rainfall of 2001. The impact of recent rainfall trends on rainfall statistics and forecasting will also be discussed.

METHODS

An experimental scheme has been developed at AGWEST (Stephens, 2001, pers. comm.) that predicts the onset and magnitude of El Nino and La Nina events in the Pacific Ocean. The scheme uses differences in atmospheric pressure between south-eastern Australia and the South Pacific to detect atmospheric forcing for El Nino and La Nina events at higher latitudes than traditionally employed by the Southern Oscillation Index (SOI). This gives a longer forecasting lead-time than conventional methods.

Historical rainfall records for Western Australian stations can be examined relative to winter values of the SOI using the computer database Australian Rainman. Rainfall totals for May to October were compared with the average SOI values during May to August for a number of sites in the agricultural region. Simple scatter plots and historical seasonal rainfall allow the strength of the relationship between winter SOI and seasonal rainfall to be determined.

Rainfall prediction schemes based on patterns of sea surface temperatures (SSTs) have been developed by the Bureau of Meteorology and other institutions. These systems define statistical relationships between SSTs and three-monthly seasonal rainfall. Published forecasts for 2001 will be presented.

RESULTS

The AGWEST prediction scheme is indicating the likely development of a weak to moderate El Nino event during 2001. Accordingly, the expectation is that the SOI will be negative during the winter. Historical growing season (May-October) rainfall for 17 key sites in the agricultural region were compared with winter SOI values. An example is shown in Figure 1 for Wongan Hills Post Office.

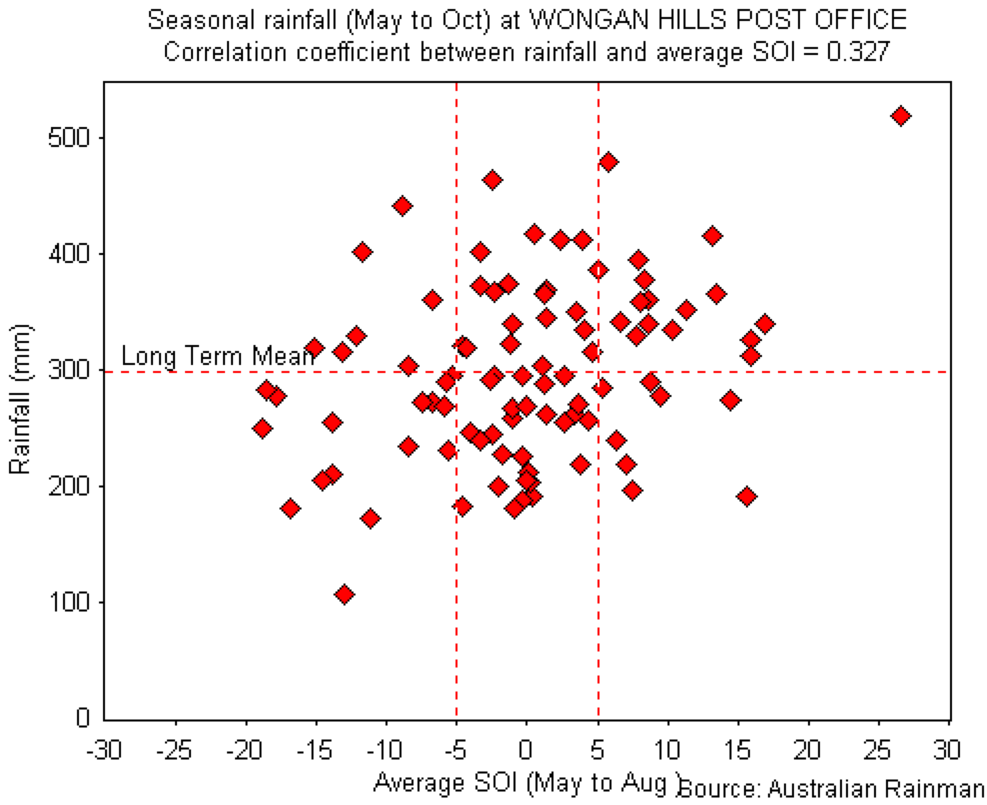

Figure 1. The relationship between growing season rainfall and winter SOI at Wongan Hills for 1907 to 2000.

This plot is typical of most of the agricultural region in that if an El Nino event is apparent (SOI below –5) then more years will be below average than above. In particular, wet years are unlikely. Of the 23 years with SOI less than –5, only 3 had well above average rainfall. In contrast, during La Nina events (SOI above +5) there is less chance of a very dry year.

The large scatter reduces the linear correlation and shows that although the SOI has an influence on growing season rainfall, it is limited. The statistical relationship is also decreased by the declining rainfall trend since the early 1970s (not shown).

The Bureau of Meteorology's seasonal outlook for Jan-March of 2001 suggests a higher chance of above average rainfall over much of the agricultural region. Recorded rainfall for January has supported that prediction.

CONCLUSION

An El Nino event is likely to develop during 2001. Historical records suggest that well above average growing seasonal rainfall is less likely over much of southern WA under those conditions. However, correlations are modest. Recent rainfall trends have further weakened the links and suggest that there is a low chance of well above average season growing season rainfall.

Seasonal forecasts of late summer rainfall, based on sea surface temperatures, suggest that above average rainfall is likely over much of the agricultural region. This has already happened in eastern parts, and will contribute to sub-surface moisture.

KEY WORDS

rainfall, forecasting, El Nino

Paper reviewed by: David Stephens

Strategies for leaf disease management in malting barley

K. Jayasena[1], Q. Knight[2] and R. Loughman[1]
[1]Agriculture Western Australia, [2]IAMA Agribusiness

KEY MESSAGES

- Cultivars Stirling and Gairdner differ in disease susceptibility and disease management can reflect this. Disease incidence also differs with regional environment.
- Throughout all barley growing regions powdery mildew is widespread and cv. Stirling is most prone. Powdery mildew has most yield impact early in the crop's life, when tiller numbers are set. Choose from seed treatments, in-furrow fungicide treatment or fungicide spray to control this disease. *Triadimefon* sprays were as effective as *propiconazole* for control of powdery mildew with later onset of the disease.
- In south coast regions spot-type net blotch is widespread, mainly affecting cv. Gairdner. Spot-type net blotch has most yield impact late in the crop's life, during grain fill. Seed treatments and in-furrow fungicide treatments are ineffective. Cost effective control can be achieved with *propiconazole* based fungicide spray.
- Crop rotation and appropriate sowing date are primary components of avoiding severe disease. The reduction in cost of fungicides in recent years has made fungicide use more practical for augmenting these primary controls.

BACKGROUND AND AIMS

While numerous foliar diseases can infect barley throughout the year, disease management should target those which have a major impact to yield and quality. Powdery mildew can reduce yields at very early stages during tillering or later in spring. Spot-type net blotch causes loss of green leaf area thus impairing grain filling. Cultivar choice is dictated by quality grade and suitably resistant cultivars are not available for commonly occurring destructive diseases. Modern cropping practices such as stubble retention have encouraged some diseases.

Various strategies can be adopted to control barley diseases and application of fungicides is an additional option in controlling leaf diseases for optimum barley production. In this situation, identification of appropriate fungicides, rates and time of application are vital for effective control that optimises yield. Field trials were conducted to determine the potential role for strategic fungicide use to control barley leaf diseases, including off-patent fungicides.

RESULTS

Armour® (*flutriafol*) or Baytan® (*triadimenol*) seed treatments are commonly used for early season disease management in barley. AGWEST experiments at Katanning have shown similar benefits from seed dressing or in-furrow treatments for powdery mildew on cv. Stirling but cv. Gairdner did not develop sufficient disease to warrant powdery mildew control in that environment. Under more favourable disease conditions the impact of powdery mildew can extend beyond the 8 week period when seed dressings lose their efficacy. IAMA experiments carried out for the last two seasons demonstrated that significant yield benefit could be gained from the use of in-furrow fungicides over the standard practice of a fungicide seed dressing (Table 1) in some situations. Yield increases can develop from extended protection against powdery mildew, scald and possibly leaf rust from 8 weeks to 16 weeks with use of in-furrow fungicides.

Late season protection against powdery mildew can also be cost effectively achieved with foliar sprays. Fungicide reduced disease and increased yield in Stirling barley grown at Gibson (Table 2).

Spot-type net blotch has had a significant impact on malting barley production in the south coast following adoption of cv. Franklin and expansion of Gairdner which are susceptible the disease. Research in 1999 demonstrated economic yield response with Tilt 250EC (*propiconazole*) when yield losses were around 20 per cent under moderate disease pressure. The performance of *propiconazole* was compared to new generation strobilurin fungicides (Table 3). Single applications of Tilt 250EC (*propiconazole*) @ 250 or 500 mL/ha significantly improved yield and was equivalent, rate for rate, to the most effective strobilurin fungicide evaluated.

Table 1. Effect of fungicides on yield of Stirling and Gairdner barley affected by powdery mildew and scald in 1999-2000 at two locations (IAMA trial data)

Fungicide	Rate	Pingrup, 1999		Speddingup, 2000		Cost (ex. GST) Approx. $/ha
		Yield (Stirling)		Yield (Gairdner)		
		t/ha	% control	t/ha	% control	
Baytan (control)	125-150/100 kg	2.95	100	3.50	100	4.50-5.40
Baytan + Impact* 250 SC in-furrow	200 mL/ha 400 mL/ha	3.30 3.31	111 111	3.53 3.73	101 107	13.00 26.00
Baytan + Accord** 125 EC in-furrow	400 mL/ha 800 mL/ha	- -	- -	3.74 3.73	107 107	3.60 7.20
lsd (5%)		0.26		0.27		

* Impact contains 250 g/L flutriafol; ** Accord contains 125 g/L triadimefon.

Table 2. Effect of fungicide spray on powdery mildew severity and yield of barley cv. Stirling at Gibson, 2000 (AGWEST trial data)

Treatments and rates (mL/ha)	% Leaf area disease			Yield	
	Z49 (26 Aug.)	Z59 (7 Sep.)	Z83 (5 Oct.)	(t/ha)	% Increase
	Ave (Flag, F-1, F-2, F-3)		Ave (Flag, F-1, F-2)		
Untreated	39	55	84	4.04	100
Triad 125EC 500 mL/ha		32	77	4.58	113
Triad 125EC 1000 mL/ha		32	59	4.53	112
Tilt 250EC 250 mL/ha		34	56	4.55	113
lsd (5%)		7	16	0.41	

Note: Fungicides were sprayed on 23 August at late booting (Z49).

Table 3. Effect of foliar fungicides spray treatments on per cent leaf area and yield affected by spot-type net blotch on Gairdner barley at Esperance, 2000 (AGWEST trial data)

Treatments	Rate g ai/ha	% Disease 6 Oct. (Z77)		Yield		Density kg/hL	% Protein
		Ave. Flat	Ave. F-1 to F-2	(t/ha)	%		
Untreated	-	57	99	3.90	100	66.3	14.1
Best strobilurin	125	16	44	5.03	129	70.0	13.1
Tilt 250EC	63	27	78	4.61	118	69.7	13.0
Tilt 250EC	125	11	31	5.16	132	69.7	13.4
Tilt 250EC x 4	125 x 4	2	8	5.89	151	70.9	13.3
Lsd (5%)		6.2	6.2	0.50		1.4	0.7 (10%)

CONCLUSION

Prevention of early powdery mildew in cv. Stirling using seed dressings such as Armour® and Baytan® is often adequate but can be improved in mildew prone environments with in-furrow fungicides. Early powdery mildew control in Gairdner barley may be less critical due to varietal resistance but control of spot-type net blotch can be advantageous later in the season. Specific foliar fungicides can be used to manage later infections of powdery mildew and spot type net blotch. The reduction in cost of fungicides in recent years has made the use of fungicides such *triadimefon* and *propiconazole* more attractive for use in barley leaf disease control strategies.

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GRDC Project No.: DAW 589

Paper reviewed by: J. Bhathal

Planning your cropping program in season 2001

Dr Ross Kingwell, Agriculture Western Australia and University of Western Australia

SUMMARY

Recent poor seasons have left many farmers with depleted cash reserves, lower farm equity and an increased need for seasonal finance. To assist farmers to improve their financial positions this plenary paper outlines a range of recovery principles.

The principles constitute general guidance for farm business management in season 2001 and range from simple ideas such as the need to 'stay positive' through to potentially more complex ideas such as 'understanding the profit drivers of the farm business'. For farmers and their advisers to apply these principles successfully requires tailoring them to specific farm situations.

INTRODUCTION

During the 1990s many farm businesses switched to greater cropping and experienced a string of favourable and profitable seasons. However, in recent years many farmers have experienced an erosion of profit margins and, in season 2000, outright losses. Many farmers now have depleted cash reserves, lower farm equity and a greatly increased need for seasonal finance. Many live in communities stretched by stress and affected by belt-tightening. How can farmers and their advisers facilitate the recovery of farm financial health in season 2001?

RECOVERY PRINCIPLES

Identify the key influences upon farm profitability that can be affected by business management

One of the best services that can be provided to a farm business in season 2001 is knowledge of the main profit drivers of the farm business, and the identification of which drivers are influenced by farm management. If farmers know the main profit drivers of their business then they can more effectively and profitably focus their efforts and expenditures. They are better able to secure or accelerate the financial recovery of their farm business.

In practice this means that the best thing some farmers could do in season 2001 would be to acquire the services of a farm business analyst so that they better understand the true nature of their farm business. For some farmers it would mean working more 'on their business' rather than working 'in their business'. This means spending time engaged in reflection and analysis rather than being busy with the constant flow of the farm calendar. In a planning context it means being strategic rather than simply reacting to daily or weekly events.

Figure 1 illustrates the role of various profit drivers for a case study farm[1]. There are a range of assumptions and limitations to the interpretation of the data in Figure 1 but it's a useful summary and starting point for discussion about how farm profit for this case study farm might be best influenced in season 2001.

For the case study farm illustrated in Figure 1 it's fairly clear that trying to reduce the cost of shearing or raise the yield of canola is not going to deliver much extra profit. By contrast locking in a higher than expected wheat price, or using an improved portfolio of wheat varieties to increase wheat yield is likely to deliver substantial profit benefits. The role of those supporting and advising farmers in season 2001 is to ensure that farmers can focus on their profit drivers and make better decisions that accelerate their financial recovery.

[1] The format of Figure 1 is based on commercially available software.

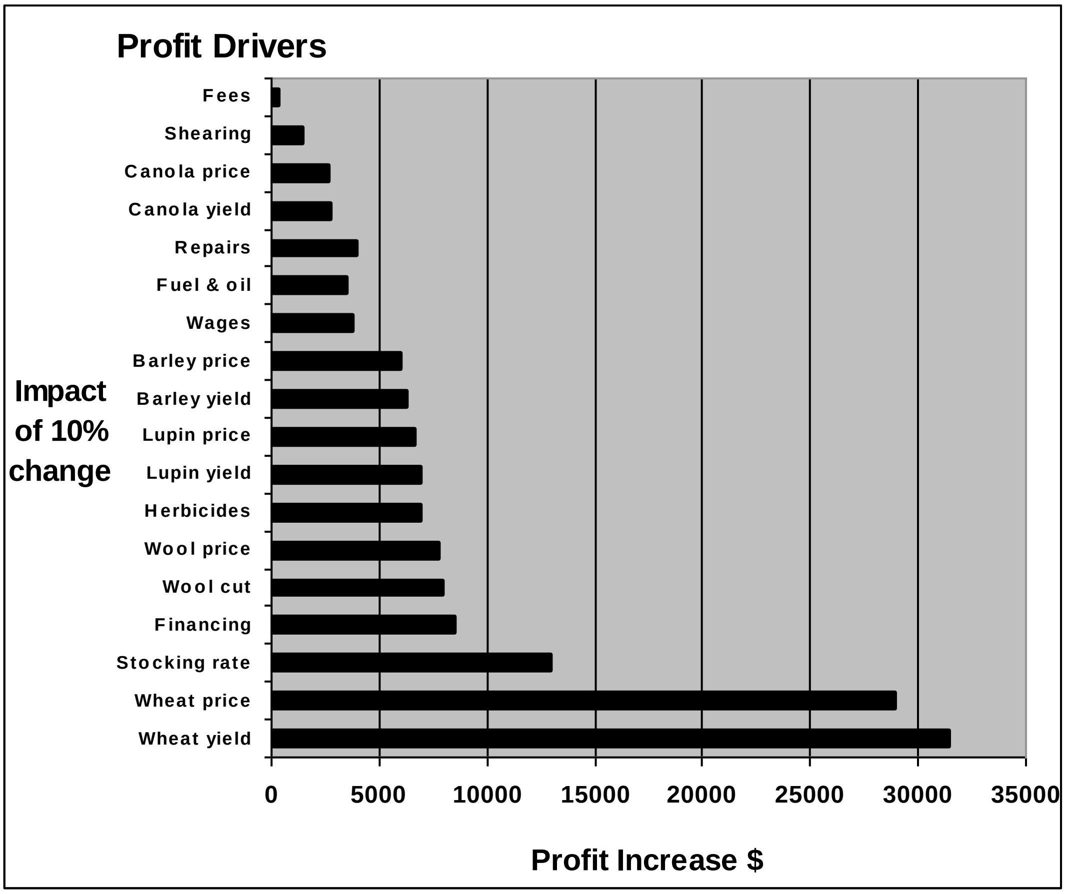

Figure 1. Profit drivers for a case study farm.

The cost to farmers of not identifying how best to influence their farm profit in season 2001 is that they risk spending their time and resources ineffectively, to the detriment of their businesses and their families.

Plan a flexible cropping program

Unfolding seasonal conditions, along with the resource constraints imposed by land use and outcomes in previous seasons, will all influence the appropriate enterprise mix of a farm in season 2001. Already in late January parts of the northern and eastern wheatbelt have had substantial rainfall. Some soils in these regions can store this moisture to facilitate subsequent crop growth. Climate predictions with no skill suggest that it is unlikely for the growing season in 2001 to be as dry as in 2000. The best mix of varieties and crop types in a season with an early break is different from that in a season with a very late break. Farmers need to ensure they have access to a range of varieties and crop types suited to the range of seasons possible in 2001.

Preparing farm budgets for different sorts of cropping programs is also a useful in revealing whether or not working capital, seed stocks and stored inputs are sufficient. Where working capital is limited it may be feasible to reduce some inputs with little impact on crop yield. For example, where soil phosphorus levels are high, maintenance applications of superphosphate may be foregone to save money by living ‘off the super bank’. Expenditure on some inputs, like nitrogenous fertilisers, can also be adjusted up or down, as the nature of the season is revealed. If farmers rigidly adhere to a cropping program and particular input levels, they risk missing out on the benefits of ‘playing the season’.

It's also worth, well in advance of crop sowing, to undertake a thorough maintenance of cropping gear so that risks of breakdown or costs of unpreparedness are reduced. Before the sowing period it is useful to think about the workload and activity sequence of the cropping program. It can lead to farmers anticipating problems and identifying better solutions and being less stressed during the sowing period.

Know your planning horizon

For some farmers season 2001 will be a 'make or break' year so their planning horizon is one season. These farmers need to make decisions that give them maximum return in season 2001. For farmers with longer planning horizons they can focus on using rotations and enterprise sequences that offer reasonable returns in 2001 as well as in subsequent years. These farmers can invest in setting up some paddocks for seasons 2002 and 2003.

Knowing your planning horizon is part of knowing yourself. Near the reflection pond at the University of Western Australia are carved the words 'know thyself'. It's important that farmers and their advisers know what they're good at and what they're not. The attitude, skill and knowledge of a farmer and their advisers can influence how successful or not are particular aspects of the farm business. In times of adversity it's often better to build from what you are already good at, rather than launch into unfamiliar activities with serious downside risk.

Spread your risk

Maintaining a complementary mix of enterprises can generate profit and spread price and production risk. Diversifying your income sources (on-farm and off-farm as well as livestock and crops) is often a useful business strategy for long-term survival.

Some people think that diversification and risk management are part of modern management. They're not; they're part of good, old-fashioned management.

"My ventures are not in one bottom trusted,
nor to one place; nor is my whole estate
upon the fortune of this present year;
Therefore, my merchandise makes me not sad."
(*Merchant of Venice, Act 1, scene 1*)

One advantage of maintaining a portfolio of farm enterprises is that you don't expose the business to price vagaries of one commodity market. Also price movements for commodities can be negatively correlated (see Table 1) which helps smooth the impacts of price fluctuations upon farm revenue.

Table 1. Correlation matrix for de-trended real prices of major agricultural commodities

	Wheat	**Wool**	**Lupins**	**Canola**	**Lamb**
Wheat	1				
Wool	-0.32	1			
Lupins	0.07	0.08	1		
Canola	0.66	-0.19	-0.40	1	
Lamb	0.62	-0.23	0.39	0.38	1

Source: Based on an annual price series for the period 1984 to 1997 published in ABARE *Australian Commodity Statistics 1998* and earlier issues as well as ABS data.

