RiverinePlains

Final report of the 3rd Crop Program

2009

A report from the GRDC-funded *Improved winter cropping systems in the Riverine Plains* project

Project funded by

GRDC
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Acknowledgements

Welcome to the final report of the 3rd Crop Program carried out between 2005 and 2009. As part of this work a large number of cooperators and contributors must be thanked for their direct support and advice.

First, to the Grains Research and Development Corporation (GRDC) for funding the program. Without their considerable help this work would not have been possible. Secondly a big thank you to the farmer cooperators; Graeme and Rhonda Hicks, Roger Macdonald, Rodger Mathews, Peter White, Malcolm Bruce and especially Susie Cay, Charles Cay, Owen Smith and the members of the Cay Family. All these provided land and direct support to manage the trial plots. They were always cooperative in spraying and managing the plots and preparing for sowing, harvest, field days and visits.

There are also a large number of people to thank for their advice and help in preparing the program and contrbutions during the program. The members of the Riverine Plains Inc (RPI) committee and particularly the present Chair, Adam Inchbold. The RPI administrative officer, Ms Fiona Hart for all the help she gave me especially with publications, field days and presentations. Mr David Wolfenden, Ms Lisa Castleman, Mr Dale Grey, Ms Janet Walker, Ms Michelle Pardy, Dr John Angus, Dr John Kirkegaard, Dr Mark Conyers, Dr Phil Newton, Dr Allan Mayfield and all the others who provided advice about what to include and how to record and analyse and write up the results.

Finally to the members of RPI who viewed the work and took home many of the ideas to try them in their paddocks. Without you trying it and adopting and adapting the recommendations to suit real farms this work would not be a good investment.

John Sykes

Project Leader

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Cover image: Third Crop Plots: Balldale October 2008, taken at the Spring Field Day.
Photographer: Fiona Hart/John Sykes.

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A word from the project supervisor

Adam Inchbold Riverine Plains Inc

This project has been carried out predominantly during drought, a fact that is likely to have reduced responses to inputs that would be seen in more 'normal' years. Despite this, a number of important findings have been obtained from this work. These findings are summarised at the start of this publication and then for each individual experiment throughout.

While the drought seasons have in many ways inhibited the project, on the other hand they give the results obtained special significance. That is, we can take from this project ideas for reducing risk in our crop rotation, and during the growing season itself, while at the same time maintaining the ability to realise high production and profits when seasons turn out well.

In that sense, perhaps the overarching findings from this project are about making our systems more robust. This is not about input minimisation, it is about knowing when we can reduce or avoid inputs and when we need to apply them. It is about knowing what is risky and what is not in our systems. And it is about knowing what we need to incorporate into our systems to reduce their risk but still maximise their profitability.

Summary of major findings

- Wheat after wheat can be a viable alternative, particularly to growing alternate crops such as lupins and canola.
- To maximise yields, wheat after wheat requires protection from root diseases and possibly more nitrogen than would be required by wheat after canola or lupins.
- Using barley or triticale in the crop rotation is a more economic option than a higher proportion of canola or lupins.
- Barley and triticale require inputs similar to wheat to yield near their potential.
  - All cereals respond to similar amounts of nitrogen (N) (up to 80 kilograms per hectare) and fungicide during good seasons.
  - All cereals respond similarly to nitrogen during dry years.
  - Barley gives a significant yield response to fungicide during dry years, whereas wheat and triticale vary in their response.
- Barley has significantly higher yields than other cereals during dry years.
- Barley grain quality is not reduced by adding too much nitrogen until the yield is maximised by the addition of nitrogen and fungicide.
- Wheat seems to respond to 5–10kg/ha of phosphorus (P) at high soil test levels (80 milligrams per kilogram Colwell) during dry years. This is not recorded in all phosphorus experiments on soils with high phosphorus levels.
- Crops with low initial tiller numbers can be manipulated to produce high grain yields.

Author: John Sykes,
John Sykes Rural Consulting

Project Leader: John Sykes,
John Sykes Rural Consulting

Project Supervisor: Adam Inchbold,
Riverine Plains Inc

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Further information: available from
Riverine Plains Inc Project team.

Phone: (03) 5744 1713

The full set of data is available on the Riverine Plains Inc website.

www.riverineplains.com.au

Introduction

For the 10 years leading up to the start of the Riverine Plains Incorporated (RPI) 3rd Crop Program, wheat was sown on about half the crop area sown in southern NSW and north-east Victoria. The remainder was a mix of other cereals, mostly barley and triticale and alternate crops, predominantly canola, lupins and an area of peas. Feedback from growers and groups in the RPI area showed:

- Wheat was yielding near the water limiting potential when grown after canola or lupins.
- Wheat produced the best long-term return of all crops.
- Yield of barley and triticale was lower than wheat and less than the water limited potential (Table 1). This and the generally lower price meant that returns from barley and triticale also were lower.
- Alternate crops gave variable results with issues such as disease in lupins and peas, yield decline in canola and poor yields and economic returns during drought.
- There is uncertainty about whether to grow a second wheat crop after canola but members were starting to contemplate using this strategy to reduce the amount of other cereal and alternate crops grown in the rotation.

To help answer some of these issues RPI completed a desktop study of the statistics for the area and relative results from scientific experiments in during 2003–2004. The results from this study are shown in Table 1. Highlights include:

- The Australian Bureau of Statistics (ABS) show a district average yield of 2.2t/ha from 2000–2003 with a Water Use Efficiency (WUE) of 12kg/mm of Growing Season Rainfall (GSR).
- The statistics show that triticale and barley have similar yields averaging 1.6–1.7t/ha with a WUE of 9kg/mm of GSR. Note: Triticale and barley were not compared in the same experiments.
- Anecdotal evidence suggested better-performing growers averaged about 3.5t/ha of wheat with a WUE of 19kg/mm of GSR, 3.4t/ha of triticale (WUE 18) and 2.3t/ha of barley (WUE 13). NB. Take care when interpreting this WUE, as it is based on RPI average rainfall not the rainfall received on each farm and it ignores stored moisture.

Altogether, these survey findings confirm members' feedback. Furthermore, results from a GRDC WUE report NSW/Vic Slopes, dated February 2008, showed the average WUE of wheat in the RPI area as being between 40% and 70% of potential, depending on the shire. Barley WUE being about 40% of potential.

A different story however was coming from results from variety trials in the area. From Table 1 it can be seen that:

- When wheat and triticale were compared in the same experiment, triticale yielded better than wheat.
- Barley yields were noted as being lower than wheat yields but these were from trials conducted on different sites. When the WUE for the two species are compared, barley has a higher WUE than wheat in the relevant experiments.

From these results it was apparent that barley and triticale had the potential to perform as well as wheat. As a result, this project was initiated.

TABLE 1 Relative yields of various cereal crops in southern Australia

Crop	2000–2003 district yield[1]		Client's yield[2]		Experimental yields (%)	
	Yield (t/ha)	WUE[3]	Yield (t/ha)	WUE[3]	Yield	WUE[3]
Wheat	2.2	12	3.5	19	100	100
Triticale	1.7	9	3.4	18	101[4]	101[4]
Barley	1.6	9	2.3	13	64[5]	104[5]

[1] ABS Statistics for southern NSW and north-east Victoria. [2] Clients of John Sykes Rural Consulting. [3] WUE calculated using the French and Schultz method using average 2000–2003 GSR for the RPI area of 293mm with no allowance for stored moisture. [4] Yield of triticale compared with the site average yield of wheat in the same experiments in southern NSW. [5] Wheat and barley not compared in the same experiments. WUE produced from the recorded rainfall or the rainfall for the nearest recording station in that year. Results compare 1999–2003 site average yield for sites in southern NSW and north-east Victoria.

