Effect of fertiliser rate, variety and variable rate in EM38 zones in Northern Mallee, 2009

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Key messages:

- Determining paddock zones using EM38 with soil testing and "Your soils potential" model highlights the levels of production potential in paddocks.
- Zoning allows development of management prescriptions e.g. fertiliser, seeding rate etc. in order to optimise production from these areas.

Aims:

- Use Precision Agriculture technologies, especially Variable Rate to reduce risk and maximise return in continuous cropping systems.
- Use EM38 and 'Your Soils Potential' soil testing service to map subsoil constraints.
- Combine previous MSF work on subsoils and soil nutrition to help farmers manage land to its potential.
- Compare this methodology across various soil types and environments.
- To demonstrate and extend the benefits of precision agriculture technology to SA Mallee growers.

Background:

This work is the Precision Agriculture component of the SA Mallee Sustainable Agriculture project. Earlier work demonstrated clearly the benefit of using EM38 mapping in conjunction with zoning, "Your Soils Potential" and variable rate seeding technology to improve paddock gross margin in the majority of situations. In addition to setting up some new sites in 2008 we were able to access 2008 yield results from paddocks mapped previously.

Work undertaken by Rural Solutions SA in creating the 'Your Soils Potential' soil testing service has shown the benefit of understanding subsoil constraints and their influence on plant available water. When combined with EM38 it was found that there was a strong correlation between Crop Lower Limit (CLL) and EM38 in the SA Mallee. In the following discussion Zone 1 is the lightest textured soils grading down to the last zone usually being a heavy textured flat with toxic levels of salt or boron or sodicity.

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About the trial:

Paringa

Mark Stoeckel designed a trial to test variety and fertiliser responses in his paddock at Paringa. His paddock 'West Chamberlain' (137 ha) was sown to wheat on 7th May 2009, with trial treatments on the eastern end sown in a north-south orientation down the length of the paddock (1890 m). Treatments were four wheat varieties (cvv. Correll, Axe, Galdius and Young) and "Yorrell", a mixture of Young and Correll. Correll had a range of fertiliser rates (0, 30, 40 and 50 kg/ha of DAP) and Young had a plus and minus Zinc seed treatment. Treatments were not replicated but were randomised. A block of Urea at 25 kg/ha was applied post seeding and cut across all treatment strips.

The trial was harvested with yield monitoring on 17th November. Grain samples (2 kg) from key zones in the paddock, including the urea strip, were collected during harvesting and with assistance from ABB were analysed for protein, test weight, screenings and moisture.

From 2008 we had the following information about the paddock:

- EM38 soil data
- Soil physical and chemical tests from six areas in paddock (0-10, 20-40, 40-60 and 60-80 cm fractions)
- Paddock zone map developed from "Your Soils Potential" model.
- Wheat yield map of paddock
- Yield analysis of treatments by paddock zone

Results:

Grain yield was recorded continuously during harvest and logged against GPS position. Fig 1 below shows the zone map of the paddock created from the 'Your Soils Potential' results. This figure shows six EM38 zones in this experiment. In 2009 for the sake of expediting the collection of grain for quality analysis some zones were combined for the analysis. These combined zones appear in Table 1. Sandhill=EM38 zone 1, Mid-slope = EM38 zones 2-4, Flat=EM38 zones 5-6. Urea was applied to a large square area of Mid-slope (zones 2-4). Fig 2 shows the recorded grain yield from header swath. Each coloured pixel on Fig 2. represents a yield record. From this map we were able to isolate treatment strips and zones within these strips and determine the yield for individual strips and therefore treatments and also where these treatments intersect with the paddock zones as detailed above.

In Table 1 the average yield for each treatment strip is given as well as the yields for the various zones within strip. Grain samples were collected during harvest from four areas of the paddock. These were the four zones detailed above: Sandhill, Mid-slope, Flat and Urea block. Yield consolidation tables are shown in Table 2.

In Table 3 grain quality figures (protein (% whole grain), test weight (kg/hL) and screenings (%<2 mm)) are given Table 3 is also an attempt at a financial analysis. The pay grade of grain from each of the Sandhill, Mid-slope, Flat and

Urea zones is calculated from the grain quality figures (protein, test weight and screenings). The farm gate price of each grade is the best Pt. Adelaide pool price for each grade available on December 1, 2009 minus $34 freight from Paringa. The gross margin is determined by deducting the cost of the fertiliser and nutrient treatments from the gross return. Also given is the average gross margin for each treatment strip.