Having touted the wisdom of diversification, I should draw attention to the costs of excessive diversification. There are adjustment costs in re-shaping the mix of enterprises on a farm, particularly with large changes in enterprise mix. The time required to master a new enterprise often means less time devoted to maintaining and properly managing traditional enterprises. Each additional enterprise that is added to the farm business brings with it the need to keep abreast of market and technical changes and to manage the enterprise and rotational sequences across the farm. In some cases, more does not necessarily mean better.

It's worth noting that, at least compared to their interstate colleagues, Western Australian farmers face relatively low levels of yield risk; even accounting for season 2000! As shown in Table 2, for the main crops of wheat and barley, Western Australian farmers experience far less yield variation. This greater dependability should provide farmers and their advisers with greater confidence of reasonable outcomes when plotting recovery strategies.

Table 2. **Measures of yield risk faced by Australian farmers for major agricultural crops: coefficients of variation of de-trended yields (%)**

Crop	Region	1970 to 2000	1970 to 1985	1985 to 2000	1990 to 2000
Wheat	NSW	22	21	22	26
	Vic	20	23	17	19
	Qld	34	34	33	36
	WA	13	15	12	11
	SA	18	20	15	13
Barley	NSW	17	17	17	28
	Vic	20	19	20	29
	Qld	31	29	32	34
	WA	10	10	11	11
	SA	14	17	11	14

Sources: Based on de-trended yield series published in ABARE Australian Commodity Statistics 1999 and earlier issues, Australian Crop Report No. 116 plus data in various Year Books for each State.

Don't be too afraid to spend money: you need to spend money to make money

Sure season 2001 will involve belt-tightening but remember it's false economy to skimp on inputs (e.g. weed control and fertilisers) that can significantly improve yields or returns. Some farmers may feel better off because they've saved some expenditure; but the reality might be that they've foregone a lot of income that would have been generated by the expenditure. It's important to spend on inputs that generate the highest return. Farming in season 2001, for many farmers, will be all about obtaining the best margins on land use in each paddock.

Having said that farmers should not be too afraid to spend money in season 2001, I now want to turn to situations where it's likely to be unwise to spend money.

*Now is **not** the time to be investing in large-scale adoption of novel crops*

When funds are tight it's usually wiser to invest in crops with which you are familiar and which display yield and price stability. Growing wheat for some farmers may be preferable to growing canola or chick peas. Let's be clear, I am not advocating that all or most farmers should cease production of more risky crops such as canola or new alternative legumes. I am saying, however, its unprofessional to advocate to some farmers, simply on the basis of gross margin calculations, that they should invest heavily in production of risky crops with which they may have limited management experience.

Identify the paddocks or parts of paddocks where your net returns to cropping are likely to be low

There are paddocks with potentially high weed burdens requiring expensive treatments, low fertility, potential disease problems and low yield prospects. In these paddocks a lot of money might need to be spent on seed, herbicides and fertilisers to ensure reasonable yields. These are the paddocks or parts of paddocks that farmers should consider **not** including in their season 2001 cropping program. Leaving out those paddocks will help reduce peak debt and might actually increase profits.

In assessing these paddocks farmers need to ask first, what will it cost to crop the paddock? Then ask, what must the paddock yield to cover that cost? If there's little chance of getting that break-even yield then leave that paddock (or its worst parts) out of the cropping program.

Take the case of 3 paddocks shown in Table 3. Each paddock is 200 hectares.

Table 3. **Paddock data**

	Paddock		
	A	**B**	**C**
Expected yield (t/ha)	1.85	1.6	1.25
Costs of production ($/ha)	170	195	185

Assuming a farm-gate wheat price of $170/t then the profit and total expenditure associated with sowing various paddock combinations is shown in Table 4.

Table 4 illustrates that including paddock C in the cropping program only increases profit by $6,000 yet it greatly increases cropping expenses by $37,000. If working capital is restricted then planting only the better paddocks (A&B) will generate reasonable profit and lessen input expenditure ($73,000 vs $110,000).

Table 4. Profit and expenditure from sowing

	Sow paddocks		
	A only	**A & B**	**A, B & C**
Profit ($'000)	29	44	50
Expenditure ($'000)	34	73	110

In real life exactly how a farm's profit and expenditure will be affected by leaving out paddocks depends on the characteristics of that particular farm business. Note that leaving out a paddock from the cropping program will still require some money to be spent on the paddock. Low-cost weed control and grazing costs will be incurred perhaps to set the paddock up for cropping in season 2002. Farm management consultants are best placed to assist farmers with decisions about cropping programs and paddock selection. The general principle, however, is that not cropping the worst paddocks is likely to be a preferred strategy when finances are tight.

Second-hand doesn't always mean second-best

If a farmer needs to make essential purchases of machinery, vehicles and equipment for season 2001 then brand-new purchases may not be the best use of funds. Sometimes second-hand is not second-best, especially when funds are tight. Consider the case where a family car[2] must be purchased and there are two options; buy a brand new car or a two-year old one with an odometer showing 50,000 km and one year remaining on a three year warranty. Table 5 shows the cost comparison.

Table 5. New versus second-hand family car[a]

	New $	**Secondhand $**
Purchase cost	33,500	21,500
Value after 150,000 km	16,000	
Value after 200,000 km		10,000
Depreciation	17,500	11,500
Extra repairs and maintenance		1,200
Interest 9% over 3 years	9,045	5,805
Extra 6 months licence		300
Extra insurance	800	
Cost comparison	27,345	18,805
Difference	**8,540**	

[a] **Source:** Based on Table in '**Agribusiness Decision'** Vol. V30 F9 October 2000.

The data in the table show that the farmer would save $8,540 over the three years by buying the car second-hand. That is the farmer would have $8,540 extra to spend on other farm inputs or other things for the family.

[2] This example is based on an illustration by Peter Hackett in 'Agribusiness Decision'.

Get the best from your input expenditure

There are a number of ways a farmer can stretch the input dollar. Use family labour rather than contract labour. Defer asset replacement, where possible. Shop around to obtain the lowest price for key inputs of fertilisers and chemicals. Form a machinery syndicate to reduce ownership costs of some cropping gear (e.g. grain grader, deep tillage gear, hay baler). Re-negotiate longer terms for hire purchase agreements and leases.

Liquidating off-farm assets to provide cash for the cropping program isn't necessarily sound business

Where off-farm investments (e.g. shares, rental properties) are performing better than the farm investment then it may be better to leave the off-farm investments alone. To cash in such off-farm assets may simply mean transferring money into an activity (farming in season 2001) that is more risky and less profitable! However, if a farmer has a non-performing asset (e.g. a Perth unit that is not appreciating much and that is rented occasionally), then maybe now is the time to cash it in.

Seek good advice and improve your technical and market knowledge about cropping and livestock

Obtaining reliable information and acting on sound advice can increase the prospects for successful cropping and livestock programs in season 2001. Consultants often have insights and knowledge worth paying for. Crop management is always evolving so it's worthwhile to maintain your practical knowledge. Markets and marketing opportunities can change, often rapidly, so it's often worthwhile having access to information or people to assist you to capitalise on opportunities.

Some information (e.g. disease and pest identification and management, climate forecasts, price forecasts, market analyses) can be gathered cheaply from a variety of sources. Even networking opportunities such as this event have their place in information dissemination.

Stay positive

Experience suggests that being positive has it's own rewards and leads to better decision-making. Being too pessimistic and negative can lead to foregone opportunities.

Beware of 'one glove fits all' strategies

Each farm business has its own unique resources of paddock histories, skills in enterprise management, machinery and labour availability, financial resources and tax position. How all these resources are best combined to the maximum advantage of the farm business typically involves individual strategies for individual farms. So question broad advice like 'don't spend too much' or 'crop more' or 'get into sheep' or 'sell off-farm assets'. Get advice tailored to your farm situation and discuss options with your family to ensure sound decisions are made in season 2001.

CONCLUSIONS

Because many farm businesses have been weakened by the outcomes of last season, management decisions in season 2001 will be particularly important in reviving farm financial health. The recovery principles advanced in this paper are not a simple recipe for success but rather a checklist that requires shaping and tailoring to each farm business.

ACKNOWLEDGEMENTS

In preparing this paper the author has benefited from reading a range of material from 'Agribusiness Decision', 'Profarmer' and drought management publications.

Rotational crops and varieties for management of root lesion nematodes in Western Australia

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KEY MESSAGE

Root lesion nematode (RLN) populations in Western Australia vary in virulence and host preferences. To minimise impact of RLN on wheat, rotation with faba bean (for *Pratylenchus neglectus*) and field pea (*P. thornei*) can be helpful. Among wheat cultivars tested so far, Cascades and Excalibur are relatively less susceptible to *P. neglectus.*

BACKGROUND

Pratylenchus neglectus and *P. thornei* are important RLN species in cereal growing areas of Western Australia. Recent surveys have shown that potentially yield limiting RLN populations are present in 43 shires. Options for RLN management in Western Australia have not yet been developed. This investigation aims to identify suitable rotational crops for management of *P. neglectus* and *P. thornei*.

METHOD

Evaluation of crop species

In 1999 and 2000 field experiments were established in RLN infested soils at Doodlakine (*P. neglectus*), Mukinbudin (mainly *P. thornei*) and Darkan (*Pratylenchus* sp). Barley (cv. Stirling), oat (cv. Dalyup), wheat (cv. Nyabing), canola (cvs Dunkeld and Karoo), chickpea (cv. Heera), faba bean (cv. Fiord), field pea (cv. Dundale) and lupin (cv. Merrit) were screened for susceptibility to RLN. Nematode numbers in soil before planting and in root 10 weeks after sowing were assessed. Wheat cv. Machete was used as highly susceptible check for comparison. In 2000, wheat cv. Cunderdin was sown in plots previously sown to different field crops in 1999. After 10 weeks of sowing, RLN infestation in roots was measured and influence of previous year crop on nematode infestation in wheat was assessed at Doodlakine and Mukinbudin. Nematode data were log- or square root transformed for analysis.

Evaluation of wheat cultivars

Reactions of selected wheat cvs to *P. negelctus* were studied in nematode infested paddocks at Doodlakine, Tammin, Newdegate and Dumbleyung. Seeds of wheat cvs and highly susceptible standard check cv. Machete were sown in RLN infested soils. After 10 weeks, RLN in roots were counted. An index of parasitism for each test cultivar was calculated by dividing the number of nematodes in roots of test cultivar by the number of nematodes in roots of check cv. Machete to determine susceptibility of each cultivar relative to cv. Machete. The parasitism indices (PI) were rated on a 1 to 5 scale: 1 = $\geq$ 0.75 (root infestation level equal to or greater than 75% of that in susceptible check); 2 = 0.50 – 0.74;. 3 = 0.25 – 0.49; 4 = 0.10 – 0.24; 5 = < 0.10 (root infestation level less than 10% of that in susceptible check). Cultivars with PI of 1 were considered as extremely susceptible relative to check cv. Machete, 2 = very susceptible, 3 = susceptible, 4 = moderately susceptible, and 5 = intermediate between moderately susceptible and moderately resistant.

RESULTS

The crop species differed in their RLN hosting ability. Field pea and faba bean supported lesser nematodes than other crops at Doodlakine and Darkan. RLN infestations were generally greater in roots of cereals than in non-cereals. The Darkan population showed special affinity for oats (cv. Dalyup) and nematode number in oat roots was as high as in roots of susceptible check cv. Machete. At *P. thornei* site, canola (cv. Dunkeld) had lowest infestation; chickpea and wheat had high root infestations.

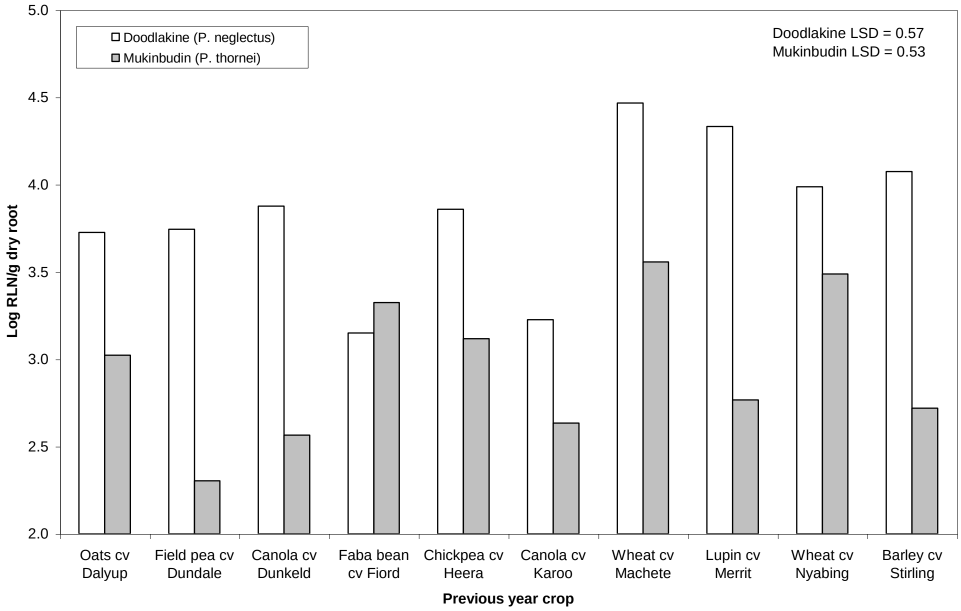

Figure 1. Densities of *P. neglectus* and *P. thornei* in roots of wheat cv. Cunderdin in plots previously planted to different crop species.

Previous year crops significantly influenced RLN infestation on wheat (cv. Cunderdin) and least RLN number were extracted from plants in plots previously planted to faba bean at Doodlakine (*P. neglectus* site) and field pea at Mukinbudin (*P. thornei* site). RLN levels in wheat roots were high in plots previously planted to wheat (cvs Nyabing and Machete) and faba bean (cv. Fiord) at Mukinbudin and to wheat, barley and lupin (cv. Merrit) at Doodlakine (Figure 1).

RLN reproduced on all the wheat cultivars though differences in root parasitism were evident (Table 1). Cultivars Cascades and Excalibur were considered as promising because of their lesser susceptibility. The PI of cv. Cascades were 4 and 5 for Tammin, Doodlakine and Dumbleyung populations. All the cultivars were susceptible or extremely susceptible to a Newdegate population, which probably consisted of a mixture of unidentified RLN species with *P. neglectus*. The virulent nature of this population could be due to interactions between the two nematode species or the unidentified species is an aggressive parasite of wheat.

Table 1. Relative susceptibility of wheat cultivars to *P. neglectus* in Dumbleyung, Newdegate, Tammin and Doodlakine regions

Cultivars	Dumbleyung	Newdegate	Tammin	Doodlakine
Cascades	4	1	5	4
Cunderdin	3	1	2	1
Carnamah	2	3	3	1
Nyabing	2	1	4	3
Excalibur	4	2	4	-
Westonia	2	1	2	3
Brookton	2	1	3	2
Camm	1	1	3	1
Eradu	1	1	2	-

- = Not studied, 1 = Extremely susceptible, 3 = Susceptible, 5 = Intermediate.

CONCLUSION

Rotation with Faba bean (cv. Fiord) in *P. neglectus* infested paddocks and with field pea (cv. Dundale) in *P. thornei* infested paddocks can be helpful in reducing RLN infestations on wheat. Though wheat cultivars are good hosts of *P. neglectus,* varietal differences in relative susceptibility exist. Cultivar Cascades and Excalibur are relatively less susceptible to *P. neglectus* in Central wheat belt region.

KEY WORDS

root lesion nematodes, management options, crop rotation

GRDC Project No.: DAW 623

Paper reviewed by: Mark Sweetingham

When and where to grow oats

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KEY MESSAGE

- Oats are a better option than other cereals in certain situations.
- Oats have a place in most cropping programs.
- Optimum plant densities are higher than those currently used.
- Sowing time should be managed to suit the paddock conditions.

2000 REVIEW

The 2000 season was a difficult one for both oat growers and buyers. The late start to the season and the lack of finishing rains reduced the potential biomass and yield of the state's oat crop. To ensure that there was enough hay to meet export demand Western Australian hay buyers began offering higher prices for oaten hay. As a result many oat growers, and numerous wheat growers, cashed in on the high hay prices. To top it off, the lack of spring rain reduced pasture growth, resulting in more grain being held on farm. All these factors contributed to a reduction of grain available to export and processing markets, thus prompting the highest prices seen over the last four years for all oat products.

A dehulled grain limit of 10% (by count) in milling oat grades was introduced for the 2000 season at receival points. The dehulled grain limit was a response to customer complaints that dehulled grain can cause rancidity in stored oats. By increasing the dehulled grain proportion, growers either deliberately or inadvertently increased the sample hectolitre weight. Presently hectolitre weight is the key quality measurement used to determine whether the grain is acceptable for delivery. Hectolitre weight is becoming less important to both domestic and overseas processors, whilst groat per cent and milling yield are becoming increasingly important. Hectolitre weight was originally introduced as an easy way of measuring groat percent, however current research is establishing the protocols for measuring groat per cent using NIR technology. This raises the question of how long will it be before groat per cent measurements replace hectolitre weight at receival points?

The 2000 season saw a change in direction for oat agronomy research from sowing time and seed rate trials to trials that help growers solve specific problems. Results from trials conducted in 2000 have been included below.

WHAT USE ARE OATS?

Oats have a wide adaptation and can be successfully grown in all Western Australian agricultural areas. Where oats surpass other cereals is in frost prone areas, acid soils, and wet to waterlogged soils. Oats are not affected by the same leaf diseases as other cereals and are more tolerant to Take-all. The dominance of oats in the hay market is a result of it's finer, more digestible stems and higher biomass. Oats are an excellent early competitor with weeds and are often used to remove grasses from pastures. The grain is relatively safe to feed to ruminant livestock. Oats are a lower risk crop than the other cereals and regarded as "an easy crop to grow".

There are good markets for oats both domestically and internationally but the price paid to growers fluctuates considerably from $140/t to $80/t. High pre-seeding prices result in increased oat sowings but when pre-seeding prices are low, less oats are sown. This results in varied levels of production. Due to the variability in production, exporters find it difficult to expand oat markets internationally as the consistency of supply cannot be maintained. As a result, during high production years the surplus grain is sold at a lower price.

WHERE IN THE CROPPING PROGRAM?

Oats can be grown where they are more suited to the conditions than other cereals. This includes areas prone to frost, waterlogging and acid soils. Oats should be grown where any grass weeds have been previously controlled or at least one useful knockdown has been applied prior to sowing. This is

most important due to the lack of effective in-crop grass weed herbicides. In saying this, high density oat crops can assist in the control of grass weeds through competition, especially if the oats are cut for on-farm hay. The hay may not be suitable for export due to the limits on the amount of weeds accepted at delivery.

Oats should be considered as a second cereal where there is a risk from Take-all or in any high rainfall area as a high yielding crop. It is not advisable to sow oats late in low to medium rainfall areas as oats suffer from lack of moisture during grain filling. This lack of moisture reduces yield, hectolitre weight and other key quality characteristics.

WHAT PLANT DENSITY AND WHEN?

If grass weeds are present then a higher seeding density should be adopted. Similarly if waterlogging is likely then to compensate for the expected reduced tillering the seeding density should be increased. Areas likely to be waterlogged should also be sown as early as possible, providing the weed densities are low.

In low and medium rainfall areas oats are best sown in late May to early June at 185-250 plants/m^2 for non-dwarf oats (variety dependent) and 240 plants/m^2 or higher for dwarf varieties. In medium rainfall areas with a mid to late June sowing there is unlikely to be a lodging problem in non-dwarf varieties. Therefore higher densities can be used for both non-dwarf and dwarf varieties. The higher seed rate will also increase the harvest height by making the dwarf varieties grow taller. In high rainfall areas when sowing late May to early June, non-dwarf seed rates should be reduced, especially for varieties prone to lodging (e.g. Pallinup). In some high rainfall situations dwarf varieties, when sown at high densities may suffer from weak straw strength. This is where the crop doesn't lodge but the base of the panicle breaks.

Delayed sowing, in the absence of any other factor, will reduce the yield and hectolitre weight of most varieties (Table 1). When delayed sowing is combined with other factors (e.g. waterlogging, poor weed control pre-sowing or lodging induced shedding) the effect on both yield and quality alters. For example, the reduction in yield and hectolitre weight with delayed sowing and waterlogging is more than delayed sowing alone. However you are more likely to get an improvement in yield but delayed sowing and spraying weeds with a knockdown herbicide compared with sowing early and having weeds in the crop.

Table 1. Sowing time effect on yield and hectolitre weight of oats

Delay sowing + environment factor	Range*			
	Yield(kg/ha/day)		Hectolitre(g/day)	
	Feed	Milling	Feed	Milling
Delay sowing	(-84) – 2	(-82) – 0	(-287) – 64	(-246) – 65
Delay sowing + waterlogging	(-66) – (-19)	(-59) – (-12)	(-47) – (-33)	(-49) – (-37)
Delay sowing + weeds (less)	36 – 37	37 – 45	(-71) – 65	0 – 60
Delay sowing + shedding (less)	28 – 147	50 – 121		

* Varieties of same plant type at each site averaged and the range of these averages shown.

CONCLUSIONS

Oats can be more than a 'throw away' crop that is poorly managed. With a bit of input oats could be an important component in many cropping systems. Oats are ideally suited to areas with growing conditions where other cereals are less tolerant. Sowing densities is an important management tool to successfully grow oats and control weeds and diseases. Because of the wide adaptability of oats they can be sown at a range of times provided the variety's plant type is considered.

