Precision Ag Trials

Soil Type Specific Nitrogen Responses

Mildura, Victorian Mallee

Although PA tools have been available to Australian grain growers for many years, and the benefits have been well documented, it is estimated that less than 1-% of grain growers utilise PA 'beyond guidance' in any form.

The objective of this GRDC / SPAA funded project is to increase the level of adoption of PA 'beyond guidance' by broadacre farmers. The project specifically aims to increase the level of adoption of variable rate (VR) by growers in the project to 30% by 2013. This goal will be achieved by demonstrating how to use PA tools to growers at a regional level and by increasing the skills of growers and industry in PA to a level where they can then use PA tools in their farming systems to achieve economic, environmental and social benefits.

Trials and demonstrations are conducted on growers' properties and are visited throughout the season using farm walks and workshops to discuss the advantages and disadvantages of PA techniques with the involvement of other regional growers.

This information sheet presents the outcomes of the SPAA trial **Soil Specific Nitrogen Responses** from season 2011.

Aims:

- To use PA maps to indentify and sample soil zones within a paddock
- To identify potential soil specific nitrogen responses within paddocks

Background:

There has been widespread use of continuous cereal in the Mallee over the past decade and one of the major issues associated with this system is the risk associated with the high nitrogen requirements of intensive cropping. By identifying soils and conditions where continuous cereal systems perform best and where inputs can be most effectively targeted, there is an opportunity to reduce risk and increase profitability. This trial used PA methods to identify soil types for targeted soil sampling to achieve a greater understanding of potential crop responses to nitrogen fertilisers in different soil zones. Yield mapping was then used to identify if and where nitrogen applied to the crop increased yield.

About the trial:

The trial paddock was located 25 km west of Mildura in the Victorian Mallee (Figure 1). The crop management details are listed below:

Crop type: Wheat

- **Variety:** Axe
- **Sowing Date:** 2nd May 2011
- **Sowing Rate:** 30kg/hectare
- **Sowing Fertiliser:** M.A.P 30-50kg/hectare Variable Rate.

Figure 1. Location of the focus paddock

Fertiliser was applied at a variable rate with a Topcon X20 screen and Bourgult air cart. Fertiliser rates varied from 30 to 50 kg/ha. Fertiliser application maps were developed by the farmer from the previous season's yield map.

The fertiliser application map was also used to select three soil sampling locations (dune & midslope and swale). At each location five soil cores to 1.2 m were collected and anaysed for soil water, nitrogen and subsoil contriaints. The topsoil was also assesed for soil fertility.

Nitrogen Rich Strips (N Rich strips) were applied to the focus paddock on the 27th of July 2011. Three N Rich treatments were applied:

- Urea @ 100 kg/ha (Nitrogen=42 kg/ha)
- Urea @ 50 kg/ha (Nitrogen=21 kg/ha)

A control strip (no incrop fertiliser applied) was left either side of each treatment (Figure 3).