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Figure 1. Six EM38 zones on West Chamberlain paddock, Paringa
Sandhill=red through Mid-slope =orange to green and flats =blue to dark blue

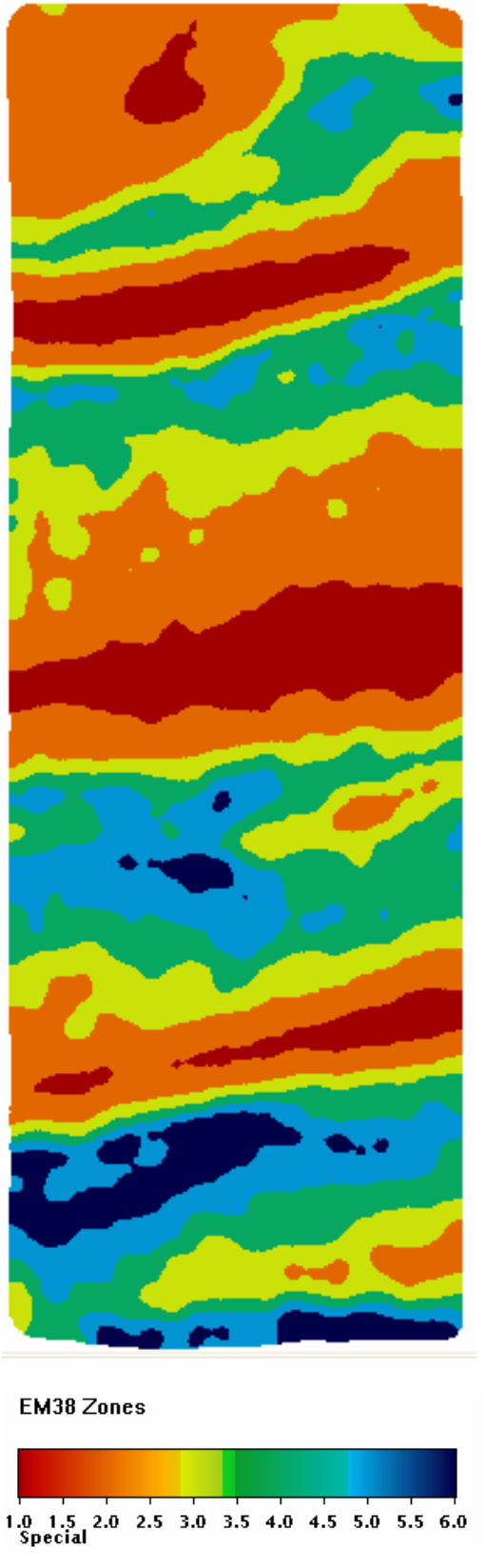

Figure 2. Yield swath map of West Chamberlain paddock. The treatment strips are shown and the square block shows the Urea application zone.