Project No.: DAW 497

Paper reviewed by: Natasha Littlewood

Managing Gairdner barley for quality

Kevin Young and Blakely Paynter, Agriculture Western Australia

BACKGROUND

Gairdner barley is our first real option as an export quality barley for high rainfall areas. Since it's release as a malting variety, Gairdner has been grown with mixed success.

The highlights for Gairdner are:

1. High yield potential (as good as many of the feed varieties, with reports of yields over 5 t/ha).
2. Can produce grain suitable for export (whereas Franklin failed to meet export grain size targets).
3. Being used by Chinese maltsters.

The disappointments seen with Gairdner are:

1. Variability in grain protein (particularly with a large number of low protein deliveries).
2. Variability in grain size (particularly in the presence of spot-type net blotch).
3. Reports of weak straw and excessive lodging.

In order to make the most of this variety we must recognise its limitations and manage it accordingly until an improved variety is released. This paper reviews the key agronomic factors in the management of Gairdner barley for yield and quality. It also previews the performance of some late spring maturity lines that are candidates for release as replacements for Gairdner barley.

GAIRDNER MANAGEMENT

The season obviously plays a big part in the problem of high screenings. The effect of an adverse finish can be partly offset by ensuring that Gairdner is sown at the optimum time. In general terms this is the first few days of May in the medium rainfall areas, getting progressively later as rainfall increases, but no later than the third week of May in the higher rainfall zones. Soil type, rotation, leaf diseases and nitrogen supply interact strongly to effect screenings, grain protein and straw strength.

Soil type and sowing date

The combination of soil type and sowing date is crucial to Gairdner's chances of achieving the malting grade.

In the high rainfall areas the optimum sowing time is mid May with good results possible right up to the end of May. Gairdner is best adapted to deeper sands where it is better able to withstand a dry spring. On shallow duplex soils that have poor moisture holding capacity, May sowing is essential in all areas. They will still give high screenings if September/October rainfall is well below average.

In the southern medium rainfall areas early to mid May sowing is essential. Shallow duplex soils are very risky unless the subsoil has reasonable structure and good moisture holding capacity.

Rotation

In areas and on soils where take-all is a problem, Gairdner should be sown after a cleaning crop such as canola, oats or after lupins if soil organic carbon is low. In the absence of take-all, Gairdner can be sown as the second cereal after lupins or peas (i.e. following wheat).

Straw strength is greatly influenced by rotation. Early sown Gairdner is much taller than later sown and Gairdner following lupins or pasture will generally be taller than after canola or wheat. Lodging is worse after maturity so crops that are direct headed will lodge more than those that are swathed.

Whilst some success has been observed in controlling spot-type net blotch using the foliar fungicide propiconazole at mid stem elongation, the presence of spot-type net blotch will limit grain size in Gairdner barley. Gairdner should not be sown in a paddock which contains barley stubble and where possible it should not be sown next to a paddock containing Gairdner or Franklin stubble.

Nitrogen supply

The practice of soil testing and then determining the optimum nitrogen rate with the 'Nitrogen Calculator' is the best way to keep protein at the desired level and avoid excessive screenings. There are two points to note about Gairdner barley:

1. Yield potential - It is very important to emphasise that Gairdner is a very high yielding variety and that allowance must be made for the expected increase in yield by entering a yield value that is in the order of 1 t/ha greater than a Stirling crop.
2. Nitrogen use efficiency - Gairdner barley is not like other malting barley varieties currently received in Western Australia. Gairdner is less efficient than Stirling at transferring the nitrogen in it's straw to its grain. Research trials have shown that at the same yield as Stirling, grain protein levels in Gairdner barley are lower than in Stirling barley.

It is therefore suggested that the following strategies should be considered when fertilising Gairdner barley with a liquid or granular fertiliser. One suggestion is to split your nitrogen application. Apply your first nitrogen application within two weeks of seeding to set up early tillers and the second application delayed until around 8 weeks to maintain yield potential and bring grain protein into the window for malting barley. Another suggestion to consider would be to target a higher protein level on the nitrogen calculator (say 11% protein rather than 10.5%) and apply some extra fertiliser nitrogen for protein.

It may be tempting to sow Gairdner barley on legume stubble to increase grain protein. Grower experience tells us that problems with straw strength and lodging may offset any potential benefit for protein management. This may be particularly so on high organic carbon soils or where the legume crop in the previous year had a high level of biomass relative to the grain harvested (lots of nitrogen left behind).

ELITE CROSSBREDS TO REPLACE GAIRDNER BARLEY

The AGWEST Barley Agronomy program has the task of assessing elite crossbreds in the final stages of testing. This serves two purposes, firstly to add information to the database that will decide which line will ultimately be released, and secondly to provide enough information to publish a management package at the time of release.

In 2000 there were two AGWEST bred lines - WABAR2076 and WABAR2080 and one University of Adelaide bred line WI-3073 assessed in the agronomy program for the high rainfall areas. The local lines arose from the cross Stirling/Franklin, whilst the South Australian line is from the cross Skiff/Franklin. An early assessment suggests that the local lines show much better potential than the South Australian line for grain size.

The most important aspect about the lines being evaluated is that all lines are similar height, straw strength and maturity to Fitzgerald with improved malting quality and grain size compared to Gairdner. The lines are also consistently similarly yielding to Gairdner and Fitzgerald across a range of environments

WABAR2080 is very promising as it has the best micro-malting quality ever observed by the Western Region Barley Improvement Program. WABAR2076 showed good grain size results in the dry season of 2000. Resistance to leaf disease appears to be similar to Gairdner, although to improve resistance spot type net blotch is a high priority. There is also some indication from agronomy trials sown in 2000, that these elite lines have greater daylength sensitivity than Gairdner, probably like Skiff. This is an important characteristic for adaptability to sowing date which both Stirling and Skiff exhibit.

According to Dr Reg Lance, Barley Breeder at AGWEST, there is enough seed of WABAR2080 to start commercial evaluation in 2001. Potential release dates from this commercial evaluation (assuming they meet commercial malting and brewing criteria) would be 2003 or 2004.

In the meantime efforts to manage the limitations of Gairdner barley will benefit the release of the Gairdner 'replacement'.

Project No.: DAW 550

Paper reviewed by: Dr R.C.M. Lance

Evaluation of pasture species for phase pasture systems

Keith Devenish, Agriculture Western Australia, Northam

KEY MESSAGE

- Cadiz(b) serradella performed the best in a one-year pasture phase.
- Cadiz(b) serradella and Herald(b) medic performed the best in a two-year pasture phase.
- Farmers should consider sowing a pasture mix for two or more years of legume pasture.

BACKGROUND AND AIM

Throughout the wheatbelt a considerable proportion of wheat is produced in rotation with pasture. A pasture phase offers the opportunity to improve soil nitrogen and organic carbon levels and to reduce the seed population of grass and broadleaf weeds by using a combination of strategies including mowing, heavy grazing, applying selective weed herbicides and seed set control using spraytopping.

A ‘phase pasture system’ is gradually being adopted by grain growers as a modification of the ‘ley pasture’ system but with less emphasis on livestock production and more on the cropping enterprise. Short term pasture phases (1-3 years) are used to break up long cropping sequences (3-8 years) to control troublesome weeds and to increase soil nitrogen and organic carbon levels.

The re-sowing of legume pasture after a cropping phase is essential and aerial seeded species (where seed can be harvested cheaply using a grain harvester) are desirable to reduce the cost of seed. Recently released cultivars such as Cadiz(b) French serradella (*Ornithopus sativus*) and the early flowering Frontier(b) balansa (*Trifolium michelianum*) have been selected for these attributes with seed produced on farm for about 50 cents per kilogram. Although these pastures are protected under the Plant Breeders Rights Act, farmers can purchase and grow the seed for their own use. They are being successfully incorporated into ‘phase’ farming systems, with Cadiz(b) serradella proving particularly popular on good sandplain and loamy soils.

AIM

The aim of this trial is to evaluate some alternative annual legume species for their performance in different lengths of pasture phases on a sandy loam soil type. Of particular importance is the performance in two and three year pasture phases.

METHODS

Pasture plots (3 reps) were sown with a cone seeder (15 m x 1.1 m) on 17 June 1999 with 100 kg per hectare of SuperPhos (9 units P). Telstar® was applied as a bare earth treatment to control red legged earth mite. The average seedling density for each plot was measured each year (5 x 0.1 m^2) after the break of the season and dry matter (total biomass) was measured in year two (before senescence) by calibrating visual assessments (5 x 0.1 m^2) with pasture cuts that were dried in an oven and weighed. The legume composition was also estimated for each plot to calculate the legume dry matter component as a proportion of total dry matter production. The pots were not grazed during the growing period.

RESULTS

All the pastures were established successfully in 1999, although some were affected by waterlogged conditions during June and July. Dry matter production was not measured in 1999, although Cadiz(b) appeared to perform the best.

Significant summer rains in March 2000 germinated a considerable amount of seed. Plant counts in March 2000 showed that Cadiz(b) (Table 1) had the highest number of plants that germinated, followed by Frontier(b) and Paradana balansa. The extended dry period after March led to a false break to the season and many plants died before rain was received in late June.

Seedling densities were again measured in July 2000 after the late break to the season. Herald(b) medic and Cadiz(b) serradella had the greatest number of plants that survived the dry spell (and/or

germinated late), and consequently were able to produce the greatest amount of dry matter (Table 1). Both cultivars produced about 4 t/ha of dry matter (ungrazed) with a legume composition in excess of 90 per cent.

Table 1. Seedling density, legume dry matter and legume component for different annual legume pastures

Cultivar	Species	Seeding rate	Plants/ m^2	Plants/ m^2	Plants/ m^2	Leg. DM (t/ha)	Legume component
		17/6/99	4/8/99	29/3/00	14/7/00	26/9/00	26/9/00
Cadiz(þ	serradella	15	117	**2507**	**542**	**4.16**	**92%**
Santorini(þ	serradella	8	122	205	83	2.09	63%
Herald(þ	strand medic	10	74	1280	**629**	**3.78**	**92%**
Santiago	burr medic	10	122	680	338	1.96	67%
Dalkeith	sub-clover	12	105	1893	429	2.86	90%
Casbah(þ	biserulla	8	117	587	238	2.44	60%
Frontier(þ	balansa	8	239	2373	375	2.84	73%
Paradana	balansa	8	255	2240	263	2.29	67%

CONCLUSION

One-year pasture phase

Cadiz(þ serradella performed well in this and other trials and is the best pasture option to produce the greatest amount of legume dry matter (and associated nitrogen fixation) on sandplain soils for one year of pasture. Other trial results suggest that Cadiz(þ does not suit the heavy clay soils but grows reasonably well for one season on loamy soils in the medium-high rainfall regions where high seed yield is not required. It is the best choice for sandplain soils and has excellent tolerance to acidic soils. Frontier(þ balansa also performed well on the sandy loam soil type in the first year and had the second highest number of plants per square metre that germinated in the second year. Unfortunately a large proportion died due to the false break to the season suggesting that balansa is susceptible to false breaks.

Two-year pasture phase

Cadiz(þ serradella, Herald(þ medic and Dalkeith sub. clover all performed well. This trial supports past experience that Cadiz(þ is an excellent choice for two years of pasture and that sub. clover often peaks in production during the second year, also making it a good choice for a two-year pasture.

The relatively new (for WA) Herald(þ strand medic (*Mediciago littoralis*) is softer seeded than most other medics and results from this and other trials suggest it is well suited to a two year pasture phase. Herald(þ medic is readily available and has very good aphid tolerance.

Frontier(þ balansa also showed promise on this soil type as well as in other trials on heavier soils. Frontier(þ requires annual rainfall greater than 350 mm and suits the heavier soils in the medium-high rainfall regions. The seed can be harvested relatively easily using a grain harvester.

Farmers should consider sowing a pasture mix for a two-year pasture phase. The best choice of species will depend on soil type and seed cost.

Three-year pasture phase

This trial has another year of evaluation to go and the hard seeded species like Santorini(þ yellow serradella and Santiago medic are expected to perform better in the third year. Farmers should definitely consider sowing a pasture mix for a three-year pasture phase.

KEYWORDS

phase pasture, serradella, medic, balansa

GRDC Project No.: DAW 593

Paper reviewed by: Dr Clinton Revell

Competitiveness of wild radish in a wheat - lupin rotation

Abul Hashem, Nerys Wilkins, and Terry Piper, Agriculture Western Australia

KEY MESSAGE

- Wild radish is highly competitive to wheat and lupins.
- Presence of 10-75 radish plants/m^2 at the reproductive stage of crops can reduce wheat yield by 7-56% and lupin yield by 28-92%.
- Competition from radish not only reduces yield but also increases wheat screening.

BACKGROUND

Wild radish is one of the most competitive weeds in cereal, legumes, and oilseed crops in WA. The extent of yield loss in crops due to competition from radish has not yet been quantified.

AIM

The aim of this study was to quantify the yield loss in crops due to competition from radish.

Additional aspects of this study are reported in this proceeding in the paper titled: *Population explosion and persistence of wild radish in a wheat/lupin rotation.*

METHODS

Wheat-lupin-wheat-lupin rotation trial in Merredin (1997-2000)

In 1997 wheat of this rotation, autumn tickling, wheat seed rates, and low and high level of herbicides from various groups, were combined to achieve eight treatments including an untreated control and a treatment for total prevention of radish seed production.

For more details on the experimental procedure see the paper titled *Population explosion and persistence of wild radish in a wheat/lupin rotation* also included in this proceedings.

Radish plant density at reproductive stage of wheat or lupins, yields of wheat and lupin, and screening of wheat, were recorded in all treatments in each year. Losses in yields were estimated separately for wheat (1997 and 1999) and lupin (1998 and 2000) by regression analyses.

RESULTS

Competition between radish and crops in Merredin

Wheat yield loss

Competition from radish greatly reduced yields of wheat and lupin in Merredin. Linear regression on the effect of radish density on the yield of wheat in 1997 and 1999 predicted that the presence of 10, 25, 50 and 75 radish plants/m^2 at reproductive stage of wheat, reduced wheat yield by 7, 20, 37 and 56% respectively. These yield losses occurred when compared to an expected maximum yield of 3010 kg/ha in a wheat crop free of radish at the reproductive stage (Figure 1A).

Wheat screenings

Competition from radish not only reduced wheat yield but also increased wheat screenings. Presence of 5, 10, 25, 50, and 75 radish plants/m^2 at the reproductive stage of wheat, increased wheat screening to 3.7, 4.1, 5.3, 7.4, and 9.5% respectively as compared to the 3.2% screening in a wheat crop free of radish at the reproductive stage (Figure 1B).

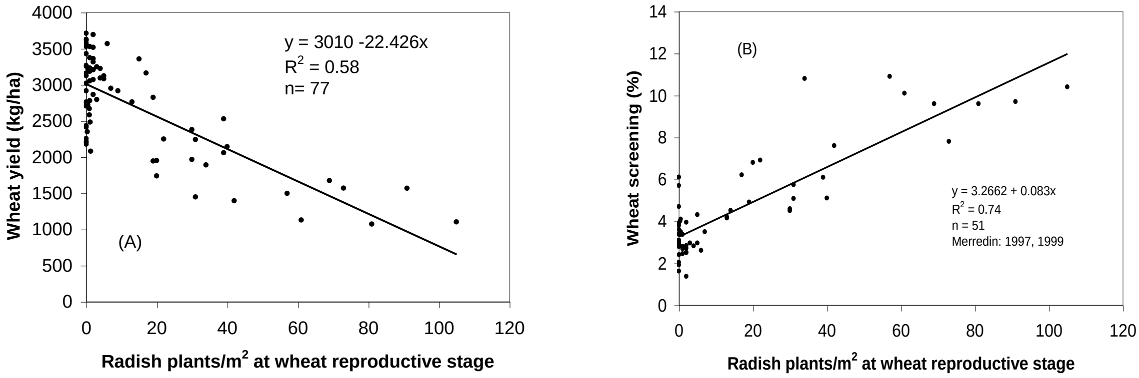


Figure 1. Regression equation predicting the effect of radish density on (A) wheat yield and (B) wheat screenings in a wheat-lupin rotation, Merredin.

Lupin yield loss

Presence of 10, 25, 50 and 75 radish plants/m^2 at the reproductive stage of lupins reduced lupin yield by 28, 56, 81, and 92% respectively. This is compared to the 541 kg/ha produced in a lupin crop with no radish at reproductive stage (Figure 2).

The yield loss data of wheat and lupin clearly established that radish is highly competitive to crops and it is more competitive to lupin than wheat.

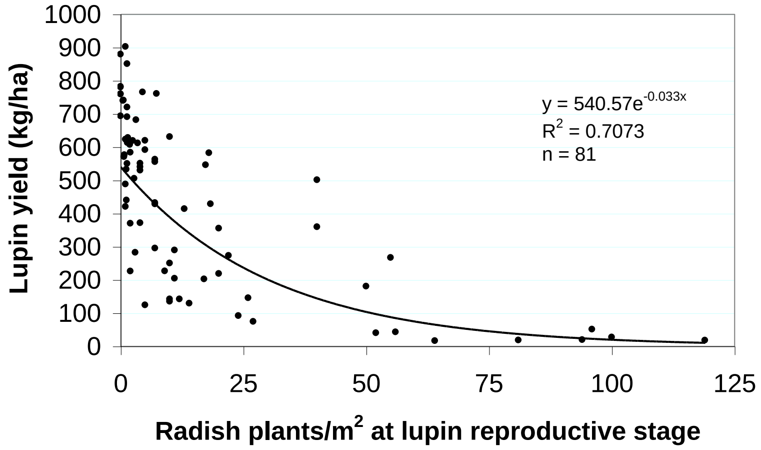


Figure 2. Regression equation predicting the effect of radish density on the yield of lupin in 1998 and 2000 in a wheat-lupin rotation in Merredin

CONCLUSIONS

Yield loss due to competition from radish is much higher in lupins than in wheat. Competition from radish increases percentage of wheat screening.

ACKNOWLEDGEMENTS

We are thankful to GRDC for funding the project.

GRDC Project No.: DAW 535 WR

Paper reviewed by: Ms Vanessa Stewart and Dr Terry Piper

Can we eradicate barley grass?

Sally Peltzer, Agriculture Western Australia

AIMS

By studying the decline of annual weed seeds from seedbanks, we can begin to understand how fast they deplete in the absence of weed seed input and which factors increase the rate of their decline. From here we can devise managemental strategies to control them. Trials were established to investigate the persistence of barley grass in heavy and light soils. These trials also compared the effect of cultivation with no cultivation on rate of seedbank decline.

MATERIALS AND METHODS

Two field experiments were conducted in former pasture fields, at Katanning (Great Southern Agricultural Research Station) in 1999 and 2000 on a sandy soil and at Beverley (Avondale Research Station) in 1998 and 1999 on a heavy red clay soil. Both sites had similar annual rainfalls of 482 and 421 mm respectively. Each site had 2 treatments (Till (4 passes of the cone seeder, two weeks after the season break) and No-till) with four replicates and 2 separate controls. Sixteen cores were taken from each plot prior to break of season and sorted for initial seed numbers. After the season break, the number of germinated and emerged barley grass were counted approximately every 6 weeks then sprayed with SpraySeed® to kill each cohort.

RESULTS

At Beverley, over 99% of the barley grass seedlings emerged from soil within 2 months of the break of the first season, irrespective of cultivation treatment (1998) ($p < 0.05$; Figures 1 and 2). Only 7 seedlings/m^2 emerged in following season (1999) and these also emerged in the first two months from the break. The pattern of emergence of barley grass at Katanning was almost identical at Beverley despite being located on a much lighter soil and beginning a year later. By comparison, annual ryegrass persisted in the soil at one trial site for several years, the seedbank declining at a rate of 70 to 80% per annum (Figure 2, including meaned results from a trial located at Katanning and designed to study the rate of seedbank decline of annual ryegrass).

Figure 1. The effect of cultivation (Till) and no cultivation (No-Till) on the emergence of barley grass from soil at Beverley in 1998 and 1999.