The start of the experimental program

Aims

The broad aims of the project were to investigate:

- If wheat after wheat after canola was a better option than growing cereals such as barley or triticale, or another canola or alternate crop in low to medium nitrogen situations.
- Why triticale and barley were not yielding as well as wheat.

Research

The program took the form of a number of experiments, conducted around Balldale in the Southern Riverina (NSW), with other issues being tested either as studies or experiments as they arose at other sites. The main program consisted of a number of individual experiments including:

- Crop comparison experiments carried out from 2004 to 2008 (five years) comparing the yields of wheat, triticale and barley (2004 to 2008) and canola and lupins (2005 to 2008) in the one experiment.
- Maximum yield experiments for wheat (after wheat), triticale and barley from 2005 to 2008 designed to investigate the issues that would produce the maximum and optimum yield of the cereals.
- Fungicide experiments for wheat (2006–2007) and barley (2005 to 2007) to test a number of fungicide alternatives and fungicide timings to quantify when yield responses are obtained.
- Trace element experiment (2007) to test for trace element responses on a common soil type in north-east Victoria, where no data on likely trace element responses could be found.

In addition, a number of other issues were addressed as part of the program. These included:

- Fungicide product experiments on wheat and barley. These experiments were carried out during 2006 and 2007 as a result of confusion about whether some products were better than others and what products were the most cost effective.
- Incorporation of new varieties of triticale and barley. In particular the new triticale varieties Tobruk and Endeavour were included in trials during 2007.
- Survey of RPI member actions to check if the recommended actions were being accepted and adopted by members. This survey covered both the 3rd Crop and Precision Agriculture Programs.
- Accuracy of Deep Soil Nitrogen (DSN) testing for determination of soil nitrogen and fertiliser nitrogen requirement. This followed many comments about the accuracy and appropriateness of using DSN. This was addressed by:
  - Contact with a number of soil nitrogen authorities and publishing of their collective views.
  - Individual sampling of a number of soil sampling holes to statistically determine the number of holes that need to be dug to obtain a repeatable result.
- An experiment testing a range of crop densities and ways of producing tillers was carried out 2008 to introduce some Water Use Efficiency (WUE) aspects to canopy management strategies.

Extension activities

As part of the process of ensuring RPI members and growers in the RPI area adopt the results of the work, opportunities were taken to extend the results and have groups undertake large plot on-farm demonstrations of the major recommendations from the experimental program. In particular, the program developed protocols for the production of maximum-yielding barley and triticale crops using the results of the experiments. These have been partially tested in the field during the past two years.

The seasons

The seasons since 2004 have been variable. Table 2 shows the recorded rainfall for Balldale, NSW, the station used for recording rainfall for the sites during the program. Comparisons of the Balldale rainfall with the available data for the surrounding farms shows that the rainfall was within 1% of that recorded at Balldale and therefore this site can be used for analysis of the years.

On average the total rainfall for Balldale is 508mm with Growing Season Rainfall (GSR) (April to October rainfall) averaging 325mm. During the experiment period:

- 2006 to 2008 GSR were in the decile 1 to 2 range, which is in the lowest 20% of rainfalls.
- GSR was 244 to 246mm or decile 4. Annual rainfall averaged 435 to 441mm or decile 3.

Table 3 indicates the potential average yields that could have been budgeted based on rainfall at Balldale, NSW, if other crop factors were not limiting. Specifically:

- On average, at Balldale the yield potential is 4.3t/ha or 5.3t/ha if summer rainfall (stored soil moisture) is considered.
- Potential yield varied from 1.2t/ha during 2006 to 6.2t/ha during 2005.
- On average during the period, the yield potential was 2.7t/ha if only the GSR was considered or 4t/ha if summer moisture was considered.

TABLE 2 Rainfall analysis for Balldale, NSW

Month	2004	2005	2006	2007	2008	Average 2004–08	Average 2005–08	Average
Jan (mm)	0	73	3	9	53	28	35	38
Feb (mm)	0	95	8	42	16	32	40	34
Mar (mm)	2	13	19	30	34	20	24	33
Apr (mm)	19	12	32	12	15	18	18	37
May (mm)	33	5	10	75	12	27	26	43
Jun (mm)	76	101	44	19	14	51	45	48
Jul (mm)	39	40	46	76	61	52	56	50
Aug (mm)	38	87	8	7	24	33	32	49
Sep (mm)	45	76	32	6	20	36	34	46
Oct (mm)	4	99	0	32	12	29	36	51
Nov (mm)	65	96	32	27	61	56	54	38
Dec (mm)	89	35	0	74	66	53	44	39
Total (mm)	410	732	234	409	388	435	441	508
GSR (mm)	254	420	172	227	158	246	244	325
Nov-Mar (mm)	146	335	161	113	204	192	203	157
Decile total[1]	4	9	1	3	3	4	4	–
GSR decile	4	8	1	2	1	3	3	–

[1] The decile (or percentile) or rainfall for the annual total.

TABLE 3 Potential yield based on Balldale rainfall

Month	2004	2005	2006	2007	2008	Average 2004–2008	Average 2005–2008	Average
GSR (mm)	254	420	172	227	158	246	244	325
Nov-Mar (mm)	146	335	161	113	204	192	203	157
GSR (mm)	303	532	226	265	226	310	312	377
Total[2] (mm)	410	732	234	409	388	435	441	–
Potential yield[1] (t/ha)	2.9	6.2	1.2	2.3	1.0	2.7[3]	2.7[3]	4.3
Potential yield[2] (t/ha)	3.9	8.4	2.3	3.1	2.3	4.0[3]	4.0[3]	5.3

[1] Potential yield based on the GSR as April to October rainfall. [2] Potential Yield based on the April to October rainfall plus a third of summer (Nov to Mar) rainfall. Potential yield based upon French and Schultz method. [3] Based on the average rainfall.

Results and discussion

Note: *This section only summarises the results of each experiment series. The full results are published in the Appendix to this section, which can be found on the Riverine Plains Inc website www.riverineplains.com.au.*

Crop comparison experiment

The main experiment in the program was a comparison of a number of cereals including wheat on wheat, barley and triticale in low to medium nitrogen situations and the alternate crops canola (2005 to 2008) and lupins (2005 to 2007).

The results

Tables 4 to 7 summarise the yield results for the crop comparison experiments that were carried out between 2004 and 2008 for the cereals, and 2005 and 2008 for the alternate crops. Table 4 also shows the average result for the whole period, Table 5 for the non-drought years and Table 6 for the drought years (2006 to 2008).

TABLE 4 Average yield and gross margin for the crop comparison experiment for 2004–2008

Crop	Control[1]		High N[2]		High N + fungicide[3]	
	Yield (%)	GM ($/ha)	Yield (%)	GM ($/ha)	Yield (%)	GM ($/ha)
Wheat	100	148	141	158	156	155
Triticale	119	194	159	164	174	187
Barley	106	192	145	239	159	228
Canola	34	42	45	28		
Lupins	30	-16				

[1] Control – The grower treatment considered the most common method for growing the crop, including direct drilling of the crop with 70kg/ha of wheat seed (90kg/ha of triticale and 60kg/ha of barley), 20kg/ha of phosphorus and common registered herbicides for weed control. Average yield 1.55t/ha.
[2] High N – Control treatment plus the addition of 40kg/ha of nitrogen (as urea). [3] High N + fungicide – High nitrogen treatment plus fungicide to completely control any disease that occurs.