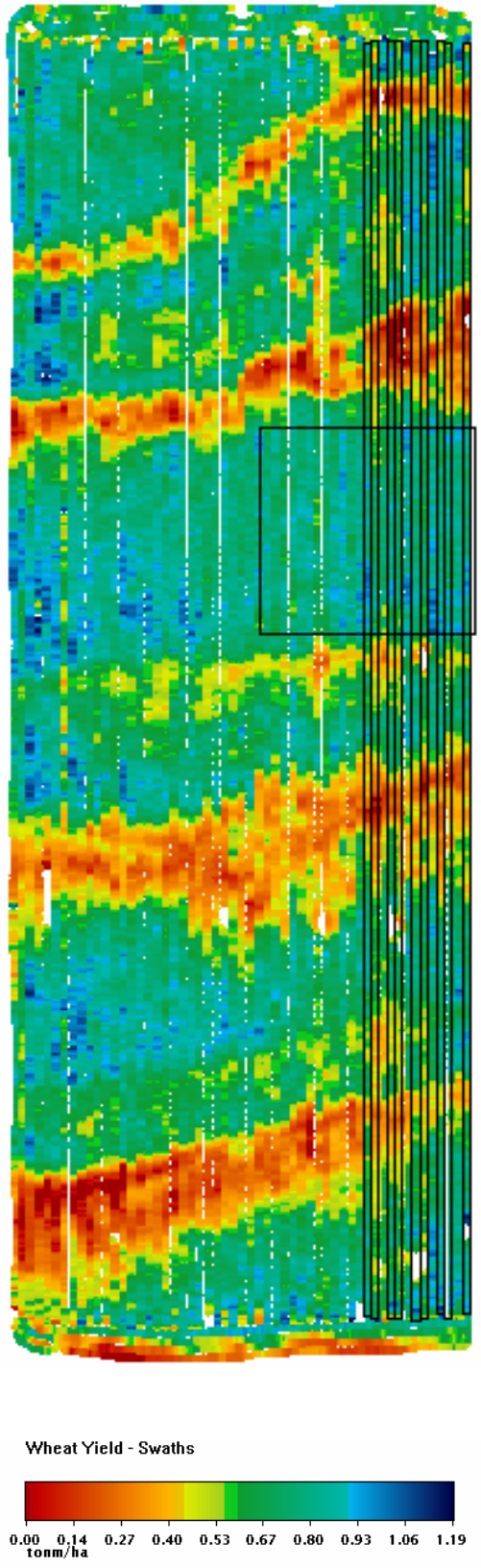

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Table 1. Variety, fertiliser, zone, area, grain yield, standard deviation and water use efficiency results for variety and fertiliser treatments, Paringa 2009

Financial Analysis -Yield and Quality

Variety Strip	Fert	Strip Yield	Zone	Area ha	Yield t/ha	SD	Rank	WUE kg/mm
Correll	0	0.504	Sandhill	0.171	0.464	0.086	30	5.7
Correll	0		Mid-slope	0.930	0.496	0.161	25	6.0
Correll	0		Flat	0.168	0.321	0.130	34	3.9
Correll	0		Urea	0.245	0.685	0.077	9	8.4
Correll	30	0.561	Sandhill	0.203	0.530	0.082	24	6.5
Correll	30		Mid-slope	1.179	0.610	0.186	19	7.4
Correll	30		Flat	0.180	0.279	0.229	35	3.4
Correll	30		Urea	0.306	0.783	0.076	4	9.5
Correll	40	0.499	Sandhill	0.193	0.494	0.056	27	6.0
Correll	40		Mid-slope	1.201	0.495	0.147	26	6.0
Correll	40		Flat	0.178	0.276	0.201	36	3.4
Correll	40		Urea	0.306	0.644	0.056	13	7.9
Correll	50	0.644	Sandhill	0.218	0.585	0.077	20	7.1
Correll	50		Mid-slope	1.153	0.630	0.164	14	7.7
Correll	50		Flat	0.214	0.479	0.149	29	5.8
Correll	50		Urea	0.306	0.848	0.085	1	10.3
Axe	40	0.639	Sandhill	0.187	0.647	0.134	11	7.9
Axe	40		Mid-slope	1.233	0.621	0.207	17	7.6
Axe	40		Flat	0.134	0.493	0.205	28	6.0
Axe	40		Urea	0.306	0.765	0.051	6	9.3
Gladius	40	0.565	Sandhill	0.187	0.534	0.111	23	6.5
Gladius	40		Mid-slope	1.405	0.555	0.176	21	6.8
Gladius	40		Flat	0.198	0.448	0.162	31	5.5
Gladius	40		Urea	0.362	0.683	0.058	10	8.3
Yorrell	40	0.633	Sandhill	0.147	0.625	0.115	16	7.6
Yorrell	40		Mid-slope	1.154	0.628	0.189	15	7.7
Yorrell	40		Flat	0.173	0.387	0.190	32	4.7
Yorrell	40		Urea	0.306	0.790	0.068	2	9.6
Young+Zn	40	0.663	Sandhill	0.173	0.718	0.086	7	8.8
Young+Zn	40		Mid-slope	1.205	0.647	0.198	11	7.9
Young+Zn	40		Flat	0.208	0.538	0.159	22	6.6
Young+Zn	40		Urea	0.306	0.775	0.076	5	9.5
Young -Zn	40	0.617	Sandhill	0.132	0.708	0.133	8	8.6
Young-Zn	40		Mid-slope	1.158	0.612	0.199	18	7.5
Young-Zn	40		Flat	0.235	0.369	0.193	33	4.5
Young-Zn	40		Urea	0.306	0.786	0.077	3	9.6
Mean					0.597	0.195		7.1

SD= standard deviation

Table 2. Consolidated tables of yield, protein, screenings and test weight by variety, zone and fertiliser rate.