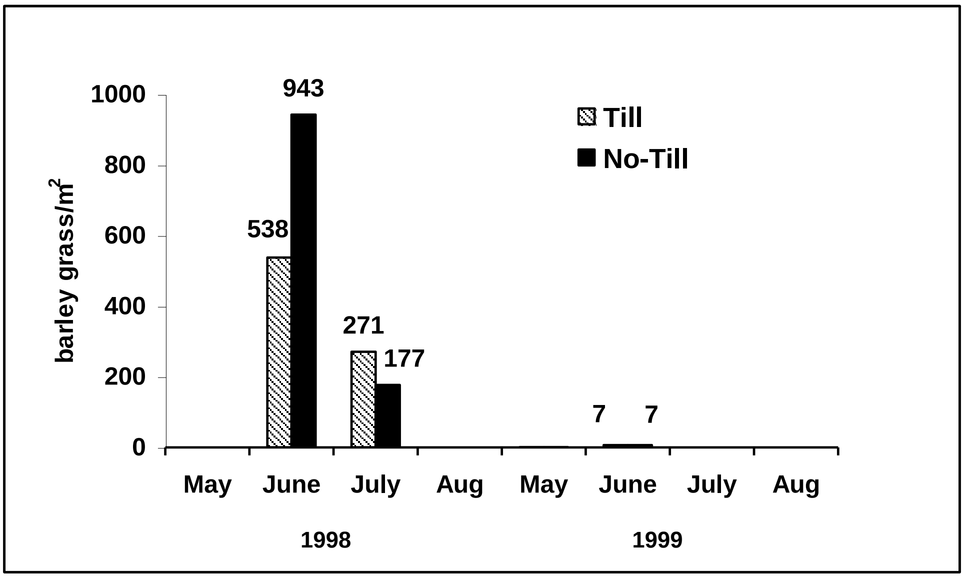
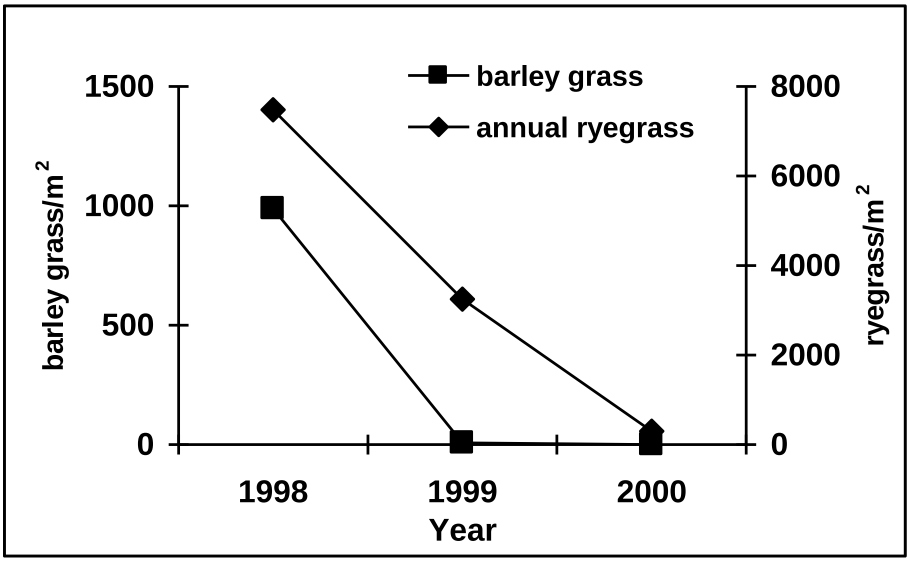


Figure 2. The emergence of barley grass (Beverley) and annual ryegrass (Katanning) from soil in 1998, 1999 and 2000.



Cultivation decreased the emergence of barley grass ($p < 0.05$; Figure 1) but did not alter the germination pattern. The cultivation operation occurred within 2 weeks from the break of the season allowing for some seeds to have already germinated by the time cultivation took place. Tilling the soil killed a percentage of these seeds before they could emerge from soil and so be counted. Tilling the soil however did not alter the pattern of emergence (with most of the seedlings emerging in the first year). Cultivation had a similar effect on barley grass emergence at both Beverley and Katanning.

CONCLUSION

Barley grass does not persist in the soil and possesses little or no dormancy. If barley grass seedlings are controlled early in the season and are not allowed to set seed then near eradication is possible.

KEYWORDS

barley grass, seedbank, control

GRDC Project No.: 613

Paper reviewed by: John Moore

Short-term pasture phases for weed control

Clinton Revell and Candy Hudson, Agriculture Western Australia, Northam

KEY MESSAGE

- Legume pastures such as Cadiz serradella can make a substantial contribution to cereal productivity through impacts on weed control and nitrogen supply.
- Soil disturbance in the pasture phase appears to be important to stimulate ryegrass germination and reduce the carryover of dormant seed to the cropping phase.
- Hay-freezing and green manuring are effective weed control strategies.

BACKGROUND

'Phase' pasture is the term now used to describe a short period of pasture (1-4 years) that is incorporated into a farming system to break up extended periods of cropping. This change to the farming system has a number of advantages. It can restore soil fertility (organic matter and soil nitrogen) that may have declined due to frequent cropping and it can provide an opportunity to control herbicide resistant weeds when combined with the use of grazing management, non-selective herbicides and cultural management practices (such as green manuring). Continual re-sowing is a feature of phase pastures but new pasture legume cultivars such as Cadiz⏀ serradella have been developed for use in such systems. Cadiz is very soft seeded and can be easily harvested with conventional cereal harvesting machinery. The objective of this research is to develop strategies for the use of short pasture phases to help control of herbicide resistant ryegrass.

METHODS

A long-term rotation experiment was established near Cunderdin in 1998 on pale loamy sand pH ($CaCl_2$) 5.3. Ten main treatments based on Cadiz serradella pasture have been established and include a range of weed control strategies such as non-selective herbicide treatments applied during winter or spring and grazing by sheep. Pasture phases range from one to three years followed by a wheat crop and treatments are replicated four times. In the final year of pasture, the rotational blocks are split into four pasture management treatments to maximise seed-set control of grass weeds. These sub-plots include an untreated control, green manuring with cultivation, hay-freezing using glyphosate and mowing (pasture-topping). In the wheat phase measurements of in-crop weed densities and grain production and quality are determined.

This paper reports crop performance after a one-year pasture phase in 1998. The pasture was either a natural regenerating grass/capeweed pasture or was sown to Cadiz serradella at 20 kg/ha. Pastures were moderately grazed in late winter and spring management treatments were imposed in October (plot size 2 m x 35 m). Westonia wheat (80 kg/ha) was sown with a 12-run combine in 1999 after a knockdown herbicide. No in-crop herbicides were used. Four rates of nitrogen (applied as Urea) were applied soon after wheat emergence in sub-plots measuring 2 m x 3 m. Ryegrass densities were measured in-crop and grain yield assessments were based on hand harvests.

RESULTS AND DISCUSSION

Pasture management decisions, even in a single year of pasture, can have a substantial influence on the productivity of subsequent crops. Differences in the size of ryegrass populations emerged in the pasture phase, with 75 plants/m^2 present in natural regenerating pastures compared with 200 plants/m^2 in sown Cadiz pastures. The difference occurred despite the use of a knockdown herbicide prior to sowing. The higher grass numbers in Cadiz pastures is presumably a response to soil disturbance when pastures are sown and the effects flow through to subsequent phases of the rotation. Final dry matter (total) was about 1.1 t/ha for natural pasture and 2.5 t/ha for sown Cadiz pastures (45% legume).

Without seed set control, densities of in-crop ryegrass were higher after Cadiz pastures (Table 1) due to higher ryegrass seed set. However, densities were substantially lower after Cadiz pastures in all seed-set control treatments. We believe this can be attributed to the stimulation of ryegrass germination in the sown pastures allowing greater efficacy of the spring seed-set control treatments. It

appears that in the no-legume phase (with minimal soil disturbance), a high proportion of ryegrass seed can remain dormant and be carried over into the subsequent cropping phase. The productivity of ryegrass under a wheat crop is related to ryegrass plant density but is strongly influenced by nitrogen supply. Even at relatively low densities of ryegrass, as in green manured and hay-freeze treatments, ryegrass biomass can still be substantial if nitrogen is readily available either through inorganic or organic sources (such as green manured Cadiz). However, the importance of low ryegrass densities cannot be underestimated in terms of reducing early competition with the cereal.

Wheat grain yields and protein were considerably higher after Cadiz pasture in all spring seed-set control treatments, with yields increasing by as much as 50% at low N levels. Increasing nitrogen supply generally compensated grain yields for previous pasture history (except at the highest ryegrass densities) but had less impact on grain protein. Clearly legume nitrogen is an important consideration for achieving high protein. The availability of organic nitrogen appears to occur earlier after green manuring but this did not necessarily translate into better crop performance, presumably because any ryegrass present also benefited from the high N status and became more competitive. Highest grain yields were achieved after hay-freezing pastures. The productivity of wheat after mowing treatments was intermediate between untreated and chemical seed-set control treatments.

Table 1. Density and productivity of in-crop ryegrass together with grain yield and protein of Westonia wheat grown (1999) after a range of pasture management treatments and with four rates of nitrogen applied as Urea. Pasture histories are either natural regenerating pasture or sown Cadiz serradella, each with four seed set-control strategies.

N rate (kg N/ha)	In-crop ryegrass density (plants/m^2)		In-crop ryegrass anthesis DM (t/ha)		Grain yield (t/ha)		Protein (%)	
Pasture history	Cadiz	Natural pasture	Cadiz	Natural pasture	Cadiz	Natural pasture	Cadiz	Natural pasture
Untreated control								
0	1925	1075	0.75	0.60	2.03	1.50	9.5	8.6
25			0.75	0.85	2.21	2.11	9.0	8.0
50			1.75	1.42	3.07	2.94	9.6	8.6
75			1.77	1.46	4.00	2.69	9.5	9.4
Green manure (disc)								
0	163	563	0.39	0.66	2.97	2.03	9.4	8.7
25			0.73	0.52	3.84	3.00	10.1	8.7
50			0.33	1.24	4.33	3.47	10.2	9.1
75			0.52	0.78	4.27	3.86	11.2	9.4
Hay-freeze (brown manure)								
0	150	488	0.17	0.46	4.14	1.96	9.6	9.2
25			0.11	0.35	3.77	2.43	9.5	9.1
50			0.35	0.48	5.11	3.34	9.6	9.1
75			0.52	0.71	4.63	4.56	10.1	8.4
Mow (pasture topping)								
0	238	488	0.36	0.35	2.93	2.71	8.9	8.3
25			0.79	0.46	4.00	3.30	9.4	8.4
50			0.57	0.21	4.34	3.43	10.0	8.6
75			0.81	0.80	4.41	3.94	9.9	8.4

CONCLUSIONS

Legume pastures such as Cadiz serradella can make a substantial contribution to cereal productivity through impacts on weed control and nitrogen supply. Soil disturbance in the pasture phase appears to be important to stimulate ryegrass germination and reduce the carryover of dormant seed to the cropping phase. One year of pasture may be insufficient to completely eradicate the ryegrass seed

bank, but if longer pasture phases are required, the combination of soil disturbance and seed-set control in each year of pasture would seem highly desirable. Research into the impact of longer pasture phases is continuing as part of this project.

KEYWORDS

pasture, serradella, ryegrass, herbicide-resistance, wheat

We acknowledge R. & J. Rogers for the use of farmland to conduct the rotation experiment.

GRDC Project No: DAW 557

Paper reviewed by: Bill Bowden

Herbicide tolerance of some annual pasture legumes adapted to coarse textured sandy soils

Clinton Revell and Ian Rose, Agriculture Western Australia, Northam

KEY MESSAGE

- Herbicide tolerance varies widely between species.
- Cadiz, Charano and Santorini serradellas were very sensitive to Tigrex, MCPA, Jaguar, Igran, glyphosate and gramoxone.
- The safest broadleaf herbicide for use in Casbah biserrula appears to be bromoxynil.

BACKGROUND

Herbicides can play an important role in pasture management but there is considerable variation amongst species in their tolerance to herbicides. Research in 1999 highlighted the need to account for soil type and seasonal variation as well as the timing of herbicide application, grazing and the use of herbicide mixtures. Research in 2000 made some progress towards quantifying some of these reactions for a range of new annual pasture legume species.

METHODS

Two replicated experiments were conducted near Dowerin, Western Australia in 2000 on a grey loamy sand pH ($CaCl_2$) 4.9 over subsoil pH ($CaCl_2$) 4.4. The first experiment examined the influence of grazing on herbicide tolerance but only data from the ungrazed treatment are presented in this paper. The second experiment included a larger range of herbicides and was ungrazed. Pasture legume species included subterranean clover (Dalkeith), French serradella (Cadiz(Φ)), yellow serradella (Charano(Φ), Santorini(Φ)), arrowleaf clover (Cefalu(Φ)) and biserrula (Casbah(Φ)). The pastures were sown after a knockdown herbicide on 26 June and maintained in a relatively weed-free condition to avoid confounding weed competition with herbicide reaction. Herbicide treatments included pre-sowing applications of Treflan®, pre-emergent applications of diuron and metolachlor and post-emergent applications (22 August - 6 leaf stage of legume) of Broadstrike®, Jaguar®, MCPA, Tigrex®, Spinnaker®, simazine and gramoxone. Pastures were sown with a cone seeder and each sprayed plot area was 5 m^2 in experiment 1 and 3 m^2 in experiment 2. About 40 mm of rain fell in the two weeks after the application of post-emergent herbicides. Plots were visually rated in September for effects on herbage production. Seed yields were measured in December and this data is still being processed.

RESULTS AND DISCUSSION

There was considerable variation in herbicide tolerance between species. Pasture growth was limited by dry seasonal conditions but ungrazed herbage production of most cultivars exceeded 3 t/ha. The most productive species was yellow serradella, which produced over 5 t/ha. Herbicide tolerance of French and yellow serradella was generally similar, although Charano yellow serradella appeared to have higher levels of sensitivity to some herbicides (e.g. diuron and Spinnaker) than Santorini.

Pre-sowing applications of Treflan resulted in some herbage reduction in most cultivars but notably Casbah biserrula. The use of Broadstrike in this situation was to simulate a knockdown of blue lupins and this timing markedly increased legume sensitivity, except for Cadiz serradella. Pre-emergent applications of diuron and Spinnaker resulted in substantial herbage reduction in Casbah biserrula and arrowleaf clover (diuron reduced seedling densities). The serradellas generally showed good levels of tolerance to these herbicides. All species showed acceptable levels of tolerance to metolachlor.

There were some notable responses to post-emergent herbicides. Cadiz, Charano and Santorini serradellas were very sensitive to Tigrex, MCPA, Jaguar, Igran, glyphosate and gramoxone. The high rate of Spinnaker caused moderate damage to all cultivars but especially Casbah biserrula. Cultivars had much better tolerance to Raptor but the rate used was half the normal recommendation. Even so, Casbah was still the most sensitive cultivar. Simazine resulted in increasing levels of damage during the season but responses in the serradellas were similar to subterranean clover. 2,2-DPA caused substantial leaf deformation in serradellas and appears to have limited use. Other grass herbicides such as Kerb and Verdict had little impact on herbage production in any cultivar. Broadleaf herbicide options in Casbah biserrula are still limited, with bromoxynil the most acceptable alternative.

Table 1. **Experiment 1 - Herbage production expressed as a percentage of unsprayed treatment for selected legume pasture cultivars measured at two times during September 2000 following post-emergent herbicide application. Days to first flower are shown in parenthesis**

Species/cultivar	**Subterranean clover**		**Biserrula**		**French serradella**		**Yellow serradella**		**Yellow serradella**		**Arrowleaf clover**	
	Dalkeith (80)		**Casbah (100)**		**Cadiz (94)**		**Charano (80)**		**Santorini (92)**		**Cefalu (112)**	
Herbicide (rate/ha)	**12 Sept.**	**27 Sept.**	**12 Sept.**	**27 Sept.**	**12 Sept.**	**27 Sept.**	**12 Sept.**	**27 Sept.**	**12 Sept.**	**27 Sept.**	**12 Sept.**	**27 Sept.**
Broadstrike 25 g + oil	76	76	13	20	73	78	80	77	81	77	88	83
Broadstrike 25 g + Diuron 100 mL	75	55	26	26	86	76	86	80	81	74	90	63
Broadstrike 25 g + MCPA 500 mL	67	53	21	34	44	26	44	21	54	32	64	58
Gramoxone 500 mL	38	83	1	3	34	61	21	65	20	56	33	75
Simazine 750 mL	82	63	80	65	85	73	73	57	83	72	84	50
Tigrex 400 mL	64	46	48	59	38	21	35	28	48	28	68	63
Raptor 20 g	82	72	48	49	83	67	90	83	90	87	68	68
Bromoxynil 1.5 L	67	87	70	87	76	81	73	77	76	74	61	58
Dry matter (t/ha) unsprayed	2.8		3.0		3.3		4.1		4.9		2.4	

Table 2. **Experiment 2 - Herbage production expressed as a percentage of unsprayed treatment for selected cultivars measured on 12 September 2000 following herbicide application**

Species/cultivar	**Subterranean clover**	**Biserrula**	**French serradella**	**Yellow serradella**	**Yellow serradella**	**Arrowleaf clover**
Herbicide (rate/ha)	**Dalkeith**	**Casbah**	**Cadiz**	**Charano**	**Santorini**	**Cefalu**
Pre-sowing						
Treflan 2 L	80	65	88	79	69	78
Broadstrike 25 g	59	7	87	43	68	64
Post plant pre-emerg						
Spinnaker 300 mL	27	15	89	83	95	24
Diuron 750 mL	78	37	71	61	87	35
Surflan 500 mL	84	81	85	76	83	90
Metolachlor 500 mL	84	85	81	77	77	76
Post emergence						
Spinnaker 300 mL	68	10	57	48	55	75
Glyphosate 400 mL	13	0	0	0	0	7
Jaguar 500 mL	53	52	35	26	46	47
MCPA (amine)1 L	60	14	27	30	25	54
Tribunil 850 g	89	87	84	86	91	93
Verdict 100 mL + oil	93	94	95	90	86	93
Igran 800 mL	41	22	9	6	14	55
Basagran 1.5 kg	90	50	94	77	91	93
2,2-DPA 2 kg	56	84	76	68	83	57
Spinnnaker 200 mL + Diuron 150 mL	78	55	76	67	77	87
2,4D-B 1.5 L	85	60	67	59	73	67
Kerb 1.5 kg	93	91	96	94	95	92
Dry matter (t/ha) unsprayed	2.4	2.3	2.6	2.5	2.5	1.6

KEYWORDS

pasture, legume, herbicide, herbage

We acknowledge G. & C. Hagboom for the use of farmland and S. Bell for excellent technical assistance. Dow AgroSciences and 4Farmers kindly supplied some of the herbicides.

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Paper reviewed by: Dr Terry Piper

Integrated weed management: Cadoux

Alexandra Wallace, Agriculture Western Australia, Katanning

KEY MESSAGES

- High ryegrass densities in pasture years can be targeted with non-selective treatments to reduce returns to the soil seed bank.
- At least two consecutive years of 100% ryegrass seed set control are needed to have a substantial impact on the soil seed bank.
- Correcting pH deficiencies has improved grain yield through optimising growing conditions, particularly for crops already at a seasonal disadvantage, e.g. late sown wheat.

AIMS

Integrated weed management (IWM) combines multiple weed management techniques to reduce weed density. The idea being to hit the weeds with such a varied battery of control measures that the plants are unable to develop an evasion strategy (e.g. resistance to herbicides). While there is some data available on individual weed control methods, there is little available on how IWM systems fit into our current farming practices. During 1997 and 1998 several sites were established to investigate the practicality of IWM on a large scale.

METHOD

The Cadoux demonstration consists of six 1 ha blocks of pasture, wheat (early and late seeding), lupin and canola/barley. Each block represents one year from a five-year rotation with an additional block of continuous wheat. Blocks are split in half, one half receiving a higher degree of management (+) than the other, for example, increased seeding rate, an altered or enhanced package of herbicides, crop topping, stubble management at harvest, green/brown manure, etc. The other half, which is managed less intensively, approaches district practice (-) (Figure 1).

Annual ryegrass density is measured prior to crop establishment, in the seedling crop and as mature plants prior to harvest (to estimate seed production). Yield and appropriate grain quality measurements are recorded for each crop species.

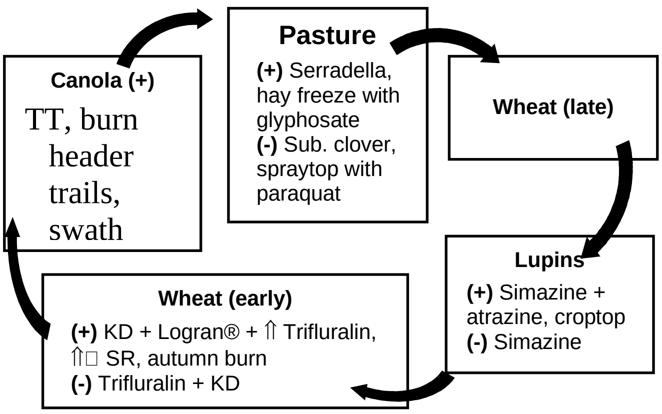

Figure 1. The rotation sequence and major treatments applied during each phase of the rotation. (KD = knockdown herbicide, SR = seeding rate).

RESULTS

Following four years of treatments, plots which are intensively managed (+) generally have lower densities of annual ryegrass than plots which are treated more conventionally (-), although in some cases the differences are not large (Table 1 and 2). When the rotation cycles to pasture the ryegrass numbers rise considerably. It is expected that the seed set control imposed in spring will control 100% of ryegrass seeds on the (+) pasture plot. The density of ryegrass germinating each year indicates that the seed bank is still considerable.

Grain yield is often increased on intensively managed plots compared to the conventionally managed plots (Table 3). A comparison of wheat yield, averaged over the four years of the demonstration (Table 4), show a marked increase of (+) over (-), with the largest differences in later sown and continuous wheat treatments. Early sown wheat has the highest grain yield potential.