TABLE 5 Yield and gross margin for the crop comparison experiment for non-drought years

Crop	Control[1]		High N[2]		High N + fungicide[3]	
	Yield (%)	GM ($/ha)	Yield (%)	GM ($/ha)	Yield (%)	GM ($/ha)
Wheat	100	251	147	308	173	341
Triticale	109	226	172	275	188	299
Barley	87	245	115	293	151	331
Canola	42	268	65	293		
Lupins	43	182				

[1, 2 and 3] See Table 4. Average yield of grower wheat 3.3t/ha.

TABLE 6 Yield and gross margin for the crop comparison experiment for drought years

Crop	Control[1]		High N[2]		High N + fungicide[3]	
	Yield (%)	GM ($/ha)	Yield (%)	GM ($/ha)	Yield (%)	GM ($/ha)
Wheat	100	125	123	110	110	56
Triticale	116	161	130	109	128	93
Barley	112	164	156	241	152	216
Canola	26	-32	22	-113		
Lupins	19	-76				

[1, 2 and 3] See Table 4. Average yield of grower wheat 0.95t/ha.

Water Use Efficiency

As the seasons have been dry and yields in many years low, a better way to assess the yield may be to assess WUE. Table 7 shows the percentage of the potential WUE that was achieved by each treatment.

TABLE 7 Water Use Efficiency as a percentage of the potential yield for 2004–2008, non-drought and drought years

	Average (%)	Non-drought year (%)	Drought years (%)
Control[1]			
Wheat	54	53	54
Triticale	64	57	60
Barley	63	46	65
Canola	47	44	25
Lupins	26	46	29
High N[2]			
Wheat	73	77	66
Triticale	81	90	71
Barley	80	60	78
Canola	74	69	25
High N + Fungicide[3]			
Wheat	78	91	62
Triticale	86	99	67
Barley	91	79	90

[1, 2 and 3] See Table 4. Potential yield calculated from French and Schultz model with factor of 20.

Discussion

The main conclusions from these trials include:

- Wheat on wheat following canola is a more economic alternative than growing alternate crops after the first wheat crop. Therefore, in a combination with other cereals this finding will enable more cereal crops to be grown in a rotation.
- Barley yields and returns better than wheat or triticale under dry conditions (see Tables 5 and 6).
- Responses to fungicide treatments and added nitrogen were particularly strong in barley compared with wheat or triticale during dry years (see Table 5).
- Across the four years, triticale had the best yield and barley the highest return.
- The addition of nitrogen (see Table 5) significantly increased the yield of wheat, barley and triticale in all years but particularly in the non-drought years, such as 2005.
- Across the whole period (see Table 5) fungicides increased the yield of wheat, barley and triticale.
- During the past four years, the application of fungicide increased yield in all cereals with a slight increase in gross margin in triticale and barley.
- Canola and lupins yielded poorly in the drought years with low WUE and negative gross margins. The gross margin of canola became increasingly negative as inputs were applied.
- During the period 2005 to 2008, canola responded positively to nitrogen applications but not to fungicide.

Wheat maximum yield experiment

This experimental program was carried out from 2005 to 2008 and was designed to test if inputs of nitrogen or fungicide could increase yields in wheat on wheat.

The results

Figures 1 and 2 summarise the major results of the wheat maximum yield experiment.

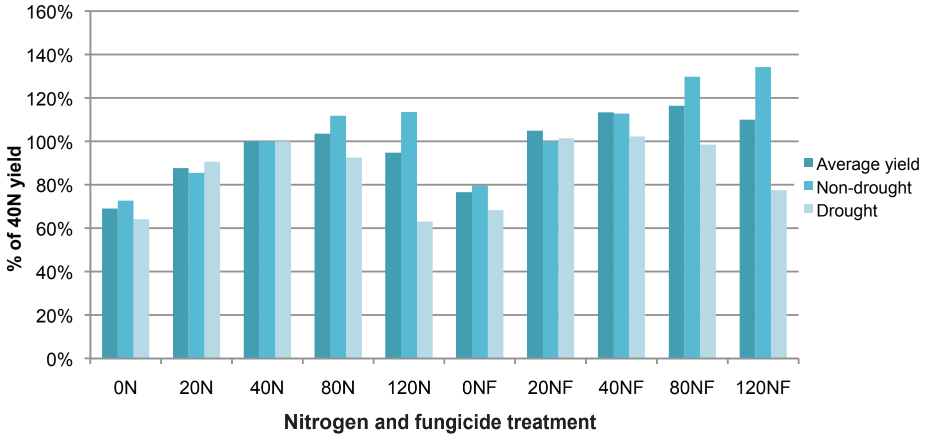

FIGURE 1 Wheat yield for 2005–2008 average, non-drought and drought years

NOTE: 40N Yield: Average 3.3t/ha, Non-drought 5.2t/ha, Drought 1.1t/ha.
Fungicide – Triademefon 125gm/L at 500ml/ha. Nitrogen applied at growth stage Z31. Fungicide applied at growth stage Z30.

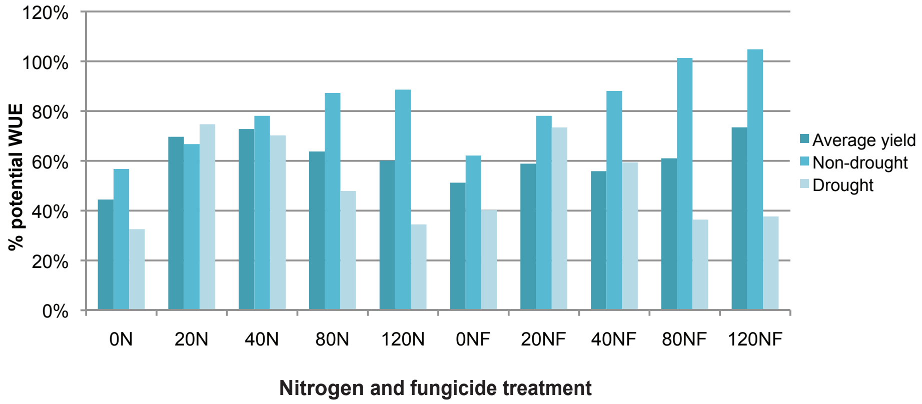

FIGURE 2 Water Use Efficiency of wheat on wheat for 2005–2008 average, non-drought and drought years

Discussion and conclusion

The major conclusions of this work were:

- Wheat responded to up to 80kg/ha of nitrogen during a non-drought year (2005) and 20kg/ha of nitrogen during drought years.
- Wheat significantly responded to fungicide applications during non-drought years, such as 2005 but has not responded during drought years.
- Across the full term of the experiment, wheat responded significantly to both fungicide applications and an average of 40kg/ha/yr of nitrogen (range 20–80kg/ha/yr).
- Use of nitrogen added to the dry matter (DM) production in each year, adding to the potential hay yield.
- Addition of 20kg/ha of nitrogen resulted in a significant increase in yield and gross margin.
- Screenings were not adversely affected until more than 40kg/ha of nitrogen was applied.