Yield

Variety	Yield
Axe	0.632
Correll	0.539
Gladius	0.555
Yorrell	0.608
Young+Zn	0.670
Young-Zn	0.619

Zone	Yield
Sandhill	0.589
Mid-slope	0.588
Flat	0.399
Urea	0.751

Fert rate	Yield
0	0.504
30	0.561
40	0.593
50	0.644

Protein

Variety	Protein
Axe	10.8
Correll	9.2
Gladius	10.4
Yorrell	10.9
Young+Zn	9.6
Young-Zn	9.6

Zone	Protein
Sandhill	8.5
Mid-slope	9.8
Flat	12.0
Urea	10.3

Fert rate	Protein
0	10.4
30	10.2
40	10.1
50	10.2

Screenings

Variety	Scrn
Axe	0.6
Correll	1.1
Gladius	0.5
Yorrell	1.1
Young+Zn	0.9
Young-Zn	1.1

Zone	Scrn
Sandhill	1.0
Mid-slope	0.8
Flat	1.5
Urea	0.6

Fert rate	Scrn
0	1.2
30	1.1
40	0.9
50	1.2

Test weight

Variety	TW
Axe	82.9
Correll	80.7
Gladius	84.1
Yorrell	83.9
Young+Zn	84.6
Young-Zn	85.0

Zone	TW
Sandhill	81.0
Mid-slope	83.1
Flat	82.8
Urea	83.5

Fert rate	TW
0	80.2
30	80.4
40	83.6
50	81.0

Discussion:

Presented in Table 1 above is the yield for each of the wheat and fertiliser treatments across each of the paddock zones. Included is the standard deviation figure (SD) for each yield. This trial was not replicated and therefore is not statistically analysed, and consequently it is difficult to state with certainty if a variety or treatment was significantly better than others.

The table above shows the influence of variety and fertiliser application rate in the various paddock zones on yield and grain quality. Also included are the water use efficiency figures as kilograms of grain per mm of effective rainfall in the growing season. Smaller tables in table 2 above show the consolidated yields for variety, zone and fertiliser rates.

Varieties: Variety yields ranged from 0.67 (Young + zinc) down to 0.54t/ha (Correll). 'Yorrell' returned a better yield than a simple average of Correll and Young and may indicate that there are some unknown synergies in mixing varieties although yield was similar to Young-Zn. Not surprisingly varieties varied in their response in various zones. Young and Axe yielded relatively better on the Sandhill than in other zones. Across all varieties there was little difference in yield between Sandhill and Mid-slope zones. Generally the heavier textured the zone the lower the yield in 2009, and this was similar pattern in 2008

Nutrition: Urea was applied to a block in the paddock and the addition of 25 kg/ha of Urea increased yield across all varieties – although less so in Young than other varieties. The comparative area to the Urea block is the Mid-slope comprising EM38 zones 2-4. This difference indicates that even in low rainfall and difficult season additional N nutrition on the lighter soils can have a significant effect on yield. This is also highlighted by the addition of Zinc to Young, increasing yield across every zone in the paddock.

Water use efficiency (WUE) figures range from 3.4 to 10.3 kg/mm. An average evaporation figure of 80 mm is used throughout. The WUE figures are much lower than expected though reflect the difficult season experienced, not only with low rainfall and no sub soil moisture but periods of below decile 1 rainfall and high evaporation and temperatures at flowering stage in mid September.

Fertiliser: The addition of fertiliser to Correll increased yields across all zones although given the yields, the zero fertiliser would again show the best gross margin.

Rainfall: Paringa recorded a decile 4 year in 2009 with growing season rainfall of 162 mm, which should have produced higher yields but it is the timing and drought and temperature stresses which are reflected in the very low yields (0.58 t/ha). Nevertheless, the grower, Mark Stoeckel, now has the information to understand why his paddocks and zones within the paddock are responding as they do and make adjustments and to continue his experiment.

Grain quality: The effect of treatments on grain quality is seen in table 3 and in the consolidated results in table 4. The first consistent feature is protein which increases with zone but dropps off in the urea zone. Proteins from the Sandhill were generally below 10% and as low as 7.5%. Mid-slope proteins were little better with some varieties (Yorrell, Gladius and Correll) recording above 10%. Most varieties would have achieved H2 (>11.5%) grade in the Flat zone. The addition of Urea appears to increase yield at the expense of protein. Most grain from the Urea zone would have made minimum APW standards.