Table 1. The density (plants/m²) of annual ryegrass prior to crop establishment and in-crop, for four years of a rotation at Cadoux. (+) indicates IWM imposed, (-) indicates more conventional methods used

1997	July		April	July		April	June		Aug.
	1997	1998	1998	1998	1999	1999	1999	2000	2000
Pasture (+)	632	Wheat, L (+)	68	29	Lupins (+)	148	185	Wheat, E (+)	47
Pasture (-)	589	Wheat, L (-)	254	39	Lupins (-)	685	278	Wheat, E (-)	39
Lupin (+)	65	Wheat, E (+)	676	101	Canola (+)	93	156	Pasture (+)	276
Lupin (-)	82	Wheat, E (-)	2672	277	Barley (-)	265	600	Pasture (-)	816
Wheat, late (+)	22	Lupin (+)	219	17	Wheat, E (+)	313	68	Canola (+)	4
Wheat, late (-)	19	Lupin (-)	534	25	Wheat, E (-)	1262	239	Barley (-)	26
Canola (+)	18	Pasture (+)	1183	110	Wheat, L (+)	125	39	Lupins (+)	91
Barley (-)	8	Pasture (-)	270	120	Wheat, L (-)	55	34	Lupins (-)	59
Wheat, early (+)	84	Canola (+)	169	29	Pasture (+)	450	502	Wheat, L (+)	79
Wheat, early (-)	25	Barley (-)	625	32	Pasture (-)	575	688	Wheat, L (-)	79
Cont. wht (+)	32	Cont. wht (+)	727	41	Cont. wht (+)	320	39	Cont. wht (+)	59
Cont. wht (-)	38	Cont. wht (-)	480	139	Cont. wht (-)	780	326	Cont. wht (-)	106

Later sown wheat (by 2-3 weeks) has a lower level of annual ryegrass than early sown wheat (Table 1, July 1997 and 1998 and June 1999). Pre-seeding weed control for the early sown wheat plots may miss the bulk of the ryegrass germinating each season, allowing it to germinate under the crop. Delayed seeding allows more time to stimulate and control grass germination.

Table 2. The density (plants m^{-2}) of annual ryegrass prior to crop establishment and in-crop, for four years of a rotation at Cadoux, averaged over treatments to compare (+) with (-) rotations (excludes continuous wheat)

Rotation	July 1997	April 1998	July 1998	April 1999	June 1999	August 2000
IWM (+)	164	463	57	226	190	99
'Standard' (-)	145	871	99	568	368	204

Table 3. Grain yield (kg/ha) during the course of the demonstration at Cadoux. (+) indicates IWM imposed, (-) indicates more conventional methods used

1997	Yield	1998	Yield	1999	Yield	2000	Yield
Pasture (+)	-	Wheat, L (+)	1428	Lupins (+)	2186	Wheat, E (+)	1790
Pasture (-)	-	Wheat, L (-)	970	Lupins (-)	2088	Wheat, E (-)	1498
Lupin (+)	540	Wheat, E (+)	1720	Canola (+)	416	Pasture (+)	-
Lupin (-)	510	Wheat, E (-)	1564	Barley (-)	660	Pasture (-)	-
Wheat, late (+)	1120	Lupin (+)	910	Wheat, E (+)	2174	Canola (+)	-
Wheat, late (-)	1150	Lupin (-)	1014	Wheat, E (-)	2086	Barley (-)	1031
Canola (+)	300	Pasture (+)	-	Wheat, L (+)	1532	Lupins (+)	780
Barley (-)	1640	Pasture (-)	-	Wheat, L (-)	1495	Lupins (-)	750
Wheat, early (+)	1280	Canola (+)	284	Pasture (+)	-	Wheat, L (+)	1194
Wheat, early (-)	1280	Barley (-)	1720	Pasture (-)	-	Wheat, L (-)	441
Cont. wht (+)	1070	Cont. wht (+)	1456	Cont. wht (+)	1284	Cont. wht (+)	1676
Cont. wht (-)	810	Cont. wht (-)	870	Cont. wht (-)	427	Cont. wht (-)	719

Table 4. Wheat yield (kg/ha) averaged over course of the trial (4 years), comparing (+) with (-) rotations. The three wheat phases are examined

Rotation	Continuous wheat	Early seeded	Late seeded
IWM (+)	1372	1741	1319
'Standard' (-)	706	1607	1014

At establishment of the demonstration the northern half of each plot received 2 t/ha of lime. There was a large effect of lime on the late wheat, barley and canola, with a doubling of grain yield where lime had been applied compared to the unlimed area (Table 5).

Table 5. Grain yield (kg/ha) 1999, the effects of lime (2 t/ha) applied in 1997 are displayed. (+) Indicates IWM imposed, (-) indicates more conventional methods used

Rotation			Yield	
1997	**1998**	**1999**	**No lime**	**Lime applied**
Pasture (+)	Wheat, late (+)	Lupins (+)	2172	2200
Pasture (-)	Wheat, late (-)	Lupins (-)	2176	2000
Lupin (+)	Wheat, early (+)	Canola (+)	320	512
Lupin (-)	Wheat, early (-)	Barley (-)	468	852
Wheat, late (+)	Lupin (+)	Wheat, early (+)	2120	2228
Wheat, late (-)	Lupin (-)	Wheat, early (-)	2044	2128
Canola (+)	Pasture (+)	Wheat, late (+)	1020	2044
Barley (-)	Pasture (-)	Wheat, late (-)	1114	1876
Wheat, early (+)	Canola (+)	Pasture (+)	-	-
Wheat, early (-)	Barley (-)	Pasture (-)	-	-
Cont. wht (+)	Cont. wht (+)	Cont. wht (+)	1200	1368
Cont. wht (-)	Cont. wht (-)	Cont. wht (-)	336	518

CONCLUSION

The largest ryegrass densities are on plots that are under pasture. The (+) pasture is treated with herbicide in spring (hay-freeze, brown manure) and 100% ryegrass seed set control is expected following this application. Ryegrass should be encouraged to germinate in the pasture phase to enable seed set control, using brown manure.

During 1999, the canola and barley plots were split, with half being sprayed out (brown manure) and the remainder continuing on to harvest. Canola has been a low yielding crop on this site for the duration of the trial and the barley never recovered from waterlogging early in the 1999 season. Spraying out half the plot, and subsequently preventing ryegrass seed set, will enable a comparison to be made of two seasons of complete grass removal with one season, following the 2001 harvest. The barley and canola is followed by pasture in the rotation, of which one plot (+) is sprayed out in spring.

No plot is free of ryegrass after four years of integrated weed management. The treatments applied have not been hard enough on the ryegrass and each year some escapes to replenish the seed bank. Two consecutive years of 100% ryegrass control may be needed to have a substantial effect on the seed bank.

Annual ryegrass density was 60-90% lower in crops, which followed pasture compared to those which followed lupins (Table 1, April 1998 and 1999). Lupins are less competitive early in the season and the level of grass control given by triazines and crop-topping appears to be insufficient to prevent substantial quantities of seed being set.

The application of lime to the paddock in 1997 improved crop yield in 1999 and again in 2000 (data not presented). It is interesting that the greatest yield responses were measured on the crops that were least suited to the demonstration site (canola and barley) or disadvantaged by sub-optimal growing conditions (late sown wheat). So it is important to get the healthiest growing conditions as stresses may reduce the potential response to grass control.

The rotation is designed to evaluate the performance of the crops and weed control treatments over a five year period. It is anticipated that a five year gross margin will demonstrate improved profitability as a result of IWM compared to the low input district practice.

KEY WORDS

integrated weed management, herbicide resistance, annual ryegrass

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Paper reviewed by: Peter Newman

Inter-row knockdowns for profitable lupins

Paul Blackwell, Agriculture Western Australia and **Miles Obst**, Mingenew

KEY MESSAGE

Better lupin yields and less weed infestation than normal agronomy was achieved with inter-row knockdowns on a blue lupin paddock at Mingenew. Estimates of ryegrass seedbank control for modelling with RIM showed average gross margins over a lupin/wheat phase could be about $135/ha with the best in-row grass control. This is about double the estimated average gross margin for the period from normal agronomy or green manure. Tramlines enable the use of inter-row knockdowns inside protective 'row-cropping' shields and are very compatible with the needs of tramline farming technology. The financial benefits of this system could be employed to help underwrite the needs for farm conversion to tramline farming.

Methods and agronomy

The trial was done with farmscale equipment on plots 36 m x 250 m (one farm boom width) and with 4 replicates. The soil was grey sand over gravel, with a blue lupin history. Sowing was on 3 May, dry over moisture. There were only a few light showers until the middle of June. 192 mm fell between May and October. Wonga was seeded at 120 kg/ha on 560 mm rows with knifepoints and presswheels. Fertiliser at seeding was 100 kg/ha of 'pasture potash'. Herbicides were: pre-seeding 1 L/ha Roundup, 2 L/ha simazine, 300 mL/ha Sprayseed; 5 July; 750 mL/ha simazine, 100 mL/ha brodal (not treatments 2,3 and 4) 1 August; 280 g/ha fusion (not treatments 2 and 3). Reglone was used for crop topping in late October.

Inter-row spraying was with 'Red Ball®' conservation spray shields mounted on a 9 m wide three-point linkage frame. The spraying tractor ran on 600 mm wide tramlines. 'Fuzzy' tramlines were used in the whole trial, i.e. seed sprayed from two hoses at about 800 mm height in front of frame and airbox wheels which rolled the seed into the soil in a broad band. Thus the tramlines resembled broad green bands, rather than bare, grey strips. Then the shields were used the crop in the tramlines was killed, as well as the weeds between the rows. The inter-row roundup, at 1.5 L/ha was sprayed when the primary flowers of the lupins were opening. The shields sprayed 350 mm width of the 560 mm rows. Green manuring was done with an offset disc plough on 28 August and brown manuring (1 L/ha of roundup) was done on 12 September. A small trial on the same site also used knockdowns in the row. The range of treatments used are shown in Table 1. Shields gave the largest yield and had the lowest growth of blue lupin weeds. Presumably the large blue lupin weeds competed for soil moisture in this dry season and contributed to a reduction of yield in the other treatments. There must have also been some compensation in the shielded crop for the lack of crop in the tramlines, compared to the other treatments. Grass weed control with inter-row hoods because grass selectives were also used, as in the normal agronomy. This was done to simulate weed control by other methods, e.g. in row Kerb® or

Table 1. Plant establishment, growth and yield; * = significantly different to normal agronomy

Treatment	Yield (t/ha)	Plants (/m^2)			Dry matter (g/m^2)			Gross income ($/ha)
		Lupin	Blues	Grass	Lupin	Blues	Grass	
1. Normal agronomy	1.067	44	2.3	4	184	29	6.4	181
2. Green manuring	0	53	3	16*	237	48	38*	0
3. Brown manuring	0	55	3.8	4	273*	64	16*	0
4. Crop topping	1.042	37	1.5	2	287*	25	0.2	177
5. Hoods and topping	1.186*	42	0.5*	3	255*	0.5*	7.5	202
LSD (5%)	0.082	17	1.9	10	69	30	22	($170/t)

late spray seed from 'lay by' nozzles on the shields. 2 L/ha of roundup in the row killed all grasses. At WHRS, Kerb® in-row has shown 97% grass control, little yield penalty and a cost of about $18/ha. Crop topping may be the best current option for the in-row weeds. Wheat yields and weeds will be followed in the 2001 season for the same treatments.

Estimates of weed control, yields and gross margins in a lupin-wheat phase by RIM

For the model run we used a lupin yield of 1.2 t/ha and a wheat yield of 2.34 t/ha ($170 and $180/t respectively). No grass selectives could be used in the lupins and there was 25% carry-over of the initial 500 seeds/m^2 rye grass into the wheat phase. The wheat was grown with delayed sowing and high seeding rates to maximise weed control. The shield treatments were estimated as the worst scenario with only 80% control by inter-row shields, or the best case scenario with additional Kerb® in the row (paid for by saving the cost of simazine) and 98% weed control. Table 2 shows the results.

Table 2. Estimates of ryegrass and gross margins for different systems over a lupin/wheat phase

		Lupin year		Wheat year	
Ryegrass (seeds or plants/m^2)	**% Control**	**Seeds; April**	**Plants; Nov.**	**Seeds; April**	**Plants; Nov.**
Res. RG no G. selective, normal agronomy	70	500	151	5195	1173
Green manure with simazine	99	500	3	155	35
IR shields on 80% width, no in-row control	80	500	38	1487	336
IR shields + in-row control; 98% grass control	98	500	17	591	134

	Gross margin $/ha		**2 years**	**Average over 2 years**
Res. RG no G. selective, normal agronomy	**21**	110	**131**	65.5
Green manure with simazine	**-130**	275	**145**	72.5
IR shields on 80% width, no in-row control	**29**	172	**201**	100.5
IR shields + in-row control; 98% grass control	**59**	212	**271**	135.5

The best IR shield treatment gave the best gross margin in the lupin year and averaged over the two years, ryegrass numbers were also kept relatively stable. This encourages the development of low cost shields for use on normal farm spraying equipment.

CONCLUSIONS

- These results are encouraging for inter-row hoods in a Tramline farming system using row-cropping technology.
- Tramlines enable the use of inter-row knockdowns inside protective ‘row-cropping’ shields and are very compatible with the needs of tramline farming technology. The financial benefits of this system could be employed to help underwrite the needs for farm conversion to tramline farming.
- These techniques may also be useful in other legume crops with a ‘bushy’ growth habit, which is easily accommodated between inter-row shields, e.g. chickpeas.

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Paper reviewed by: Bill O’Neill

Paper reviewed by: Mark Sweetingham

Wild radish - the implications for our rotations

Dr David Bowran, Centre for Cropping Systems, Northam

INTRODUCTION

Wild radish remains one of the most severe weed problems in cropping systems in Western Australia. There appears to be a general trend towards increasing amounts of the weed in northern agricultural regions. Many farmers in southern regions are now experiencing the problem. In addition the increasing levels of resistance to many common and cheap herbicides will pose very real problems for its management into the future.

Despite this there are still many effective control measures available for the weed. It is the process of placing these measures into biologically and economically realistic systems that is probably the greatest challenge.

COMPONENTS

For IWM to be successful a good understanding of the weed and its possible control measures is necessary. However the real value of any program will lie in the ability to place it in context - that is within the context of management of all weeds within the system and in an economical manner. Various parts of the system require careful attention if this is to be achieved.

Understand the weed

Wild radish has characteristics in common with many weeds that lead to its successful growth in our farming systems.

It has substantial plasticity in response to its environment, especially in regard to seed production. The characteristics of its seed pods ensure that even after 5 years viable seed can still be present in most soils, and in non-wetting soils where biological degradation is minimised, carryover is likely to be very significant.

Seed pods are readily shed at maturity ensuring minimal harvest capture, yet harvested pods are light enough to ensure that when harvested with large seeded crops most pods are returned to the paddock from the harvest operation.

When germinating early in autumn seeds may be set in as little as 60 days. Radish is quite drought tolerant and appears able to produce seeds under severe competition from other species. Being an outcrossing species it can recombine genes quickly to ensure the next generation is better adapted. As with many weeds herbicide resistance can occur quickly with some groups of herbicides such as the ALS inhibitors (Group B herbicides).

Understand the management practices

The majority of management practices for effective control of wild radish are similar to those used for control of most other weeds. In continuous cropping selective herbicides remain the primary method of control. Most selective herbicides can achieve 95% control if used at rates and under conditions favourable to a particular herbicide. Problems arise when reduced rates are used under less than optimal conditions, and poorer control is achieved. The crop into which the herbicide is used can also play a significant role. Lupins are largely sown dry, ensuring the pre-emergent triazines have reduced efficacy, while if non-wetting soil is present much of the herbicide may be unavailable to the weed.

The extent to which herbicide groups can be used will be largely determined by use of the other groups in an alternative phase of the rotation. Therefore where simazine or atrazine are used in lupins the strictest interpretation of the guidelines would suggest that no diuron, bromoxynil or terbutryn be used in the cereal. If Brodal is used in lupins, then no Tigrex or Jaguar be used in cereal. Were Eclipse to be used on flowering radish in lupins then in theory no sulphonyl urea herbicide should be used in wheat.

However the system nearly always has more than one weed and particular herbicides may be desirable to remove some weeds. Thus sulfonylureas provide good doublegee control, and to remove them from the system would require an effective alternative (e.g. dicamba, either alone or in mixture). It must also be borne in mind that a weed like wild radish shows numerous germinations in one season and early applications for yield response may result in sufficient later germinations to re-build the seed bank for future years. Consequently herbicide based management systems may become extremely difficult to use once resistance to one or more groups is present on a farm.

Other management practices are available which can be extremely useful. Pasture combined with spray-grazing, hay or silage making, green (brown) manuring or fallowing should all be able to reduce seed set by 100% in a particular year. Seed catching should provide some level of control in early harvested crops, while crop-topping with non-selective herbicides can be effective in minimising seed set in crop. Reduced disturbance seeding systems may reduce plant establishment but require other measures for good control to be achieved. Cultivation will effectively control small germinated wild radish, though disturbance may provoke additional germinations to occur within crop.

Design the rotation - use as many control options as possible

Improving system design to ensure weed management is optimised would seem a desirable path to adopt. However any change to the current system will have both costs and benefits, and achieving a better-balanced system may not always be possible. Any new system which is advocated, if widely adopted, may lead to broader economic impacts which reduce overall gross returns, e.g. every farmer cutting hay to sell on the local market. Rotation design should also aim to ensure optimal pest management, nutrient flows, soil management, water use efficiency and effective management of other weeds in the system. Getting the system balanced so effective management of a particular weed is maximised, while the rest of the system is still optimal is not as easy as it seems!

- **Aim to reduce the seedbank inputs to zero in at least two consecutive years - 3 or 4 is better still**

If in an ideal world herbicides were able to control 100% of a weed population in a paddock in every year, with no resistance evolving, seedbank inputs would become zero! The fact that weeds haven't disappeared from continuous crops implies we can't achieve this goal.

It is necessary to effectively lower seed numbers returning to the seedbank if competition in future crops is to be minimised. This is particularly important for longer-lived seedbanks. Even having 5% of a seed rain still present (in the seedbank) after 5 years will be sufficient to cause problems. Achieving 2 years of zero input while maintaining economic viability on a paddock is difficult, so whole systems approaches become necessary.

It is important to be aware that seed is being set. While the weed may not be flowering visibly above the crop, seed set can and does occur within crops. This has important ramifications in achieving multiple years with no seed set. Radish plants germinating following summer rain can contribute large quantities of seed to the seedbank. This is often seed that has high levels of dormancy.

- **Once weed numbers are low keep them low**

This is much easier said than done. Yet the tools are generally available but do come at a cost. In most cases herbicides are required and the tradeoffs between higher rates under low weed burdens and very high levels of seed set control, versus reduced input costs but longer-term higher weed burdens have to be carefully considered.

- **Calculate rotational gross margins - use models**

Modelling is by far the common sense way to look at new systems of weed management. As models such as RIM are provided, sufficient flexibility for real time analysis then becomes easier. Single year gross margins can never truly capture the true returns of different practices. What looks expensive in a given year (e.g. sacrificing of a crop) can have long term benefits and payoffs that will never be captured by a single year calculation.

DOES THE SYSTEM MAKE SENSE

The lupin-wheat rotation classically builds up radish numbers very quickly, with evidence from both farmers and trials supporting this view. In contrast rotations which include significant amounts of well-grazed pasture have little build up and may decline in radish numbers. A balance between these two systems which allows grain legumes to be effectively grown would be ideal.

Table 1 illustrates the effects of different rotations on relative wild radish buildup after 8-10 years (2-4 cycles) of a number of rotations using a spreadsheet model in which the following parameters were used:

- Seedbank germination - 33% yr 1, 20% yr 2, 7% yr 3 and 3% yr 4 with 37% of the total seedbank being lost to other factors.
- A herbicide efficacy of 90% in lupins or grain legume, 95% in cereal and 100% in spray grazed pasture.
- Seed production ratio for wild radish for lupin against wheat of 2:1.

Table 1. Relative change in wild radish seedbank with different rotations

Rotation sequence	Relative radish seedbank compared to start
L :W (4 cycles)	159
L : W : W (3 cycles)	23
L : W :C : W (2 cycles)	10
L : W : GM : W (2 cycles)	2
L : P : W : W (2 cycles)	0.6
L : P : P : W : W (2 cycles)	0.14
P : W : W (3 cycles)	0.05
P : P : W : W (2 cycles)	0.01

L = lupin, W = wheat, C = canola, GM = green manure lupin, P = sown pasture.

The classic lupin-wheat rotation shows high levels of enrichment of the seedbank, and even if we start with low seed numbers in the seedbank we should anticipate that system failure should occur given the levels of control and seed production indicated. Reducing the amount of lupins in the rotation reduces radish buildup, and a single break year of no seed set has dramatic effects on the enrichment process. Increasing the level of cereal also has an impact due to higher competitiveness and generally better weed control from herbicides. The use of single pasture years with 100% control has the ability to reduce radish buildup and appears to run seedbanks down. It is important to note that two of the pasture containing rotations which contain lupins have relative seedbank changes of less than 1.0.