Photo: Fiona Hart/John Sykes

Canola Plots: Balldale October 2008, taken at the Spring Field Day.

Barley maximum yield experiment

This experimental program was carried out from 2005 to 2008. It was designed to test if the use of extra nitrogen inputs or fungicide applications could increase yields of barley and make them comparable to wheat on wheat.

The results

The main results are summarised in Figures 3, 4 and 5.

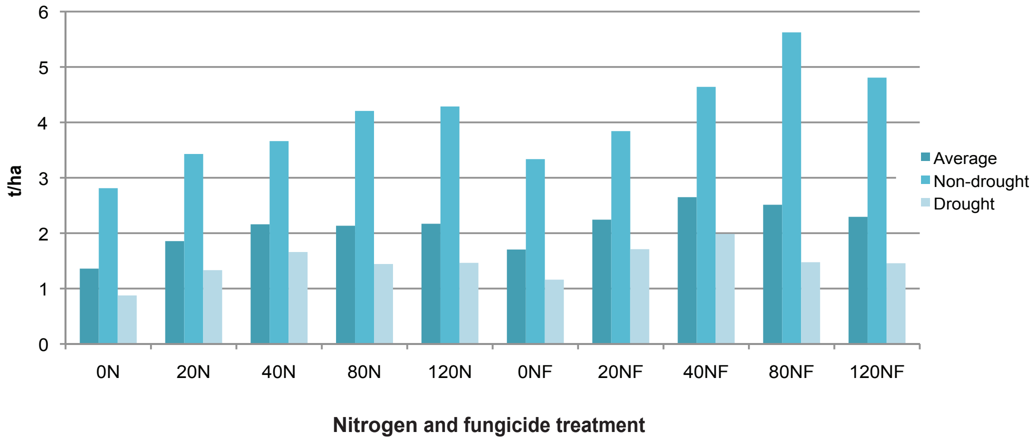

FIGURE 3 Yield for barley maximum yield experiment for 2005–2008 average, non-drought and drought years

NOTE: Fungicide – Triademefon 125gm/L at 500ml/ha. Fungicide and nitrogen applied at growth stage Z31.

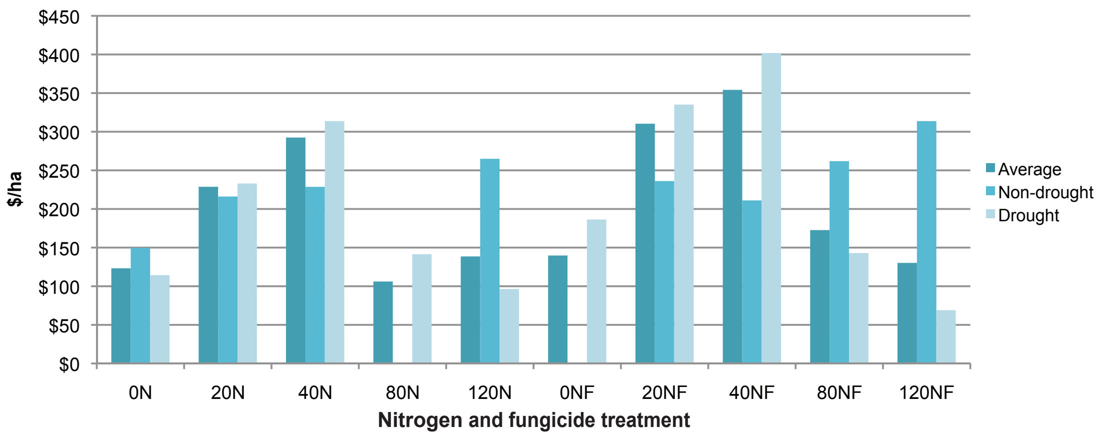

FIGURE 4 Gross margin for the barley maximum yield experiment for 2005–2008 average, non-drought and drought years

Barley plots: Balldale October 2005.

Photo: Fiona Hart/John Sykes

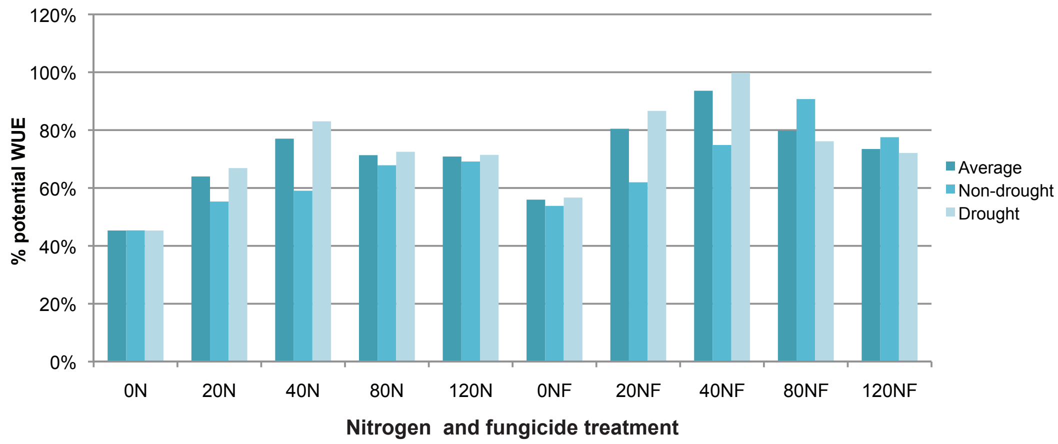

FIGURE 5 Water Use Efficiency for the barley maximum yield experiment for 2005–2008 average, non-drought and drought years

Other results of the experiment were:

- The 2008 experiment demonstrated that under dry conditions, 50kg/ha of seed was the optimum rate sowing rate.
- Development of less than 700 tillers/m^2 at growth stage Z32 produced near-to-maximum yields (measured as % of potential WUE) except during non-drought years.
- Grain quality was not affected by the application of nitrogen or fungicide until the rate of nitrogen required to maximise yield was exceeded. Then nitrogen application resulted in higher protein and screenings and the addition of fungicides resulted in higher screenings in during some years.

Discussion and conclusions

The major conclusions of this work were:

- Barley responded to inputs of nitrogen and fungicide across all years.
- 40kg/ha of nitrogen was required to maximise yield during drought years and up to 80kg/ha of nitrogen in non-drought years. Nitrogen efficiency was noted to be about 40%.
- Fungicide response was independent of nitrogen application.
- Applications of up to 40kg/ha of nitrogen significantly increased the yield of barley. Subsequent yields then decreased with additional nitrogen applications.
- Fungicide applications at growth stage Z30-32 and Z39 were optimum for producing the best yield.
- Above 40kg/ha of nitrogen there was no response to either nitrogen or fungicide.
- Using 50kg/ha of seed, 40kg/ha of nitrogen and fungicide gave the highest gross margin.
- During 2008, 50kg/ha was the optimum sowing rate.

Triticale maximum yield experiment

The triticale maximum yield experiment was carried out between 2005 and 2008 to assess if higher input rates would result in increased yields and better WUE.

The results

The results are summarised in Figures 6, 7 and 8.