Screenings were low (<2%) across all treatments and there appears no real trend or patterns. Test weights were mostly all above 80 kg/hL with the exception of a few treatments with Correll, which is not unexpected. Variety seems to be the greatest influence in test weight with no obvious trends.

Table 3. Grain yield, quality and gross margin by variety, zone and fertiliser rate

Variety Strip	Fert	Strip Yield	Zone	Yield t/ha	Protein	Scrn	TW	Pay Grade	farm gate $/tonne	$/ha Return	$/ha Fert cost	$/ha GM	Rank	from top diff	Strip Averages
Correll	0	0.504	Sandhill	0.464	9.6	1.4	78.6	ASW1	178.25	82.71	0.00	82.71	15	-29.69	
Correll	0		Mid-slope	0.496	10.1	0.9	81.7	ASW1	178.25	88.41	0.00	88.41	11	-23.99	
Correll	0		Flat	0.321	11.8	1.8	78.3	H2	197.25	63.32	0.00	63.32	28	-49.08	
Correll	0		Urea	0.685	10.1	0.5	82.3	ASW1	178.25	122.10	12.50	109.60	2	-2.80	86.01
Correll	30	0.561	Sandhill	0.530	8.5	1.4	77.0	ASW1	178.25	94.47	22.50	71.97	24	-40.43	
Correll	30		Mid-slope	0.610	9.5	0.8	81.4	ASW1	178.25	108.73	22.50	86.23	12	-26.17	
Correll	30		Flat	0.279	11.8	1.2	82.5	H2	197.25	55.03	22.50	32.53	35	-79.87	
Correll	30		Urea	0.783	10.8	0.9	80.5	APW1	188.25	147.40	35.00	112.40	1	0.00	75.78
Correll	40	0.499	Sandhill	0.494	8.6	1.1	79.6	ASW1	178.25	88.06	30.00	58.06	30	-54.34	
Correll	40		Mid-slope	0.495	10.1	0.9	82.0	ASW1	178.25	88.23	30.00	58.23	29	-54.17	
Correll	40		Flat	0.276	13.0	1.8	80.7	H1	202.25	55.82	30.00	25.82	36	-86.58	
Correll	40		Urea	0.644	10.1	0.6	82.8	ASW1	178.25	114.79	42.50	72.29	22	-40.11	53.60
Correll	50	0.644	Sandhill	0.585	8.6	1.2	77.2	ASW1	178.25	104.28	37.50	66.78	26	-45.62	
Correll	50		Mid-slope	0.630	9.9	0.9	81.9	ASW1	178.25	112.30	37.50	74.80	20	-37.60	
Correll	50		Flat	0.479	12.2	2.2	83.2	H2	197.25	94.48	37.50	56.98	31	-55.42	
Correll	50		Urea	0.848	10.0	0.6	81.9	ASW1	178.25	151.16	50.00	101.16	4	-11.24	74.93
Axe	40	0.639	Sandhill	0.647	7.9	0.6	81.6	ASW1	178.25	115.33	30.00	85.33	14	-27.07	
Axe	40		Mid-slope	0.621	8.7	0.3	83.0	ASW1	178.25	110.69	30.00	80.69	18	-31.71	
Axe	40		Flat	0.493	12.6	1.1	83.7	H2	197.25	97.24	30.00	67.24	25	-45.16	
Axe	40		Urea	0.765	10.3	0.4	83.3	ASW1	178.25	136.36	42.50	93.86	9	-18.54	81.78
Gladius	40	0.565	Sandhill	0.534	8.2	0.5	83.1	ASW1	178.25	95.19	30.00	65.19	27	-47.21	
Gladius	40		Mid-slope	0.555	11.0	0.5	83.5	APW1	188.25	104.48	30.00	74.48	21	-37.92	
Gladius	40		Flat	0.448	11.2	0.6	84.4	APW1	188.25	84.34	30.00	54.34	32	-58.06	
Gladius	40		Urea	0.683	11.0	0.4	85.4	APW1	188.25	128.57	42.50	86.07	13	-26.33	70.02
Yorrell	40	0.633	Sandhill	0.625	9.3	0.9	83.4	ASW1	178.25	111.41	30.00	81.41	16	-30.99	
Yorrell	40		Mid-slope	0.628	12.3	1.4	84.7	H2	197.25	123.87	30.00	93.87	8	-18.53	
Yorrell	40		Flat	0.387	11.3	1.1	83.7	APW1	188.25	72.85	30.00	42.85	33	-69.55	
Yorrell	40		Urea	0.790	10.8	1.0	83.7	APW1	188.25	148.72	42.50	106.22	3	-6.18	81.09
Young+Zn	40	0.663	Sandhill	0.718	7.5	1.0	84.2	ASW1	178.25	127.98	34.00	93.98	7	-18.42	
Young+Zn	40		Mid-slope	0.647	8.8	0.7	85.1	ASW1	178.25	115.33	34.00	81.33	17	-31.07	
Young+Zn	40		Flat	0.538	12.3	1.5	83.7	H2	197.25	106.12	34.00	72.12	23	-40.28	
Young+Zn	40		Urea	0.775	9.7	0.5	85.5	ASW1	178.25	138.14	46.50	91.64	10	-20.76	84.77
Young -Zn	40	0.617	Sandhill	0.708	8.0	1.0	84.5	ASW1	178.25	126.20	30.00	96.20	6	-16.20	
Young-Zn	40		Mid-slope	0.612	8.1	1.0	84.2	ASW1	178.25	109.09	30.00	79.09	19	-33.31	
Young-Zn	40		Flat	0.369	12.1	1.9	85.0	H2	197.25	72.79	30.00	42.79	34	-69.61	
Young-Zn	40		Urea	0.786	10.3	0.6	86.4	ASW1	178.25	140.10	42.50	97.60	5	-14.80	78.92
Mean				0.597	10.2	1.0	82.6				Av.	76.32			