By taking two of these rotations and changing the parameters of seedbank characteristics, efficacy of herbicides or seed set it is possible to test the robustness of the system. The effects of these changes are shown in Table 2.

In the rotation in which a single year of break is used (LWGMW) changing germination patterns to either more germinating in the first year after seed production, or delaying the germination of the seedbank as might occur with non-wetting soil increase the radish buildup. The two year pasture rotation is more effectively buffered against such changes in germination patterns. The effect of changes in herbicide efficacy in lupins are significant and should be carefully considered. In drier seasons efficacy of 80% may just be achievable, while in high rainfall years the 95% is possible. The use of reduced rates of herbicides combined with dry seasons may have led to the increases in wild radish in the northern wheatbelt.

Reduced efficacy in lupins has a strong effect in the rotation with the pasture phase also showing increases in wild radish - the combination of reduced efficacy with non-wetting soils could make this rotation have a net increase in radish. The effect of delaying germination of wild radish by 20% so that higher seed production were to occur later in the crop is consistent with the view that later emerging

weeds have less impact on seedbank return. The most dramatic effect is with reducing seed input at harvest by 50%. Even in the non-pasture rotation it becomes possible to contemplate long term reductions in the seedbank.

Some of the rotations presented represent a series of possible solutions to wild radish management but they are by no means the only solutions. The use of mechanical methods of control such as with hay cutting and silage making should also be considered, and are likely to be of increasing importance where high value crops such as chickpea and lentils are considered.

The stability of rotations must be considered from both biological and economic viewpoints. The lupin:wheat rotation has been extremely profitable for much of the northern wheatbelt and to dramatically alter such a rotation will require excellent alternative solutions

Table 2. Effect of changing biological and control parameters on relative wild radish seedbank

Parameter	LWGMW (2 cycles)	LPPWW (2 cycles)
As above	2	0.14
Change germination pattern (50,20,10,3)	5.5	0.6
Change germination pattern (25,25,15,10)	4	0.6
95% herbicide efficacy lupins	0.6	0.14
80% herbicide efficacy lupins	7.3	1
Delay germination of 20% radish in lupins	2.8	0.19
50% reduction in radish seed set both crops	0.1	0.01

CONCLUSION

Wild radish poses a significant threat to cropping rotations, with the lupin-wheat rotation particularly at risk from both weed increase and herbicide resistance. Management practices which reduce this threat such as longer term breaks without seed set, improved herbicide efficacy and improved seed set control can all contribute to reducing the threat but will come at a cost. The longer-term challenge is to manage wild radish within the perspective of all weeds in the system and for maximum economic return.

Lupin variety performance: Are you making the most of it?

Bevan J. Buirchell, Senior Plant Breeder, Agriculture Western Australia

KEY MESSAGE

The new lupin varieties (Tanjil, Wonga, Kalya, Belara, Quilinock) offer higher yields than the older varieties (Danja, Gungurru, Merrit and Myallie) and therefore greater economic return to farmers. Economic returns from Tanjil and Belara have been estimated at $12-$25/ha better than old varieties.

AIM

To analyse annual lupin deliveries to CBH and Crop Variety Testing (CVT) data to ascertain what varieties are being grown by farmers and where varieties perform the best.

METHODS

The Grain Pool of Western Australia supplied annual deliveries of lupin varieties to CBH. Data from CVT trials (1990-2000) were used to analyse lupin variety performance across zones and regions, and across soil types.

RESULTS AND DISCUSSION

Production: Approximately 75% of lupin production in Western Australia occur north of the Great Eastern Highway. The dominant varieties for the 1990s have been Gungurru and Merrit. In 1999 these two varieties accounted for 61% of deliveries while in 2000 season this was reduced to 38% (Table 1). This is a large change but these two varieties still account for a significant amount of production. Tanjil and Belara look like becoming the dominant varieties in the future.

Table 1. Annual production of lupin varieties (percentage of annual tonnage) for the years 1995-2000

Released	Variety	1995	1996	1997	1998	1999	2000 est.
1986	**Danja**	5.4	3.9	2.9	1.8	1.6	1.4
1988	**Gungurru**	56.8	54.6	51.4	44.6	32.3	17.2
1989	**Yorrel**	2.2	1	0.8	0.5	0.3	0.2
1991	**Merrit**	34.9	39.7	37.5	35.7	29.3	20.7
1995	**Myallie**		0.4	6.5	10.4	11.9	11.2
1996	**Kalya**		0.1	0.8	6.7	14.2	14.7
1996	**Wonga**					1.3	7.2
1997	**Belara**				0.1	7.6	18.3
1997	**Tallerack**				0.1	1.2	1.4
1998	**Tanjil**					Trace	7.1
1999	**Quilinock**						Trace
	Deliveries (x 1000 tonnes)	860.9	843.6	916.7	947.8	1197.7	416

Distribution: In 1999 Gungurru and Merrit were the preferred variety in the north and central districts. Kalya and Wonga increased popularity in the northern districts especially with the onset of anthracnose in 1996. Belara has been favoured in the eastern area of the north and central districts while Myallie has been the variety of choice in the eastern half of the central and upper southern districts. Danja is still produced but is confined to the eastern part of the central districts. Tallerack has found a niche in areas were crop topping is used for control of herbicide resistant rye grass. However, the higher yielding but early maturing variety, Belara, should dislodge Tallerack from that system.

Yield: The highest yielding variety across the State is Quilinock (Table 2). Belara and Tanjil yield, on average, 7-12% greater than Merrit. With an average yield of 1.2 tonnes per hectare across the State this is the equivalent of $12-$25/ha extra return (lupins at $175/t). In higher yielding environments the extra return would be even greater.

Table 2. Yield of each variety as a percentage of Gungurru for each region/zone

Region/zone variety	VH	H1+H2	H3+H4	H5	M1+M2	M3+M4	M5	L1+L2	L3	L4+L5
Quilinock	115	117	116	115	117	118	116	114	111	115
Belara	111	113	113	114	117	114	113	114	107	107
Tanjil	112	109	109	108	109	111	108	109	108	110
Wonga	111	108	107	107	107	106	105	107	106	108
Kalya	111	110	106	106	105	106	106	105	104	108
Merrit	102	102	102	100	101	102	102	102	102	102
Gungurru	100	100	100	100	100	100	100	100	100	100
Myallie	100	101	98	97	97	100	98	96	96	98
Danja	104	97	96	95	93	96	95	94	93	97
Tallerack	94	101	97	100	94	96	94	89	93	96

Performance across soil types: Analysis of CVT data (Table 3) showed that on the trials conducted on gravel soils Quilinock out performed Merrit 58% of the time and Belara and Kalya were the next best on 20%. For all trials on sandy soils, Quilinock was the best performer (49%) followed by Belara (36.5%), Tanjil (27.3%) and Wonga (24.3%). Quilinock (72%) and Belara (51.5%) were outstanding on loamy soils with Tanjil and Wonga ahead of the rest. On duplex soils, either shallow or deep, the outstanding performers were Quilinock (53.3%) and Belara (43%). All varieties post Kalya offer better performance than Merrit and Gungurru across all soil types.

Table 3. Performance of lupin varieties in trials on different soil types (percentage of trials where the variety had significantly greater yield than Merrit)

	Gravels	Sands	Loams	Duplex soils	Overall
Tanjil	20.0	27.3	28.0	16.9	27.8
Wonga	0.0	24.3	22.0	12.3	23.3
Belara	20.0	36.5	51.5	43.0	39.4
Quilinock	58.0	49.0	72.0	53.3	50.0
Kalya	19.0	19.6	16.6	14.1	17.6
Myallie	0.0	6.0	3.8	2.2	6.2
Tallerack	0.0	14	14.0	14.1	11.1
Merrit	0	0	0	0	0

CONCLUSION

The latest lupin varieties like Tanjil, Belara, Wonga and Kalya offer farmers greater returns through disease resistance, yield and adaptation. Even though Merrit and Gungurru are still the dominant varieties farmers who continue to grow these varieties are loosing approximately $12-$25/ha.

KEY WORDS

lupin varieties, production, yield, soil type

GRDC Project No.: DAW 485

Paper reviewed by: Kedar Adhikari

Anthracnose in lupins - understanding the risk

Moin Salam, Art Diggle, Geoff Thomas, Mark Sweetingham and Bill O'Neill,
Agriculture Western Australia

KEY MESSAGES

A computer model, 'Anthracnose Tracer', has been developed to produce site and season specific information about management of anthracnose in lupins. The model calculates the day-to-day state of the disease during the whole growing season and allows the effectiveness of control strategies to be evaluated. Consultants, researchers and development officers will find that the model can help to address their particular problems.

The following questions have been addressed here and on the Crops Update CD to highlight the potential applications of the model:

- Why wasn't anthracnose a problem last (2000) year?
- How much crop damage can you expect in your area? How bad could it get in a bad year?
- Is it worth using clean seed if you have infected blue lupins on the fence line?
- How much good are fungicides and resistant varieties?

BACKGROUND

Since the outbreak of anthracnose in 1996, Agriculture Western Australia (AGWEST) scientists have made important progress in understanding the disease and its control. The results from this research have been incorporated in a computer model that predicts how the disease will spread. The model can handle any combination of weather, initial level of seed infection, variety, spread of the disease from outside, and control with fungicides, so it can be tailored for any situation.

In this paper we explore the potential impact of anthracnose in the Geraldton area. We look at the effect of variety, the effect of fungicides and the initial level of seed infection, the effect of blue lupins outside the paddock, and the reason why 2000 wasn't a big problem. On the CD for the conference we include results for many combinations of rainfall zone, variety, initial level of infection, average vs bad years, and presence or absence of blue lupins. In these results, you will be able to find situations that apply to you.

RESULTS AND DISCUSSION

Dry weather curbed the spread of anthracnose last season (2000). In the Geraldton area, the model estimates about a 10% loss in 1999 for the variety Belara with a 1 in 10,000 level of seed infection (Plate 1). This compares to < 1% loss in 2000 with the same variety and seed infection level (Plate 2). The difference in rainfall in the first month of the growing seasons explains most of this striking difference.

The level of seed infection has a profound effect on anthracnose damage. The model shows, based on Geraldton weather in 1998 (one of the worst years for anthracnose spread in that area), that a 1 in 10,000 level of seed infection would have produced over 15% loss in Myallie (Plate 4). For the extremes, 1 in 640,000 infection would have caused little loss (0.03%), and 1 in 1,000 would have caused total (100%) loss. A more resistant variety like Wonga would have suppressed the disease to a considerable extent (Plate 3 compared to Plate 4).

The presence of infected blue lupins on the fences especially in the up-wind direction can spoil the benefits of using clean seed. A 1 m wide infected blue lupin fence, 10 m west of the paddock, would have caused about 1% loss in Wonga, 6% in Belara and 9% in Myallie (Geraldton 1998 season). These levels of damage are comparable to those caused by 1 in 10,000 seed infection (Plates 3 and 4 for Wonga and Myallie). Plate 5 shows the combined effects of infected blue lupins in the fence and 1 in 5,000 seed infection in Belara. These conditions would have caused about 11% loss even with the use of 'thiram'.

Plate 1. Initial seed infection 1:10,000; 10% loss with 'Belara' in 1999

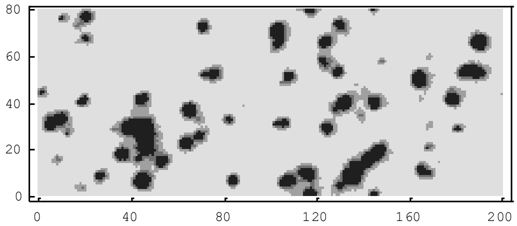


Plate 2. Initial seed infection 1:10,000; <1% loss with 'Belara' in 2000

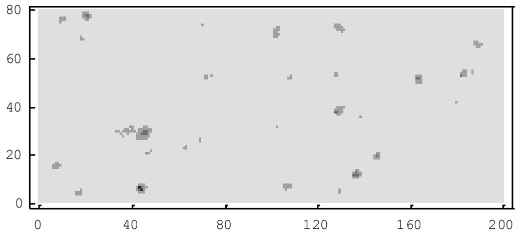


Plate 3. Initial seed infection 1:10,000; <1% loss with 'Wonga' in 1998

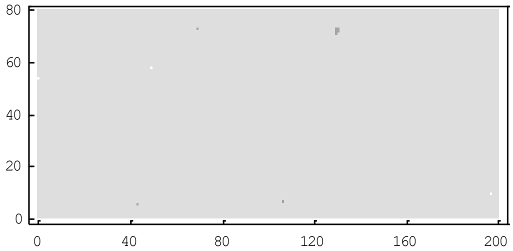


Plate 4. Initial seed infection 1:10,000; >15% loss with 'Myallie' in 1998

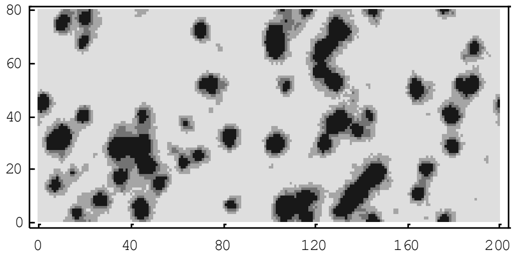
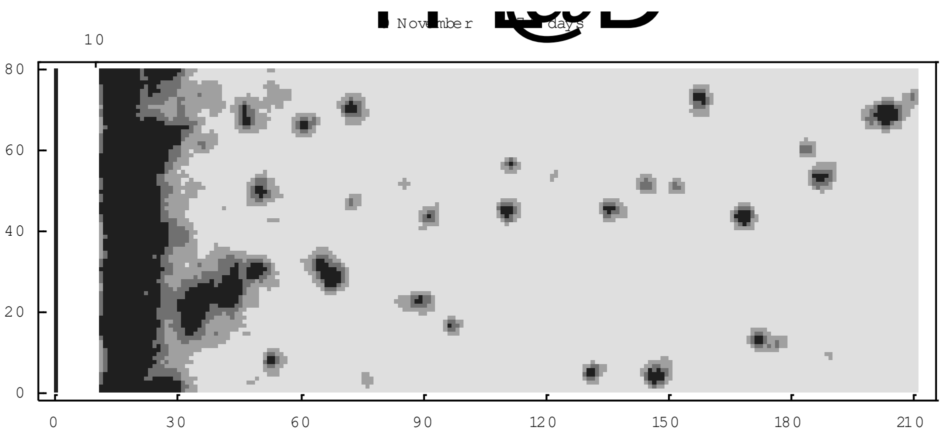
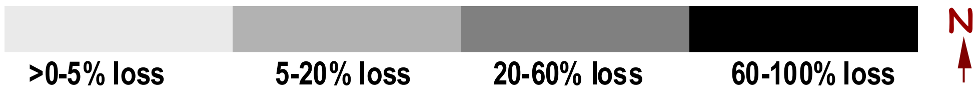


Plate 5. Infected blue lupins located 10 m from the paddock fence ; initial seed infection 1:5,000; recommended seed dressing with 'thiram' was used; >11% loss with 'Belara' in 1998





A BIT ABOUT THE MODEL

'AnthracnoseTracer' simulates splash of spores from infected to healthy plants in a lupin paddock. It uses hourly weather data to account for the wind speed, wind direction, and the variability in the wind throughout the season. The model takes into account the effect of temperature on the length of the latent phase of the infection, and it accounts for the effect of duration of leaf wetness on chance of infection. The model also estimates growth of new growing points by the lupins and the degree of compensatory growth when disease strikes. Disease status is described as the per cent loss of healthy (uninfected) lupin growing points in each 1 m^2 segment of a paddock. The model produces animated maps of the paddock through the growing season showing the intensity of the disease at each location. For the details of the model, see Diggle *et al*. (2001).

THE FUTURE

This model will be useful in providing location and season specific forecasts of anthracnose risk. These forecasts will make use of seed testing data from the AGWEST Plant Laboratories to indicate probable levels of infection of seed around the State, and as far as possible will use long range

forecasts to refine estimates of rate of spread early in the season. Seed tests reports may in future include reports of risk of loss that are tailored for the individual seed samples and the locations where they will be sown.

ACKNOWLEDGEMENTS

The Grains Research and Development Corporation (GRDC) provide the fund for this project. We thank several staff of Agriculture Western Australia for help, especially, Mike O'Connell for early development of the model, Dr Miles Dracup for information about growing point development in lupin, Mr Ken Adcock for data collection, Ms Fiona Gianoli for assistance with programming.

LITERATURE

Diggle, A.J., Salam, M.U., Thomas, G.J., Yang, H.A., O'Connell, M. and Sweetingham, M.W. (2001). AnthracnoseTracer: A spatio-temporal model for simulating the spread of anthracnose in a lupin field. Prepared for Phytopathology.

KEY WORDS

anthracnose, lupin, model, seed infection, blue lupin, seed treatment, rainfall pattern

GRDC Project No.: DAW 621

Paper reviewed by: Dr Bill Bowden

Effect of stubble, seeding technique and seed size on crop establishment and yield of canola

Rafiul Alam, Glen Riethmuller and Greg Hamilton, Agriculture Western Australia

KEY MESSAGE

Large seed is more reliable than normal seed for crop establishment and yield of canola.

AIM

Low plant density (< 60 plants/m^2), patchy establishment and/or uneven crop growth were recorded in 98% of the canola paddocks in a recent establishment survey across the Northern and Central Agricultural Regions. At seeding time, some seeds may fall into deeper and some may be trapped at shallower depths or soil surface depending on the crop residues, furrow opener, seed covering device, seed-bed conditions, sowing methods and seed size used. A series of field trials was undertaken to investigate the effect of stubble, seeding technique and seed size on crop establishment and yield of canola.

METHOD

An experiment was conducted with six seeding techniques with and without wheat stubble of previous crop at five sites (Table 1) in Northern Agricultural Region. The six seeding techniques were: (i) Narrow Point (NP; 50 mm wide; inverted T-shape), Press Wheel (PW; soft centred, 80 mm wide, chamfered 'V', set at 2 kg/cm press wheel width), Large seed (> 1.7 mm); (ii) NP, PW, Normal seed (ungraded); (iii) NP placing the fertiliser, seed tube attached directly in front of the PW followed by a finger tine to move some loose soil over the seed, Normal seed; (iv) NP, Loxton Rotary Harrow (LRH), Normal seed; (v) Full-cut Point (FP; 180 mm wide steel points), LRH, Normal seed; and (vi) FP, Seed top dressed in between the points and LRH, Normal seed. For the normal and large seeds, same number of Karoo seeds per m^2 were sown directly. The row spacing was 22 cm. The fertiliser banded about 3 cm below the seed.

Table 1. Five sites with soil type, soil moisture condition at seeding time, fertiliser and sowing date

Site	Soil type	Soil moisture condition at seeding time	Fertiliser (rate per hectare)	Seeding date
Maya	Sand	Top 7 cm dry, moist below	Agrich plus Impact-in-Furrow (80 kg)	4.5.00
Erregulla	Sand	Top 4 cm dry, moist below		3.5.00
Ogilvie-S	Sand	Top soil getting dry, moist below		2.5.00
Ogilvie-LS	Loamy sand	Just moist		2.5.00
Mingenew	Loamy sand	Moist soil	Agras No. 1 (120 kg)	15.6.00

RESULTS

Effect of stubble

There was no effect of stubble on grain yield and oil content. The stubble effect was statistically significant for seedling number/m^2 at Mingenew (Table 2). At this site, stubble was very long (40 to 55 cm) and some stubble were dragged off the trial site on the stubble retained treatment at the time of seeding. In this season, wheat leachate might have leached out through the sandy and loamy sand soils before seeding due to summer rain or might have been less due to the dry period during the seedling growth.

Effect of seeding technique

The seeding techniques significantly influenced: (i) the seedling number at all five sites; (ii) grain yield at four sites; and (iii) oil content at two sites (Table 3). Among the seeding techniques investigated, the narrow point, press wheels was the best, regardless of the seed size. Compared to full cut points, the narrow points disturbed less soil and consequently soil moisture evaporation was probably less

and produced a better seedbed. Compared to other seed covering techniques, the press wheels seemed to cover the seed better, improve seed-soil contact and harvest more rainwater.

Table 2. Mean seedling number/m², grain yield (kg/ha) and % oil over the six seeding techniques for stubble retained and stubble raked treatments at the five sites

Variable	Stubble	Maya	Erregulla	Ogilvie-S	Ogilvie-LS	Mingenew
Seedling no./m²	Retained	20.6	32.3	56.3	51.5	89.3 a
	Raked	19.0	40.1	59.9	50.8	81.0 b
Grain yield (kg/ha)	Retained	1722	1635	1852	1407	727
	Raked	1636	1725	1842	1514	675
% Oil	Retained	42.0	37.0	40.5	40.6	34.2
	Raked	42.1	37.7	40.8	41.2	34.0

Data followed by same letter are not significantly different.

Effect of seed size

Using the narrow point, press wheel seeding technique, the large seed produced a higher seedling number at four sites, higher grain yield at four sites and higher oil content at three sites than the normal seed (Table 3). Probably, small seeds of the normal seed supplied less food to seedling in a dry situation or ran out of its reserve during upward penetration of its seedling from a deeper position.