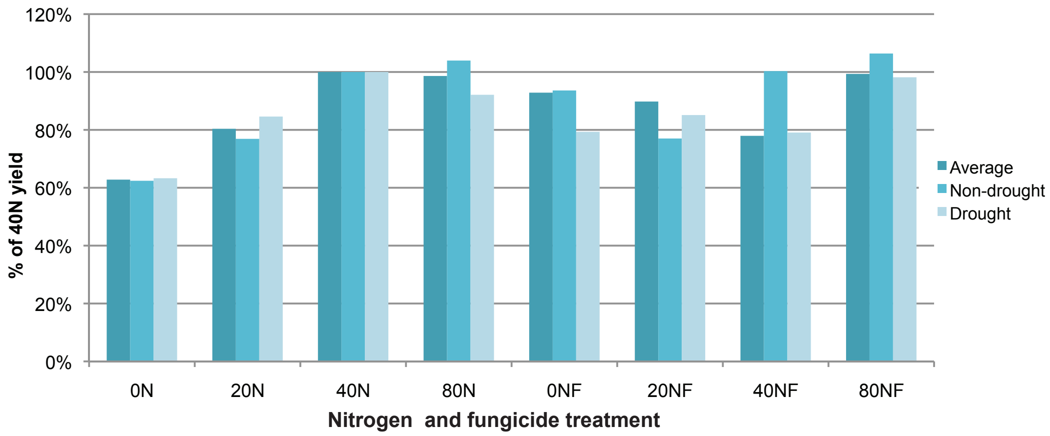

FIGURE 6 Yield for triticale maximum yield experiment for 2005–2008 average, non-drought and drought years

NOTE: 40N Yield: Average 3.4t/ha, Non-drought 5.6t/ha, Drought 1.0t/ha.
Fungicide – Triademefon 125gm/L at 500ml/ha. Nitrogen and fungicide applied at growth stage Z31.

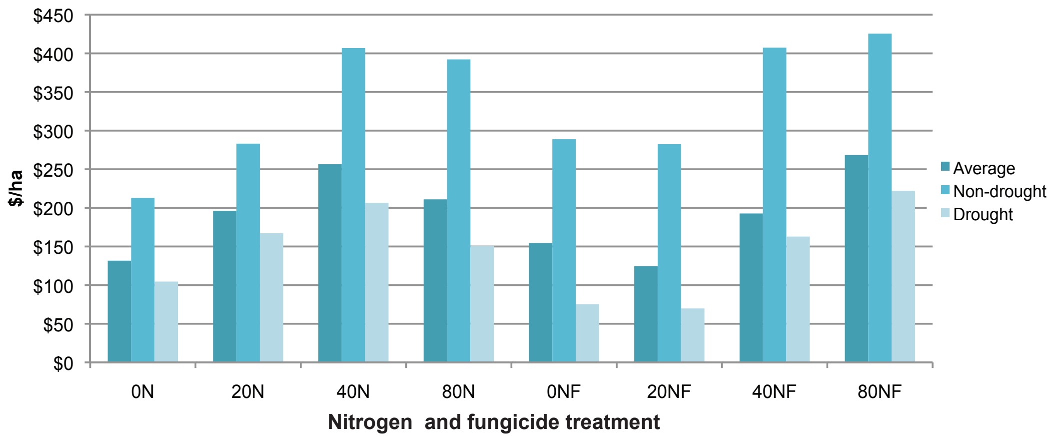

FIGURE 7 Gross margin for triticale maximum yield experiment for 2005–2008 average, non-drought and drought years

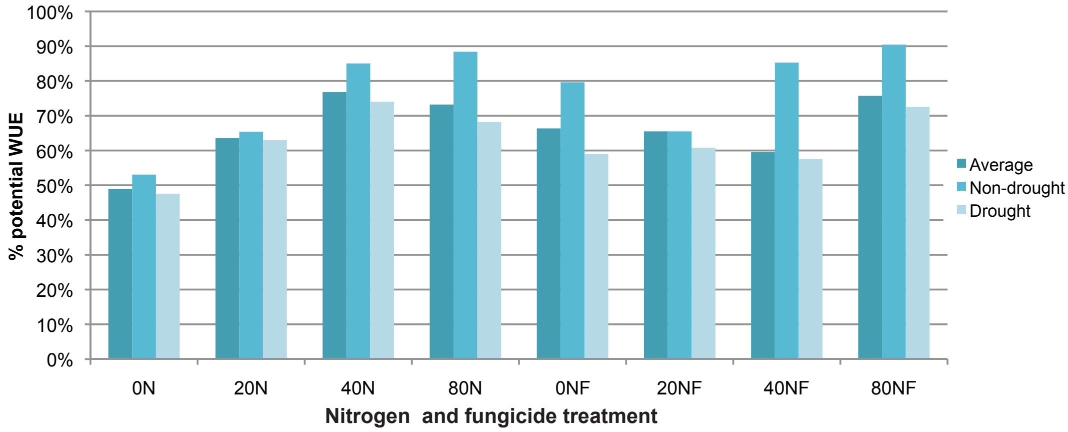

FIGURE 8 Water Use Efficiency for triticale maximum yield experiment for 2005–2008 average, non-drought and drought years

Variety comparison

During 2007 the variety Tobruk had an equal yield to the standard variety Kosciusko but during 2008 Kosciusko yielded significantly better than Tobruk. During 2007 the variety Endeavour yielded significantly less than either Tobruk or Kosciusko.

Discussion and conclusions

The major conclusions of this work were:

- Triticale responded positively to the addition of up to 40kg/ha of nitrogen during drought years and 80kg/ha of nitrogen during non-drought years.
- Triticale did not respond significantly to fungicide during drought years.
- The most economic treatment (having the highest gross margin) was 40kg/ha of nitrogen with or without fungicide.
- Kosciusko yielded better than Tobruk with and without fungicide.
- During 2008 neither Tobruk or Kosciusko responded to fungicide.

Photo: Fiona Hart/John Sykes

3rd Crop Site: Balldale October 2008.

Wheat fungicide experiment

A number of experiments involving the use of fungicidal seed dressings or fungicides were completed during the program. Initially the program was to only investigate fungicide timing and seed dressings but some product comparisons were introduced between 2005 and 2008 due to interest from RPI members.

The results

The results are summarised in Figures 9, 10 and 11.

Fungicide timing

Figure 9 shows the results of the work on fungicide timing.

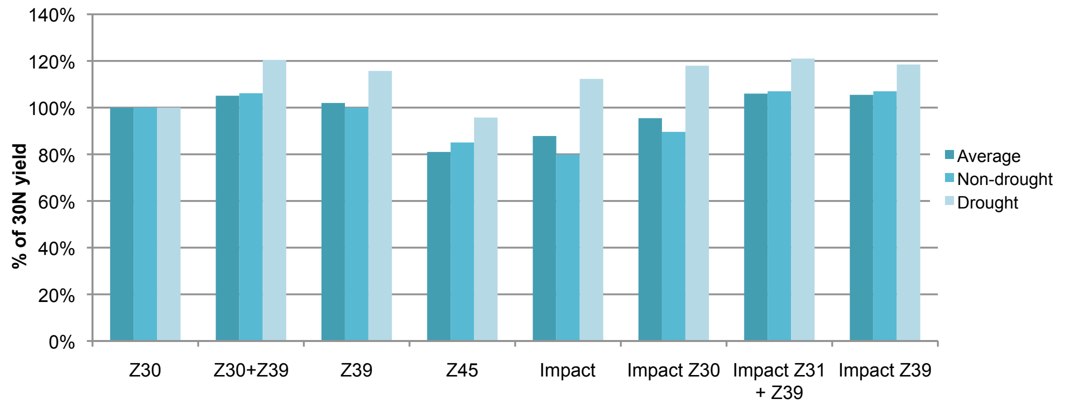

FIGURE 9 Yield for the timing of fungicide applications on wheat for 2005–2008
NOTE: Where not stated the standard fungicide is Triademefon 125gm/L at 500ml/ha.
Variety – Diamondbird or Ventura.