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Gross Margins: The biggest GM difference between the best and worst of the treatments was $86.58. Generally the best GM's were where Urea had been applied - apart from variety Young on Sandhills the applied Urea treatments dominated the best gross margins. The discrepancy was the Young on Sandhill which yielded as well as the Urea treatments. It is worth remembering that as this trial is not analysed that these difference could be due to chance.

Table 4 below is a consolidation of Table 3 showing gross margins for treatments or varieties or paddock zones and the prices used along with the receival standards used. The addition of Urea on average added $17.08 above the GM of the next best which was the Mid-slope zone. The variety with the best GM was Axe followed by Yorrell. The addition of Zinc to Young improved the GM by $5.85. By not putting fertiliser on Mark improved his GM $11.00 over other fertiliser treatments. The GM of other fertiliser rates were all within $1 of each other indicating no advantage with increased fertiliser rates.

Table 4. Consolidated gross margin by variety, zone and fertiliser rate. Grain and fertiliser prices and wheat grade receival standards

Variety	GM
Axe	81.78
Correll	72.58
Gladius	70.02
Yorrell	81.09
Young+Zn	84.77
Young-Zn	78.92

Fert rate	GM
0	86.01
30	75.78
40	75.03
50	74.93

Zone	GM
Sandhill	77.96
Mid-slope	79.68
Flat	50.89
Urea	96.76

Product	$/t	rate	$/kg	$/ha
DAP	750.00	variable	0.75	
Urea	500.00	25.00		12.50
Zn				4

receival standards

Grade	Protein	TW	Scrn	farm gate Price
H1	13	74	5	202.25
H2	11.5	74	5	197.25
APW1	10.5	74	5	188.25
ASW1		74	10	178.25
AGP1		68	10	176.00

Who's Involved:
The trial is supported by:

- Grower: Mark Stoeckel (Paringa),
- Consultant: Peter Treloar, Precision Ag Services, Visions Ag.

Future Directions:
The work will continue under the current Caring for our Country SA Mallee project. The technology enables us the conduct and analyse large scale trials, like this one at Paringa and get good results. We are at this point still waiting for that wetter year to assess the lower rates on the heavier soils.

Future work will also look at paddocks that have been in the EM38 program to monitor longer-term results. Work may also be expanded to look at paddocks under long-term no-till continuous cereal systems, which preseason soil testing has shown a lack of available nitrogen. Whether this is having an affect where rates are cut needs to be explored. There is a possibility of using EM38 zones in larger agronomic trials such as time of sowing or disease control. There are many possibilities emerging with EM38 and GPS technology.

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