Interaction effect of stubble and seeding technique

Stubble interacted significantly with the seeding technique at the Erregulla site for the seedling number (data not presented). The narrow point, press wheel, large seed seeding technique with stubble raked treatment produced the highest seedling number/m² (89.3). At this site, long melon vines blocked the seeder on few occasions at seeding time.

Table 3. Mean seedling number/m², grain yield (kg/ha) and % oil over stubble retained and stubble raked treatments for six seeding techniques at the five sites

Seeding technique	Maya	Erregulla	Ogilvie-S	Ogilvie-LS	Mingenew
Seedling number/m²					
NP, PW, large seed	38.8 a	74.8 a	71.0 a	60.6 ab	98.7 a
NP, PW	37.7 a	61.5 b	68.2 a	65.3 a	87.6 bc
NP, LRH	17.8 b	19.7 c	64.0 ab	58.3 ab	81.9 c
NP, Seed pressing	13.5 b	22.5 c	60.4 ab	52.0 b	91.3 ab
FC, LRH	7.2 c	26.3 c	56.1 b	35.5 c	72.0 d
FC, Top dressed	3.8 c	12.2 d	29.0 c	34.8 c	79.4 cd
Grain yield (kg/ha)					
NP, PW, large seed	1984 a	2015 a	1878 a	1563 a	724
NP, PW	1979 a	1911 a	1941 a	1474 a	718
NP, LRH	1787 b	1576 b	1907 a	1552 a	705
NP, Seed pressing	1640 c	1536 b	1878 a	1550 a	716
FC, LRH	1412 d	1649 b	1846 a	1356 b	693
FC, Top dressed	1270 e	1392 c	1633 b	1269 b	651
% Oil					
NP, PW, large seed	42.3 a	38.2	40.7	41.1 a	34.0
NP, PW	42.4 a	37.8	40.8	41.0 ab	34.1
NP, LRH	42.1 ab	37.3	40.7	41.1 a	34.2
NP, Seed pressing	41.9 bc	36.8	40.8	41.4 a	34.0
FC, LRH	41.8 c	37.3	40.3	40.4 bc	34.5
FC, Top dressed	41.6 d	36.9	40.8	40.5 c	33.8

For each character, data followed by same letter are not significantly different in each column.

At Mingenew, improved crop establishment and reduced grain yield may have been due to sufficient soil moisture at seeding time and the late sowing, respectively. At harvest, a few branches of some plants in the plots were green at Erregulla and Mingenew. Harvesting may have been done a few days earlier than the optimum time, which may be the reason for the reduced oil content at these sites.

CONCLUSION

Previous wheat crop stubble did not influence crop establishment and grain yield in the season 2000. The narrow point, press wheel was the best among the seeding techniques investigated, which will be investigated with popular and advanced seeding techniques and possibly with an increased number of stubble treatments. Using the narrow point, press wheel seeding technique, the large seed produced a higher number of seedlings and higher grain yields at four of the five sites than the normal seed.

GRDC Project No.: DAW 625 WR

Paper reviewed by: The authors

Canola - More responses to lime

Chris Gazey and Paul Carmody, AGWEST, Centre for Cropping Systems, Northam

KEY MESSAGE

Although canola is known to be highly responsive to lime further testing has shown yield responses are more likely on soils with pH < 4.5 and where lime has been applied 2 to 4 years prior to the canola. Responses to lime can be anticipated for up to 9 years after application.

In 2001, plant canola on paddocks where lime has been applied previously (2 to 4 years).

INTRODUCTION

For the past decade in WA research into canola responses to lime have been about as exciting as they can get. This paper reviews this work and reports on more recent results in 1999 and 2000. It forms part of a larger project for studying lime in the system which uses both small plot trials and large scale demonstration sites to illustrate the benefits of lime. Lime is a good investment. By correcting soil acidity it encourages better root growth and exploration. Growers are pushing the limits of canola's tolerance to low soil pH as production packages become more refined. Canola is more sensitive to low pH than crops such as wheat and lupins. However reasonable crops of 1.0 to 1.2 t/ha are being grown on soil with very low pH (e.g. 4.3 in 0-10 cm and 3.9 in the 10-20 cm, measured in Calcium Chloride). Increasing soil acidity is a long term problem and with rising costs, canola is proving itself to be one of those crops which will realise your returns on investment sooner for the lime you apply. But how much is this worth?

METHODS

During 1999 and 2000 three old lime trials were sown with canola. One at Varley (Bruce Hill's property), one at Mullewa (Desmond's property) and a third at Buntine (Kim Diamond's property). All paddocks have been a part of a wheat-lupin-canola rotation. In 1999 at Buntine on the large scale site canola was sown across three treatments of lime applied in 1996. At Mullewa last year large plots of Karoo canola were sown across 1996 treatments of nil, 1 and 2 tonnes of lime. The 1994 trial at the Lake Varley site was sown by the farmer in 2000 as part of the paddock and then individual plots were harvested using a small plot harvester. Trials were assessed for grain weight using a weigh trailer or a plot harvester depending on the site. Soil pH_{CaCl2} measurements have been made at all sites each year since each trial was established.

RESULTS

Yield increases in canola have been observed in most trials with lime (Table 1), regardless of the amount of time that the lime had been applied. This was despite the fact that the subsurface pH was still quite acid. Early growth responses were observed and these persisted during the season for all trials except the lime trial established in 1996 at Varley (96LG7) which also gave significant grain increases.

Table 1. Canola grain yields (t/ha) for various lime trials over last three seasons

Lime rate (t/ha)	Trial (year lime applied)			
	Canola 1996	**Canola 2000**	**Canola 1999**	**Canola 1997**
	94LG17 (1994)	**94LG18 (1994)**	**96TS3 (1996)***	**96NA3 (1996)**
0.0	1.29 a	1.85 a	0.74 a	1.32 a
0.5	1.42 b	1.92 ab	N/T	N/T
1.0	1.55 c	1.92 ab	0.99 b	1.46 b
2.0	1.69 d	2.01 bc	0.86 ab	1.60 c
4.0	1.67 d	2.11 c	N/T	N/T
lsd		0.15	0.18	

Numbers in the same column with the same letter are not significantly different $p < 0.05$).

N/T: No treatment at this level of lime was made at this site.

* Additional lime treatments of Dolomite and G-Lime were also used in trial 96LG7. Dolomite was less effective than G-Lime which was less effective than Lime Sand. However all amendments increased canola grain yield above the un-limed treatment. Neutralising Values of amendments: Lime 97% NV, Dolomite 67% NV, G lime 100% NV. Rates were adjusted to account for the lower NV of this product to allow for a fair comparison.

The pH results for two of the trials are presented below (Table 2a, b) in the Narrogin trial (96NA3) there was an increase in soil pH below the zone of incorporation (0-10 cm). There was also a significant increase in the pH in the 10-20 cm layer at Varley seven years after the lime was applied and there was a similar increase at Buntine four years after the lime was applied.

Table 2a. pH measured in 0.01M $CaCl_2$ in 1999 for 96TS3, (lime spread in 1996)

Depth	0 (t/ha lime)	1 (t/ha lime)	2 (t/ha lime)	Stats (lsd) 5%
5-10 cm	4.39	5.64	6.48	0.50
10-20 cm	4.11	4.50	4.74	0.53
20-30 cm	4.16	4.57	4.43	0.40

Table 2b. pH measured in 0.01M $CaCl_2$ in 2000 for 94LG18, (t/ha lime spread in 1994)

Depth	0	1 0	2 0
0-10 cm	4.52	5.17	5.21
10-20 cm	4.17	4.44	4.60
20-30 cm	4.68	4.74	4.78

DISCUSSION OF RESULTS

The above data is not a summary all the lime trials in which canola was planted. The most recent applications of lime (1998) did not show a response in 2000 and this possibly due to the dry conditions not allowing the neutralising effect of the lime on the surface to occur. Amazingly, the Lake Grace site where lime was applied in 1994 continues to show the greatest responses of all the sites. Here the pH ranges from 4.75 on the surface to 4.43 at depth whereas at Mullewa it ranges from 5.28 to 4.25 at depth and no significant response was detected there in 2000. The Narrogin site has a more consistent pH down the profile around 4.70 similar range and gave a immediate response the year after application.

Purely from a canola point of view the investment into lime at Varley has been highly profitable, at this site canola in 2000 has virtual paid for over one tonne of lime ($45/ha). Some simple costs for lime are summarised in Table 3.

Table 3. Cost of lime in the three major regions of the wheatbelt

	Southern	Central	Northern
Lime price	$5.30	$5.30	$5.30
Freight cost	$34.00	$20.00	$9.00
Spreading costs	$8.00	$8.00	$8.00
Total lime cost per tonne	**$47.30**	**$33.30**	**$22.30**

When evaluating lime it is important to consider the particle size, it's neutralising value, and the grade of lime and therefore this table is a simplification of the true cost of lime in the different regions of WA.

No benefit can be attribute to oil bonus. Where oil contents have been done no significant differences could be detect between treatments. In future a closer look at the effect of lime on diseases in canola, like blackleg or damp off diseases, could be more important (Arshad *et al*. 1997).

The longer the lime has been down the better the investment looks for canola responses. According to a commercial operator[1], although none of their sites gave response to lime in 2000 in canola, one site at Wongan Hills where lime was applied 13 years ago gave a significant response in 2000.

A more detail economic analysis of the benefits of lime in the system will be presented at the 2001 AGWEST Crop Updates.

CONCLUSION

On average canola responding to lime ranges from 0.1 to 0.26 tonnes per hectare for applications of 1 tonne from 2 to 9 after the application has been made. In the year canola is grown this amounts to $30 to $75 alone, but the benefit carries across all crops in the system. Only a few trials have had oil contents measured on them and there appears to be no relationship with oil and lime at this stage. This work further consolidated the importance of applying lime to canola on those soils which tend towards more acidity (< 4.5 pH).

While previous work suggested that in some cases you can get an almost immediate response to lime from canola, this is very dependant on the seasonal conditions and the baseline acidity you are beginning with.

The benefits of lime for canola paddock is clear where the pH is low. Although tight cash flows in 2000/2001 means only the very 'hottest' of paddock should be considered for liming in 2001 and seeding these to serradella or pasture. Canola should be grown only on those paddocks that have had lime 2 to 4 years ago to ensure a benefit this year. Growers not only should be looking at these potential short term responses but also understand that lime has a long residual value and reapplication is usually only required once every five to seven years. The other obvious benefit of managing acidity is the wider choice of crops available to be grown, including barley and acid sensitive wheat varieties, allowing for a more profitable and sustainable rotations.

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Performance of new canola varieties in AGWEST variety trials in 2000

G. Walton, Crop Improvement Institute, South Perth, from Crop Variety Trials

KEY MESSAGE

When choosing a variety, the performance characteristics to be considered are the potential yield for your environment, which includes having a suitable maturity to match the length of the growing season and the level of blackleg resistance desirable for the paddock situation.

INTRODUCTION

Over the past two years a great number of new canola varieties have been released. The first opportunity of comparing these new varieties together in trials occurred in 2000. The season was difficult for crop performance and yields, with, in most regions, a late start to seeding, low rainfall during the season plus the damage to crops by insects, particularly in the northern region.

This summary records the relative performances of the new varieties in the season 2000, performances that have been influenced by interaction between variety maturity and low rainfall. In other years of better rainfall and earlier sowing, the performances of yield and oil may alter, especially in favour of the mid-maturity varieties. Looking ahead, the results of these trials will be incorporated into the databank available from all trials conducted in previous years to provide a consistent analysis of variety performances.

DESCRIPTION OF SOME CHARACTERISTICS OF THE NEW VARIETIES

Triazine tolerant varieties in comparison with Karoo

Variety	Height	Maturity	Oil concentration (1, low – 9, high)	AGWEST blackleg rating[1]
Hylite 200TT	Short	Early	7	2
Surpass 300TT	Medium - short	Early	7	N/A[2]
ATR-Hyden	Medium	Early - medium	6	5P
Surpass 501TT	Medium	Early - medium	7	N/A
Beacon	Medium	Early - medium	6	4P
Surpass 600TT	Tall	Medium - late	7	5
TM 8	Medium	Medium - late	6	5P
ATR-Grace	Medium	Late	6	N/A
Karoo	Medium - short	Early - medium	5	4

[1] The AGWEST ratings for resistance to blackleg combines both the plant survival and stem canker scores. 1 = highly susceptible, 8+ = highly resistant.

[2] Surpass 300TT has shown poor plant survival scores, select with caution.

N/A; Rating not available because of insufficient data.

P; Rating is Provisional, based on a minimum of data.

Imidazolinone tolerant varieties in comparison with Karoo

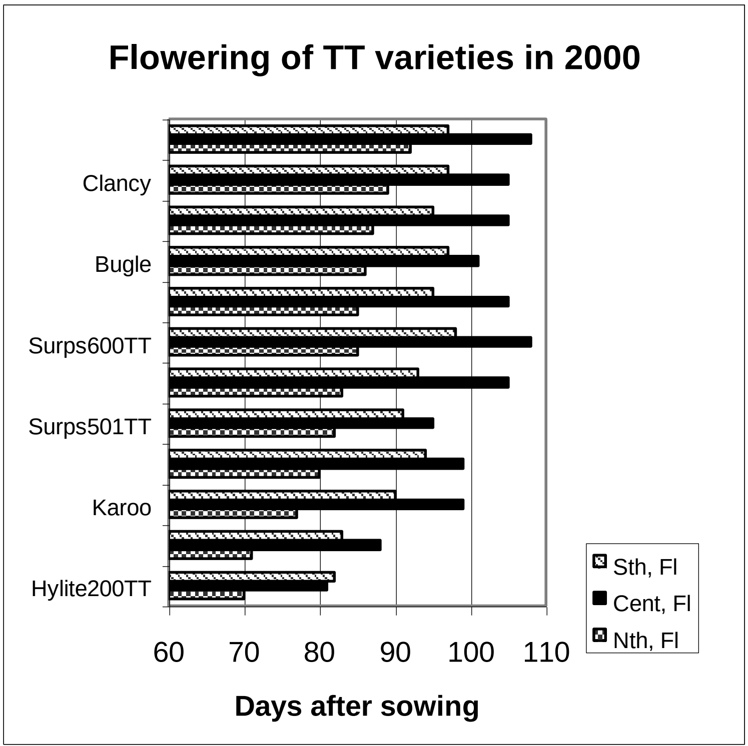
Variety	Height	Maturity	Oil concentration (1 – 9; low – high)	AGWEST blackleg rating[1]
Surpass 402CL	Medium - tall	Early - medium	*	8+
44C73		Early - medium	7	N/A
Surpass 603CL	Medium	Medium	*	8+
44C71	Medium - short	Medium	6	4
46C72	Medium - short	Medium	7	4
46C74		Medium - late	6	N/A
Karoo	Medium - short	Early - medium	5	4

* High oil potential.

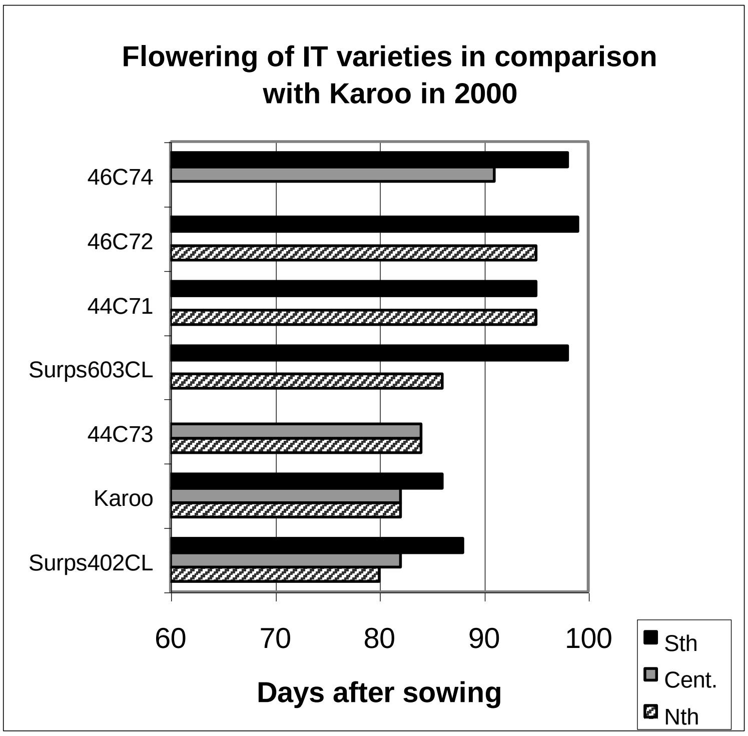
Non-herbicide tolerant varieties in comparison with Monty and Oscar

Variety	Height	Maturity	Oil concentration (1 – 9; low – high)	AGWEST blackleg rating[1]
Georgie	Medium - short	Early - medium	7	4P
Surpass 400	Medium - tall	Early - medium	8	8+
Ag-Outback	Medium	Early - medium	5	4P
Ag-Emblem	Medium	Early - medium	6	6
46CO3	Medium	Early - medium	6	N/A
Trooper	Medium - tall	Medium - late	7	5
Hyola 60	Medium - tall	Medium - late	8	8+
Insignia	Medium	Medium - late	8	6P
Purler	Medium	Medium - late	8	7
Ripper	Medium - tall	Medium - late	8	6P
Surpass 600	Medium	Medium	6	6
Oscar	Medium	Medium	5	6
Monty	Medium - short	Early	6	5

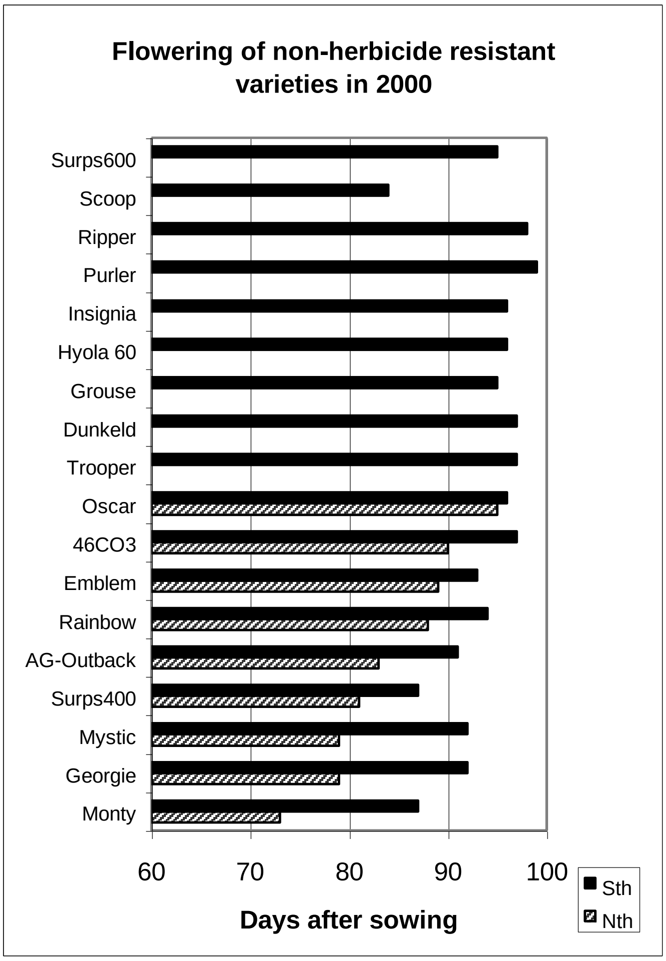
Flowering dates of the varieties were recorded on many trials, histograms showing the differences in days after sowing that 50% of plants had first flowers are presented for the different types of herbicide tolerance. The flowering differences are recorded for the north, central and south agricultural regions.



North region includes the Geraldton district out to Mullewa and Coorow.



Central region includes Badgingarra and Wongan Hills.



South region includes Katanning and Esperance.

GRAIN YIELD

A summary of the yield of varieties is presented as relative (percentage of) to Karoo for the herbicide resistant varieties and to Oscar for the non-herbicide resistant varieties. The yields are grouped into geographic regions and average annual rainfall zones.

Triazine tolerant varieties in the northern region

Variety	High	Medium	Low
Karoo	100	100	100
Beacon	100	100	79
Hyden	121	101	79
Bugle	87	81	31
Clancy	75	74	25
Drum	72	66	44
Hylite200TT	74	81	116
Pinnacle	86	72	38
Surps300TT	83	83	128
Surps501TT	91	106	119
Surps600TT	92	82	40
TM8	96	78	58
No. trials	1	3	1
LSD, p = 0.05	15	16	28

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

Triazine tolerant varieties in the central region

Variety	High	Medium	Low
Karoo	100	100	100
Beacon	118	102	101
Hyden	108	80	103
Bugle	90	59	74
Clancy	93	77	76
Drum	89	71	68
Hylite200TT	65	94	96
Pinnacle	97	54	70
Surps300TT	85	90	106
Surps501TT	110	101	78
Surps600TT	100	65	71
TM8	99	94	96
No. trials	2	3	2
LSD p = 0.05	14	25	20

Trials located at Badgingarra, York, Wongan Hills, Meckering, Kunjin (sown between 8 May and 15 June) and Merredin and Karlgarin (sown 18 and 31 May).