Seed dressings

The 2005 results (see Figure 10) best show the effect of seed dressings and fungicides on yield. Other years showed similar results.

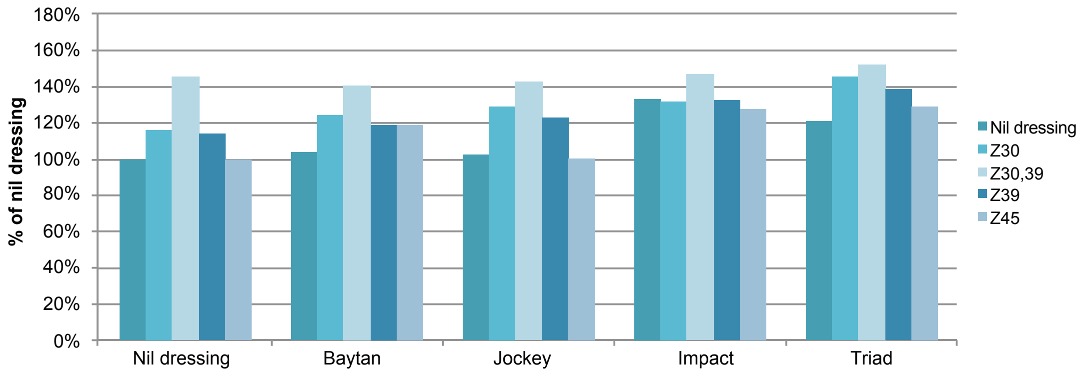

FIGURE 10 Yield for the seed dressings for 2005 with and without added fungicide
NOTE: Fungicide – Triademefon 125gm/L at 500ml/ha. Variety – Diamondbird.

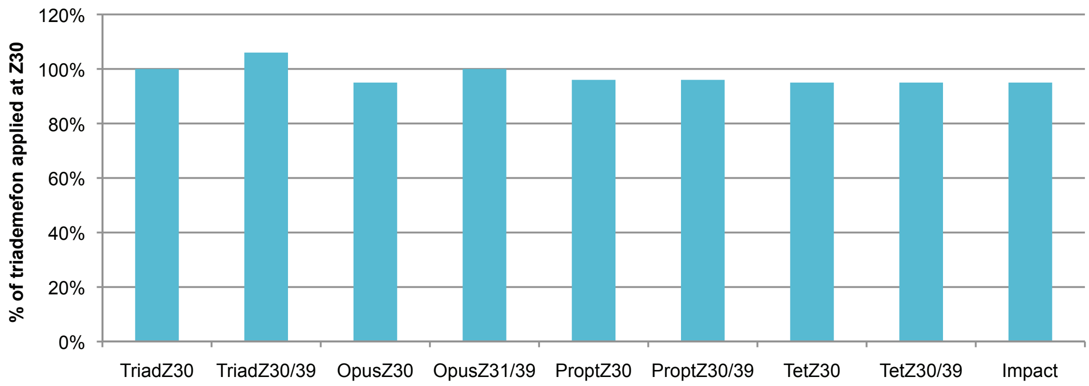

FIGURE 11 Yield of wheat treated with different products for 2005
NOTE: Fungicide rates: Triademefon – 125gm/L at 500ml/ha. Opus – 250ml/ha. Propiconazole: as foliar at 145ml/L. Tetraconazole: as Tilt at 250ml/ha. Variety – Diamondbird or Ventura.

Product work

During 2007 and 2008 experimental work was carried out on products in wheat. The results are summarised in Figure 11.

Discussion and conclusions

The major conclusions of this work were:

- Optimum response in all years was to a single application at growth stage Z30 (range Z30 to Z32) or two applications of fungicide at growth stages Z30 and Z39.
- Product choice was not important with all products giving similar responses.
- Use of fertiliser treatments like Impact and Triademefon reduced the need to use in-crop fungicides and produced better responses.
- Best results were often obtained with a combination of a seed dressing and a single in-crop fungicide.

Barley fungicide experiment

The barley fungicide experiment was carried out from 2006 to 2008 to test the effect of different timing and products on the yield of barley. During 2006 and 2007 the experiment was part of the barley maximum yield experiment but during 2008 it was a separate experiment.

The results

The results are summarised in Figure 12.

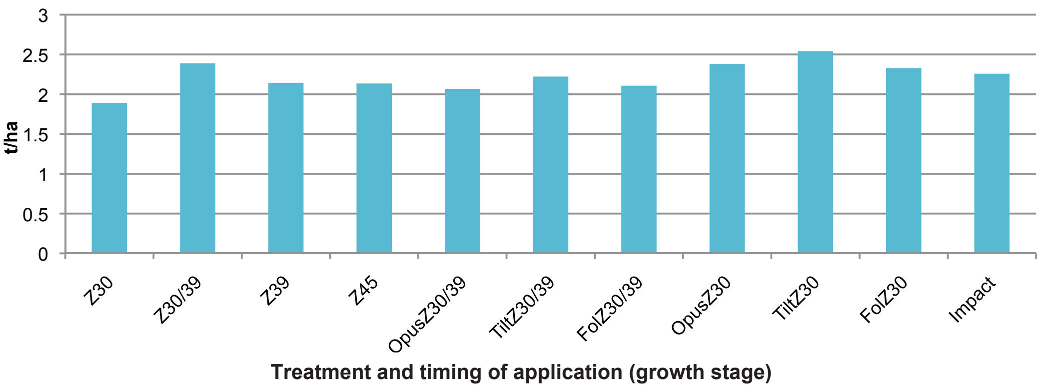

FIGURE 12 Yield for barley fungicide timing and product for 2006–2008
NOTE: Where not stated the fungicide is Triademefon 125gm/L at 500ml/ha.

Discussion and conclusions

The major conclusions of this work were:

- The optimum response in all years was to two applications of fungicide at growth stage Z30–32 and Z39.
- Product choice was not important with all products giving similar responses.

Photo: Fiona Hart

NSW Spring Field Day: 3rd Crop trial site at Balldale, September 2005.

Wheat phosphorus and nitrogen experiment

During 2007/08, the price of phosphorus fertiliser rose and RPI members started to question the amount of phosphorus that was necessary, particularly in paddocks with high levels of soil test phosphorus. During 2008 a phosphorus experiment was included as part of the 3rd Crop Program. This was to provide extra data in support of a number of phosphorus experiments being undertaken by the Department of Primary Industries, Victoria in north-east Victoria. The paddock tested had a high level of phosphorus.

The results

The results are summarised in Table 8.

TABLE 8 Summary of the tiller count, yield and gross margin for the phosphorus by nitrogen experiment 2008*

Treatment (kg/ha)	Tillers (Z15 t/m^2)	Yield (t/ha)	GM ($/ha)
0P 0N	322	0.8	34
0P 40N	325	0.8	-1
6P 0N	389	1.3	154
6P 40N	412	1.6	190
12P 0N	447	1.7	265
12P 40N	435	1.8	274
20P 0N	459	1.1	123
20P 40N	461	1.3	137
25P 0N	414	1.0	87
25P 40N	439	1.4	159
12P 20N	414	1.9	331
12P 80N	476	1.3	137
12P 120N	449	1.2	132
20P 20N	431	1.8	137
20P 80N	447	1.2	145
20P 120N	437	1.2	101
Average	422	1.3	
LSD	52	0.32	
CV	11.40%	14.80%	

*Phosphorus applied as double super at sowing. Nitrogen applied as urea at Z31. LSD — Least Significant Difference CV — Co-efficient of variation. The CV is high due to drought conditions.

Discussion and conclusions

The major conclusions of this work were:

- Wheat responded significantly to up to 12kg/ha of phosphorus without added nitrogen and to 6kg/ha with added nitrogen.
- Higher rates than the above did not improve yield or tiller numbers.

Wheat inputs experiment

During 2008 an experiment was carried out to investigate alternative approaches to manipulating the crop canopy to nitrogen. This was both a reaction to high fertiliser prices and an effort to determine if high tiller counts could be produced by adjusting the amount of seed sown, and the level of fertiliser used. During the 1990s, Dr John Angus and Mr Geoff Pitson investigated a similar approach in the Cootamundra area, NSW.

The results

Table 9 summarises the results.

TABLE 9 Summary of the plant count, tillers, yield, cost to grow and gross margin for the wheat inputs experiment for 2008

Treatment description	Plant count (pl/m²)	Tillers (Z15 t/m²)	Tillers (Z32 t/m²)	Tillers (Z70 t/m²)	Yield (t/ha)	Cost ($/ha)	GM ($/ha)
12P 35S 0N	81	367	479	387	0.9	158	94
12P 35S 40N	86	458	351	378	1.4	214	203
20P 35S 0N	84	351	343	327	1	183	122
20P 35S 40N	93	472	336	409	1.4	255	162
12P 70S 0N	167	462	334	288	1.1	159	174
12P 70S 40N	174	495	351	405	1.4	229	188
20P 70S 0N	176	437	329	264	1.1	201	132
20P 70S 40N	180	523	338	323	1.5	273	172
12P 70S 80N	171	456	312	421	1.2	293	68
12P 120S 0N	223	561	342	260	1	180	125
12P 120S 40N	238	501	360	224	0.8	244	5
20P 70S 80N	164	481	574	329	1	313	-8
20P 120S 0N	235	462	344	365	0.9	220	57
20P 120S 40N	239	479	339	318	1	288	17
12P 35S 20N	168	478	366	421	1	175	130
12P 70S 40N++	171	457	345	396	1.4	235	182
20P 70S 40N++	164	431	363	325	1.3	275	114
5P 35S 20N	86	258	327	298	1.1	140	193
5P 35S 40N++	91	294	340	409	1.4	183	234
5P 35S 80N++	78	306	357	427	1.3	248	141
5P 70S 40N++	162	507	497	386	1.5	200	245
12P 70S 40N (no fungcide)	167	453	344	354	1.4	224	193
Average	154	440	367	351	1.2		
LSD	37	72	84	67	0.33		
CV	9.60%	12.40%					

Treatment nominated as rate of phosphorus (XP) rate of seed (XS) rate of nitrogen (XN). ++ - Split application of nitrogen with the first application of half the nitrogen at Z15 with the rest applied at Z31. Phosphorus applied as double super at sowing and nitrogen as urea at Z31 except for the split applications. All plots, except no fungicide, had two applications of 500ml/ha of 125g/L Triademefon at growth stages Z30 and Z39. Cost to grow (whole $/ha) based upon gross margin costs (including harvest). Gross margin (whole $/ha) based on $280 /t (delivered local silo) and nitrogen @ $1.74/kg delivered. LSD — Least Significant Difference. CV — Co-efficient of variation.

Discussion and conclusions

The major conclusions of this work were that during 2008:

- Similar yield results can be obtained using a number of combinations of seed and fertiliser.
- Low tiller numbers can be recovered by using light amounts of nitrogen.
- There may be opportunities to use much lower initial inputs and still produce high yielding and profitable crops.
- A sowing rate of 35kg/ha was the optimum with no significant yield increase achieved by adding more seed.
- A sowing rate of 70kg/ha produced the optimum tiller numbers but due to the dry season this did not produce the highest yield.
- Addition of nitrogen significantly increased yield at all sowing and phosphorus rates.
- Initially low inputs (5kg/ha of phosphorus and 35kg/ha of seed as in 5P 35S 40 N++) can be recovered by an early application of nitrogen fertiliser. Due to the dry season it was not possible to determine if the recovery would produce near maximum yields.
- Similar yields could be produced with input savings of up to $78/ha during 2008.

Photo: Fiona Hart

NSW Spring Field Day: 3rd Crop trial site at Balldale, September 2005

Wheat trace element experiment

The trace element experiment was established in north-east Victoria during 2007 to test a number of trace elements and mixtures of trace elements for responses in wheat.

The results

Table 10 summarises the results of this experiment.

TABLE 10 Summary of tiller count and yield for wheat trace element experiment for 2007

Treatment	First tiller count (Z15 t/m^2)	Second tiller count (Z39 t/m^2)	Yield (t/ha)
Nil (no trace elements)	342	492	2.4
Half rate of Zn, Mn, Cu, B, Mo*	328	471	2.5
Zn Mn Cu B Mo	418	599	1.9
Zn Mn Cu B	423	582	2.1
Zn Mn Cu Mo	422	595	2.0
Zn Mn B Mo	399	601	1.8
Zn Cu B Mo	410	588	2.0
Mn Cu B Mo	328	471	2.5
Zn Mn Cu B Mo S	420	588	2.0
Liquid Zn Mn Cu B Mo S	407	583	2.1
Average for all full rate of Zn treatments	342	492	2.4
No Zn	414	593	2.0
Average	403	565	2.1
LSD	62	87	0.4

* Elements applied as liquids at sowing at approximately half the recommended rate of the products. LSD — Least Significant Difference.

Discussion and conclusions

The major conclusions of this work were that during 2007:

- There was no response to any trace elements or mixtures of trace elements, except zinc (Zn).
- Zinc responses may occur in red soils particularly if a Chlorsulphuron herbicide, such as Logran, is used.
- Zinc produced significantly more tillers but no yield response.
- No trace elements, except the full rate of zinc, resulted in a significant increase in tiller numbers or yield over the nil treatment.
- Applications of zinc produced visible responses in early crop growth and significantly more tillers at both the first count (early August before Z31) and the second count (late September). This did not relate to a yield response.
- Plots treated with the full rate of zinc produced significantly less yield than the non-zinc-treated plots.
- The visual zinc responses may have been enhanced by the use of a Chlorsulphuron herbicide (Logran) that can induce zinc deficiencies. The lower-than-average spring rain probably resulted in the thicker plots (those with zinc applied) yielding less than the thinner plots.
- Response in tiller numbers to zinc application suggests that zinc may produce a yield increase, particularly if a Chlorsulphuron herbicide is used. This requires further testing by growers.

Wheat sulphur and zinc experiment

The zinc and sulphur experiment was carried out during 2008 as a response to RPI members' questions about whether wheat would respond to applications of sulphur or zinc and if the products containing these elements were important.

The results

The results are summarised in Table 11.