Triazine tolerant varieties in the southern region

Variety	High	Medium
Karoo	100	100
Beacon	121	119
Hyden	115	114
Bugle	96	88
Clancy	96	98
Drum	85	93
Hylite200TT	79	101
Pinnacle	107	100
Surps300TT	90	99
Surps501TT	95	114
Surps600TT	99	87
TM8	105	116
No. trials	2	4
LSD p = 0.05	13	15

Trials located at Esperance Downs (sown 9 May), Kendenup (sown 19 June), Newdegate, Wittenoom Hills, Ravensthorpe and Katanning (sown between 10 May and 14 June).

Imidazoninone resistant varieties in the north, central and south regions

	North	Central		South
Variety		Medium	Low	Medium
44C71	58	93	135	125
44C73		164		168
46C72	40	54	122	75
46C74		115		120
Surps402CL	162	113	92	126
Surps603CL	115		115	138
Karoo	100	100	100	100
No. trials	2	6	1	3
LSD p = 0.05	80	30		25

Trials located in north at Coorow and Mullewa (sown 15 may and 15 June), in central at Meckering, Kunjin, Avondale and Wongan Hills (sown between 31 May and 7 June), in south at Katanning and Wittenoom Hills (sown 14 June and 10 may).

NOTE: The comparison of varieties in these trials have been conducted without the use of the triazine or imidazolinone herbicide systems.

Non-herbicide tolerant varieties in the north, central and south regions, with medium to low annual rainfall

	North	Central	South
Variety	Medium	Medium-Low	Medium
Mystic	144	128	101
Monty	137	158	99
Surps400	136	120	115
Ag-Outback	133	174	126
Georgie	112	129	100
Oscar	100	100	100
Rainbow	96	106	99
Emblem	87	127	96
46CO3	86	84	82
No. trials	1	3	2
LSD p = 0.05	27	28	27

Trials in north located at Coorow (sown 15 May); in central region located at Meckering and Kunjin (sown 3 and 7 June), in south located at Katanning and Wittenoom Hills (sown 14 June and 10 May).

Non-herbicide tolerant varieties in the central and south regions, with high rainfall

	Central	South
Variety	High	High
Grouse	111	106
Hyola 60	111	97
Oscar	100	100
Rainbow	99	106
Ripper	98	92
Scoop	96	80
Dunkeld	95	93
Surps600	93	86
Trooper	92	87
Purler	91	88
Insignia	84	94
No. trials	1	4
LSD p = 0.05	12	30

Trial in Central region at York (sown 6 June), trials in the south at Bridgetown, Katanning, Boxwood Hills and Esperance Downs (sown between 4 May and 14 June).

NEW VARIETIES SHOWING GOOD YIELD AND BLACKLEG CHARACTERISTICS IN 2000

Triazine tolerant

North and central regions; low to medium annual rainfall:
Hyden, Surpass 300TT, Surpass 501TT.

North and central regions; high annual rainfall:
Hyden, Surpass 501TT, Surpass 600TT.

Beacon gave good yield, but should not be used where the incidence of blackleg is likely to be high.

South region, high and medium annual rainfall:
Pinnacle, Hyden, TM 8, Surpass 501TT, Surpass 600TT.

Imidazolinone tolerant

All imidazolinone tolerant varieties gave good yields relative to Karoo in the Central and South regions (in the absence of in-crop herbicide). The main consideration when choosing a variety will be the blackleg resistance rating.

In the North region, the Surpass 402CL and Surpass 603CL were clearly superior.

Non-herbicide tolerant

In North and Central regions, the early-medium maturity varieties of Mystic, Monty, and Surpass 400 performed well. Ag-Outback and Georgie gave good yields but have lower resistance to blackleg disease.

In the South and Central regions, the medium-late maturity varieties Hyola 60, Grouse, Rainbow and Ripper performed the best.

GRDC Project No.: DAW 486

Paper reviewed by: Christine Zaicou-Kunesch

The ascochyta management package for 2001

B. MacLeod, AGWEST, Northam

There are two major influences on the final level of ascochyta, and yield loss, in a chickpea crop in the absence of a fungicide management program. The first is the number of infected seedlings in the crop in the first two weeks after emergence (whether these are from seed-borne or stubble-borne sources). The second is the number of cycles of multiplication, which occur in the crop, this is roughly equivalent to the number of rain events, which occur between emergence and harvest. These two factors will also determine the cost and success of the fungicide management program.

The regional zones given below for seed quality have been based on the average number of rain-days for the June-September period. The zones are based on the CVT areas familiar to most farmers. The lowest number of rain-days occurs in the L1 CVT area and the highest number in the H5W. It should be noted that annual rainfall is not always directly related to the number of rain days.

PADDOCK SELECTION

Only grow chickpeas in paddocks with suitable soils as the yield from marginal soils may not be adequate to recover the costs of establishing a chickpea crop and managing ascochyta with a fungicide spray program. Keep a three year break between chickpea crops in a paddock (i.e. 1:4 rotation) to minimise the carry-over of stubble-borne infection. For the year 2001 chickpea crops, paddock separation from 2000 and 1999 stubbles is far more important than rotation. The level of ascochyta blight present in 1997 and 1998 chickpea crops was low and almost all infection potential will have broken down prior to sowing the 2001 crop.

PADDOCK SEPARATION

Only sow chickpeas into paddocks that are at least 500 m from 2000 stubble. This distance should be increased where the selected paddock in relation to the 2000 stubble, is down-wind for the prevailing wind or strong summer/autumn winds.

SEED SOURCE

Ascochyta blight is a seed borne disease so select seed with the lowest risk of disease. Low risk seed is not guaranteed 100% free from ascochyta.

SEED TESTING

Test all seed for ascochyta (AGWEST Plant Laboratories will be using a DNA test available through SARDI - this is the only test with adequate sensitivity at present). The results from tests conducted for the 2000/01 season will be reported in three categories; Undetected (< 0.01%), Low infection (0.01-0.25%), High infection (> 0.25%).

SEED QUALITY AND INFECTION RISK FOR CHICKPEA GROWING ZONES IN THE 2001 GROWING SEASON

ZONE 1 (L1 & L2): Ascochyta has been seen in many crops in this zone so a significant risk exists of crops becoming infected from the previous year's stubble. The average number of rain days is lowest in this zone, therefore the multiplication from seed borne infection will be least. Seed with up to 0.25% infection can be used, but clean seed is preferred.

Zone 2 (M1, M2, M3 & L3): Ascochyta has been seen in many crops in this zone so a high risk exists of crops becoming infected from the previous year's stubble. Multiplication from seed borne infection alone is sufficient in this area to result in crops being wiped-out if disease spread is not restricted by a foliar fungicide program. Seed in which ascochyta is undetectable (i.e. < 0.1%) is preferred. Seed with up to 0.25% infection can be used if sowing is delayed to the end of the recommended sowing window.

Zone 3 (L4, L5, M4 & M5E): Ascochyta has been seen in chickpea crops in the eastern half of this zone, however the majority of the zone remains free of ascochyta. Multiplication from seed borne

infection alone is sufficient in this zone, in an average year, to result in crops being wiped-out if disease spread is not restricted by a foliar fungicide program. Only seed in which ascochyta is undetectable (i.e. < 0.1%) should be sown.

Zone 4 (M5W, M5C, H1, H2, H3, H4 & H5): Ascochyta has been severe in crops in the northern half of this zone, it has also been detected in some crops in the southern half of this zone. An initial low level of infection from stubble or seed-borne infection is sufficient in this area to result in crops being wiped-out. To control ascochyta in desi varieties in this zone will require a strict foliar fungicide program which may amount to six to eight applications in an average year. Kabuli varieties should be considered, because the potential returns are greater in suitable soil types. Only seed with in which ascochyta is undetectable (i.e. < 0.1%) should be sown.

CROP HYGIENE

Undertake a program of stubble reduction (i.e. burning, cultivation, grazing) to minimise the carry-over of stubble borne infection. Ensure stubble from the 1999 crop is not moved to the year 2001 chickpea paddock by vehicles or moving stock.

VARIETY SELECTION

Select varieties which have the lowest level of susceptibility to ascochyta blight if new seed is being purchased (Table 1). However, it is not recommended that growers change their varieties based solely on the relative susceptibility of the chickpea variety to ascochyta blight, because a fungicide spray program is essential to achieve satisfactory yield regardless of the variety grown.

Table 1. Chickpea variety susceptibility to ascochyta blight

Disease rating	Desi	Kabuli
Extremely susceptible	Lasseter, Gully, Norwin, Desavic, Semsen	
Highly susceptible	Heera, Tyson, Barwon	Garnet, Kaniva, Bumper
Moderately susceptible	Sona, Dooen, Amethyst,	
Resistant	None	None

SEED DRESSINGS

Seed should be treated with P-Pickel T®. This product has proven better than thiram alone.

TIME OF SOWING

Delaying the time of sowing of chickpea crops will minimise the multiplication of ascochyta blight and may reduce the number of fungicide applications required. Varieties should be sown during the recommended sowing window for each region (Table 2).

Table 2. Time of sowing recommendations for chickpea

Region	CVT areas	Desi sowing window	Kabuli sowing window
North			
Low rainfall	L1	15 May - 30 May	Not recommended
Medium rainfall	M1	1 June - 15 June	25 May - 10 June
High rainfall	H1	Not recommended	1 June - 15 June
Central			
Low rainfall	L3	15 May - 10 June	Not recommended
Medium rainfall	M3	20 May - 15 June	25 May - 15 June
High rainfall	H3	Not recommended	1 June - 20 June
South			
Low rainfall	L4	20 May - 15 June	Not recommended
Medium rainfall	M4	5 June - 20 June	
Medium rainfall 2	M4,M5	Not recommended	5 June - 20 June
South E			
Medium rainfall	M5E	25 May - 15 June	Not recommended

Note: Desi chickpeas are not recommended for the high rainfall zone.

FUNGICIDE APPLICATIONS

Coverage is important so high water volumes are recommended (100 L/ha for ground equipment, and 30 L/ha for aircraft), maintain high pressure to ensure atomisation of spray. A brochure produced by Pulse Australia, 'Strategies for the control of foliar diseases in chickpeas (2001)', provides more information on fungicide application and nozzle selection.

Spray 1. 4 weeks after emergence. 1.5 L/ha* Bravo® (720 g/L chlorothalonil).

***Spray 2*.** 3 weeks after first spray. 1.5 L/ha* Bravo® (720 g/L chlorothalonil).

Zone 1 (L1, L2) Monitor crop for ascochyta blight. Use the guidelines given under Spray five to determine the required fungicide application strategy.

***Spray 3 (Zone 2, 3 & 4)**.* Three weeks after second spray. 1.5 L/ha Bravo® (720 g/L chlorothalonil).

Zone 2 & 3 (L3-5, M1-4, M5E) Monitor Crop for ascochyta blight. Use the guidelines given under Spray five to determine the required fungicide application strategy.

Spray 4 (Zone 4). Three weeks after third spray. 2.0 L/ha Bravo® (720 g/L chlorothalonil).

Monitor crop for ascochyta blight. Use the guidelines below to decide the required strategy.

Spray 5, etc. Spray at three weekly intervals if required until the crop reaches maturity. The product and rate of fungicide to be applied will be determined by the disease level in the crop and the intensity and frequency of rain likely to occur during the next two to three weeks:

- If ascochyta is conspicuous in a crop (i.e. patches are evident or an infected plant can be found every one or two paces when inspecting the crop) and two substantial fronts are likely during the next two weeks, then 2 L/ha of Bravo® is recommended.
- At the other extreme, where ascochyta is only present at very low levels (no patches evident and only one infected plant is found in 10 or more paces when inspecting a crop) and low in the canopy. No spray would be required if the forecast were for a brief front. Two kg/ha mancozeb may be appropriate where a single substantial front is forecast to be followed by an extensive dry period.

Fungicides should only be applied just prior to a rainfall event. Therefore, if rain is forecast for 20 days after the last fungicide application, spray on day 18 or 19 to avoid the strong pre-frontal winds that accompany rain-bearing patterns in WA. If no rain is forecast at the end of the three week period, delay the next fungicide application until just prior to the next forecast event.

* In zone 1 (L1 & L2), Bravo® may be applied at 1.0 L/ha for the first two applications if the disease pressure for the crop is low and exceptional rain events are not forecast.

MACHINERY HYGIENE

It is important to clean down ground spraying rigs before moving between chickpea paddocks to minimise the risk of spreading ascochyta.

Herbicide tolerance of new field pea varieties and lines

ESPERANCE REGION

M. Seymour, AGWEST, Esperance

The WA breeding program has a number of new dun field pea lines close to commercial release. Two trials were conducted in the Esperance region at Scaddan (00ES23, topsoil pH 8 in water) and Beaumont (00ES24, topsoil pH 7.5 in water) to evaluate the safety of commonly used herbicides on field pea varieties grown on alkaline mallee soils.

The lines tested were Dundale, Parafield, Helena, WAPEA2074 and WAPEA2127. The treatments consisted of six herbicides applied either immediately before sowing (IBS) or post sowing pre emergent (PSPE) (Table 1). At the 3-5 node stage plots were split to include a plus or minus treatment with a Brodal/Lexone® mix treatment.

At both sites there were very few weeds present. The main weed was wild mustard, which was only present in the interplot spaces. There was no visual damage caused by herbicide application in any plot in either trial.

At Scaddan, Dundale produced the least seed yield, and there was no difference in seed yield between Parafield, Helena and WAPEA2127. No herbicide treatment had any significant effect on seed yield, so only the variety data is shown (Table 2). The new line WAPEA2074 and Parafield produced good quality seed (Table 2). Helena produced smaller seeds and more screenings using a 7 mm screen, but achieved the current delivery standard for No.1 milling grade peas of 97% above a 4.76 mm round sieve.

Table 1. Herbicide treatments evaluated at Scaddan and Beaumont

IBS or PSPE treatments	Rate (mL/ha)	Timing
Unsprayed	Nil	
Bladex®	2000	IBS
Diuron	2000	IBS
Lexone®	300	PSPE
Spinnaker®	150	PSPE
Spinnaker®/Diuron	150/1000	PSPE

Table 2. Seed yield,mean seed weight (MSW, g/100 seeds) and screenings for field pea varieties at Scaddan (00ES23) sown 2 June

Variety	Seed yield kg/ha	Screenings (%)			MSW
		> 7 mm	4.76 to 7 mm	> 4.76 mm	
Dundale	1323	18	81	99	16.5
Helena	1516	6	94	99	14.5
Parafield	1575	59	41	100	20.8
WAPEA2074	1525	56	44	100	20.2
WAPEA2127	1468	40	60	100	17.1
LSD 5%	77	6	6	0	2.2
CV%	3	6	3	0.1	3

At Beaumont the herbicide treatments had no effect on seed yield ($P > 0.05$), however the application of Brodal/Lexone® increased yield despite low weed levels (Table 3). Seed yields were low due to a combination of late sowing in a dry year and budworm damage. Observations close to harvest indicated Parafield was more affected by budworm than other lines. The early maturing line WAPEA2127 produced the greatest seed yield at this site and has shown good potential at other low rainfall regions of the mallee in 2000.

The results of these trials indicate that the new Dun field pea lines react in a similar manner to Dundale for the herbicides evaluated.

Table 3. Seed yield (kg/ha) of field pea varieties treated with post emergent herbicides at Beaumont (00ES24) sown 29 June

Variety	Seed yield		Mean seed yield
	Nil	Post emergent[a]	
Dundale	429	490	460
Helena	534	593	564
Parafield	440	536	488
WAPEA2127	590	643	616
WAPEA2074	407	447	427
Mean	480	542	
LSD 5%	Variety	33	
	Post emergent	61	
CV%	22		

[a] Brodal 60 mL/ha + Lexone 60 mL/ha (applied at the 5 node stage on 10 August).

MULLEWA

H. Dhammu and T. Piper, AGWEST, Northam, **D. Nicholson**, AGWEST, Geraldton and **M. D'Antuono**, AGWEST, South Perth

Trials during 1999 showed some sensitivity of new field pea varieties to registered herbicides. This trial was intended to further evaluate these sensitivities. The site was a red sandy loam soil at Mullewa, well suited to field peas. The herbicide mixes tested were aimed at achieving the best chemical weed management practice (Table 4). Seven varieties were sown on 30 June 2000 in 20 m wide strips parallel to each other. Herbicides were applied across these strips in three randomised blocks. Half of the trial strip (10 m) of each variety was sprayed with Brodal 100 mL + Lexone 100 g/ha when the field peas were at 3-5 nodes. No post-emergent treatment was scheduled for the other half of the strip, but after a high density of brassica weeds appeared, it was sprayed with Brodal 100 mL/ha when field peas were at the 4-6 node stage.

In summary, the results indicate that:

- With no pre-emergent treatment, field pea yielded slightly more when treated with Brodal + Lexone compared to Brodal alone, except for Helena. This is probably a reflection of its greater efficacy on radish.
- Bladex, Diuron, Spinnaker, and their combinations were generally safe. Diuron reduced the yield of Parafield significantly (2 L/ha), but at 1.5 L/ha plus Bladex, there was no effect. These results are consistent with previous years.
- Lexone caused significant yield reductions in all except Cooke and Parafield, both alone and in mixtures. This is consistent with previous results, except that King was then more tolerant than Cooke.
- Brodal/Lexone applied post-emergent caused no crop damage, provided that Bladex and/or Diuron had not been used pre-emergent, except for WAPEA2074. This result is in contrast to previous results where Brodal/Lexone has been a very safe option.
- Spinnaker as immediately post planting (IPP) followed by post-emergence application of Brodal + Lexone reduced the yield of King, Magnet, Helena and Parafield. Spinnaker + Diuron applied IPP followed by Brodal + Lexone also reduced the yield of Parafield and WAPEA 2127 significantly.
- Cooke, Magnet and WAPEA2127 tolerated all the herbicides applied IPP well, while King tolerated everything except Lexone, and Parafield tolerated all, except Diuron. This contrasts somewhat with previous results, where King has been generally more tolerant than Cooke or Magnet.
- Spinnaker/Diuron remains the best overall recommendation, both for safety and efficacy.
- The use of Brodal/Lexone for post-emergent radish control must be considered carefully, given the crop damage observed in this trial when used following pre emergent herbicides. This result may be due to the very short growing season, which did not allow the crop to fully recover from any crop damage caused by this mixture.

Table 4. Herbicide effects on yields of field pea varieties (% of untreated in all varieties except % of Bladex in WAPEA 2074) at Mullewa (00MW32)

Trt[a]	Herbicide treatment	King[b]	King[c]	Magnet[b]	Magnet[c]	Cooke[b]	Cooke[c]	Helena[b]	Helena[c]	2074[b]	2074[c]	2127[b]	2127[c]	Parafield[b]	Parafield[c]
1	Untreated (kg/ha)	100	100	100	100	100	100	100	100	85	116	100	100	100	100
		472	512	803	855	626	647	748	629	491	744	878	895	741	802
2	Bladex 2.0 L[d]	111	99	102	92	116	98	93	98	580[e]	641[e]	104	111	110	111
3	Diuron 2.0 L	93	91	87	90	112	100	99	87	102	115	103	102	**87**	90
4	Lexone 300 g	**58**[f]	**34**	83	**52**	100	**83**	**71**	**60**	76	**72**	87	**50**	98	**55**
5	Spinnaker 200 mL	85	**51**	84	**77**	97	96	96	**80**	79	97	97	87	101	**82**
6	Lexone/Diuron 200 g/1.5 L	101	**80**	92	**57**	91	**88**	112	**67**	94	91	93	**78**	109	**84**
7	Spinnaker/Diuron 150 mL/1.5 L	113	88	95	89	96	95	101	91	81	107	112	**85**	110	**86**
8	Spinnaker/Lexone 150 mL/200 g	80	**39**	84	**57**	101	**85**	**86**	**78**	**67**	96	107	87	107	**88**
9	Spinnaker/Lexone/Diuron 100 mL/150 g/1.0 L	**64**	**61**	108	**75**	102	94	109	**81**	104	96	95	**66**	124	91
10	Diuron 2.0 L + 1.5 L[d]	94	101	109	85	112	98	108	90	94	128	91	108	112	113
LSD 5%	Untreated v/s Herbicides (%)	21	19	20	18	12	11	13	15	20	13	15	14	11	11
	Herbicides v/s Herbicides (%)	26	25	24	23	15	14	16	19	25	16	19	18	14	13
	Herbicides across [a] & [b] (%)	25	25	23	23	14	14	17	17	20	20	18	18	14	14
	Untreated across [a] & [b] (kg/ha)	65	65	109	109	49	49	65	65	64	64	81	81	55	55

[a] Treatment 2 was incorporated by sowing, Treatments 3-10 were applied immediately post-plant.
[b] Brodal @ 100 mL/ha was applied along half of the each variety at 4-6 nodes.
[c] Brodal 100 mL + Lexone 100 g/ha was applied along half of the each variety at 3-5 nodes.
[d] Basal Bladex @ 2.0 L/ha.
[e] Yield kg/ha of WAPEA 2074.
[f] Figures in bold are significantly different from untreated in all varieties except from Bladex 2.0 L/ha in WAPEA 2074.