TABLE 11 Summary of 2008 yield, protein, screenings and gross margin

Treatment description	Yield (t/ha)	Protein[6] (%)	Screenings[6] (%)	GM[7] ($/ha)
0N[1]	0.9	14	1.6	55
20N	1.5	14	1.5	158
20N + Zn[2]	1.4	15	1.8	137
25N	1.3	15	1.9	108
Gypsum[3]/N15/20[4]	1.4	14	1.4	136
Gypsum/N22/25	1.4	14	1.2	128
SOA[5] 22/25	1.4	15	1.9	101
SOA/N15/20	1.4	14	1.1	107
LSD	0.3			
CV	14.8%			

[1] N – Nitrogen all treatments applied at Z17 (7 leaf stage) during early August. [2] Zn — Zinc as 5kg/ha of zinc sulphate. [3] Gypsum assuming 18% sulphur. [4] Sulphur rate applied/nitrogen rate. [5] SOA — Sulphate of ammonia fertiliser containing 22% sulphur and 25% nitrogen. [6] Protein and screenings based on one sample from Repetition 1. [7] GM — Gross Margin (whole $/ha) based on $280/t (delivered local silo), urea @ $800/t and SOA at $650/t delivered.
All treatments received one application of 500ml/ha of 125g/L Triademefon at growth stages Z33. LSD — Least Significant Difference.
CV — Co-efficient of variation.

Discussion and conclusions

The major conclusions of this work were:

- Wheat did not respond significantly to additional sulphur.
- Wheat did not respond significantly to additional zinc.
- The addition of 20kg/ha of nitrogen resulted in a significant increase in yield and gross margin over nil nitrogen, regardless of the product used.
- Addition of sulphur in any form (gypsum or sulphate of ammonia) did not increase yield.
- Protein and screenings were unaffected by the amount of nutrient applied or the product used.

Other aspects of the program

Deep soil nitrogen demonstration

During 2005–2006 the potential variability of deep soil nitrogen (DSN) was demonstrated as part of the precision agriculture, 3rd Crop and an Extension Grant Program. Table 12 shows that there was a major difference in the DSN status reported by the sampling organisations. On average the calculated DSN varied by 27kg/ha of nitrogen with the maximum variation of 82kg/ha of nitrogen.

Contact with a number of nitrogen authorities showed that the most likely cause was the low number of holes that were used when taking the sample. To investigate this, samples were taken at set points in a grid on two properties in southern NSW.

From a common central point in the centre of the paddock, other holes were dug at 0.5, 1, 2, 4, 8, 64, 128 and 256 metres in a north, south, east and west direction. The position of the holes was determined with a tape measure to eight metres and then with a hand-held GPS unit accurate to about 1m. The samples were taken with a 50mm motorised auger. All the soil collected at each depth was mixed before a sample was taken for analysis.

To determine the number of samples that needed to be taken, a formula provided by Dr Mark Conyers of NSW DPI at Wagga Wagga Agricultural Research Institute was used. This used the variation (as measured by the standard deviation) between the results from the individual holes to determine the number of sample holes required to ensure a 95% chance the result of any one test can be replicated.

The results

Table 13 shows the preliminary results of the DSN analysis for the Balldale and Walla Walla paddocks.

TABLE 12 Results of Deep Soil Nitrogen tests taken by two different samplers from three paddocks for 2005

Paddock	Organisation 1	Organisation 2	Difference (2 to 1)
Paddock 1 DSN (kg/ha)	51	133	82
Paddock 2 DSN (kg/ha)	67	107	40
Paddock 3 DSN (kg/ha)	86	44	-42
Average difference DSN (kg/ha)	68	95	27

TABLE 13 Summary of the preliminary results of Deep Soil Nitrogen tests for 2005

	Balldale	Walla Walla
Average DSN* (kg/ha)	122	85
Highest individual hole DSN (kg/ha)	849	361
Lowest individual hole DSN (kg/ha)	36	12
Highest DSN in any group of five holes (kg/ha)	251	196
Lowest DSN in any group of five holes (kg/ha)	75	21
Chance of success (%)**	22	29
Number of holes required to get a reliable result***	12	16

* Average of 33 samples/paddock. ** Chance of success — The chance (as correlation) that the result of any group of five holes would produce the average DSN result. *** The number of holes that would need to be dug to ensure there was a 95% chance that the results from any one DSN result would consistently be the same as the average. Rounded to the nearest whole number.

Overall response to nitrogen

Throughout the program a number of nitrogen responses were identified. Figure 13 shows the total response (as extra kg of grain per kg of nitrogen applied) of adding nitrogen throughout the program.

Figure 13 shows that at low rate of nitrogen (20 and 40kg/ha), responses were common but as higher rates were applied the response varied greatly as a reaction to:

- The dry seasons.
- Higher biomass growth.

Calculations (see Table 14) were also made about the efficiency of nitrogen conversion.

This showed that for where nitrogen responses were recorded, the best correlation was 40–45% efficiency with a range from 35% efficiency during 2007 to 55% efficiency during 2005. This is lower than the accepted efficiency of nitrogen conversion of 50%. This may indicate that:

- Nitrogen efficiency is lower in wheat on wheat and possibly other cereals. Feedback from successful wheat on wheat growers show that they tend to use more nitrogen on the wheat on wheat crop than on wheat following canola.
- Nitrogen efficiency was low due to the dry season.

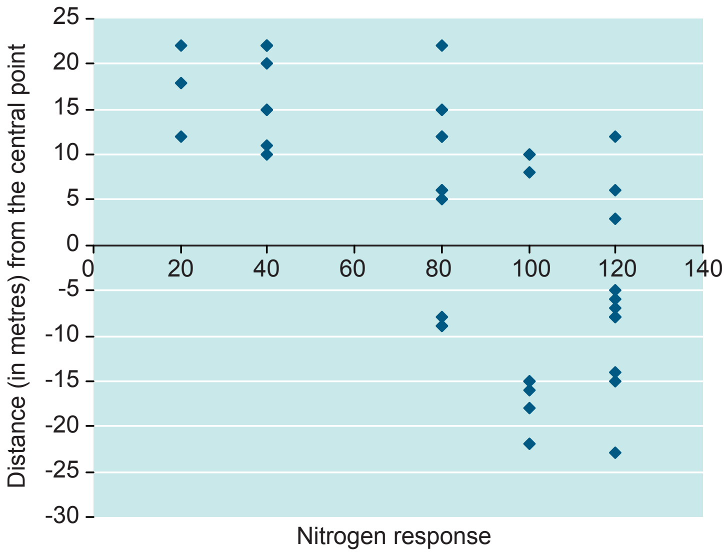

FIGURE 13 Response of all cereals to the addition of nitrogen (as kg of extra grain/kg of N applied) to the application of fertiliser nitrogen for 2005–2008

NOTE: Slope – 1.66 Correlation – 0.69

TABLE 14 Correlation of predicted nitrogen requirements at various nitrogen use efficiencies with actual response for 2005–2008

Efficiency (%)	Average	Non-drought	Drought
60	0.48	0.77	0.37
55	0.52	0.83	0.65
50	0.64	0.64	0.71
45	0.71	0.45	0.74
40	0.72	0.34	0.77
35	0.62	0.36	0.54

Riverine Plains Inc
PO Box 386 Yarrawonga VIC 3730
T: (03) 5744 1713
F: (03) 5743 1740
E: info@riverineplains.com.au
W: www.riverineplains.com.au