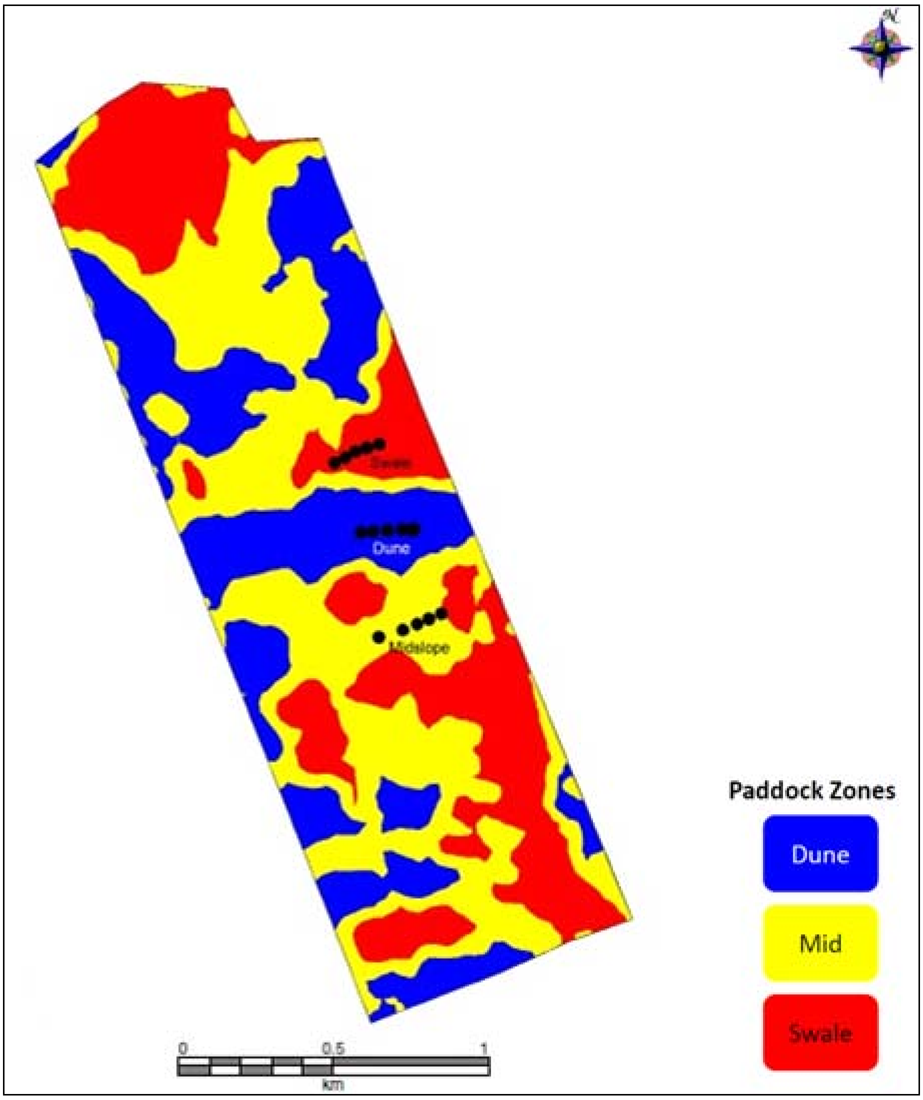

Figure 2. Zone map of the focus paddocks including soil sampling locations (Dune, Midslope and Swale)

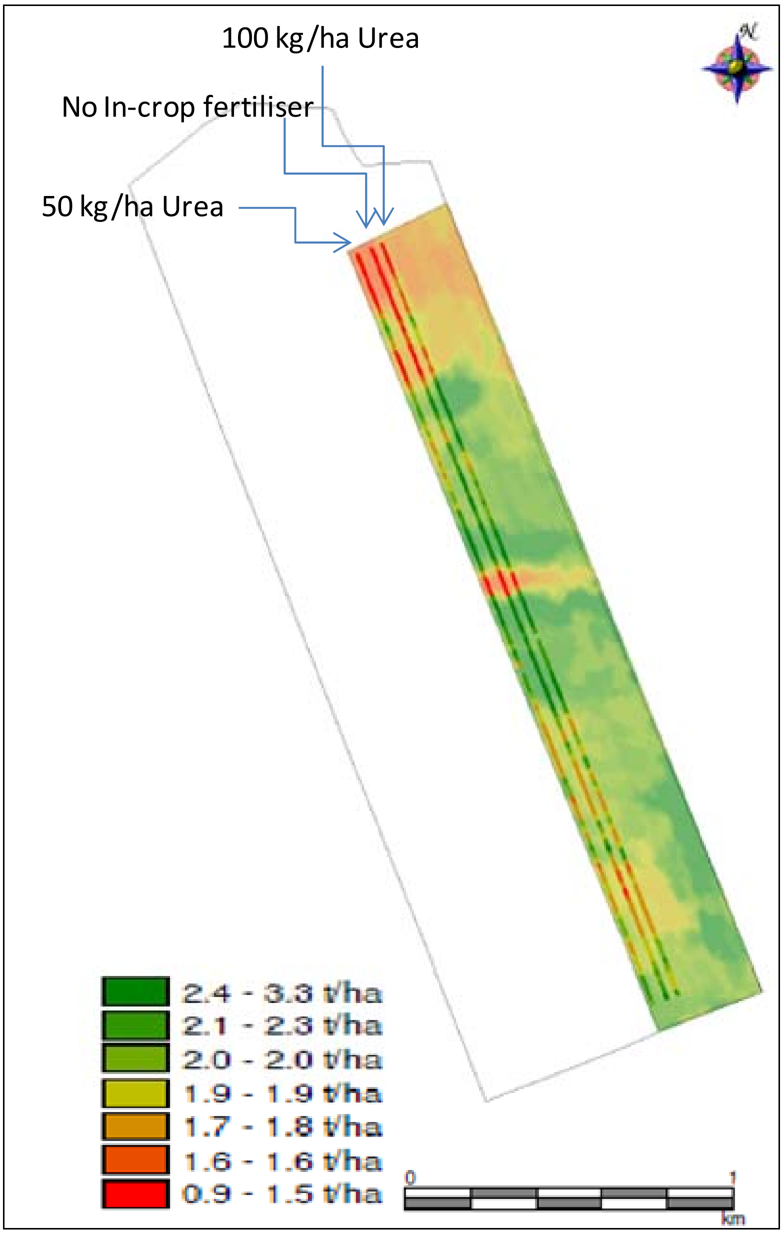

Figure 3. Focus paddock yield map (2011) showing the treatment strips of 100kg/ha of Urea (42 kg N/ha) and 50kg/ha of Urea (21 kg N/ha). The background yield map has been limited to the trial area as two headers were used in the paddock but only one had yield mapping ability.

Assessments:

The following soil parameters were measured for three soil types in the paddock:

- **Topsoil fertility (0-10cm):** Carbon, Phosphorus, Phosphorus Buffering index (PBI), Nitrogen, Potassium, Sulphur, pH and Electrical Conductivity (EC)
- **Subsoil (10-30, 30-60, 60-90, 90-120cm):** Nitrogen, pH, EC, Boron and Chloride

The yields of both the treatments and the control strips were measured. Yield was averaged in 20m sections for one header run closest to the middle of the treatment strip.

Protein samples were also collected from six locations along the two N Rich strips and the control strip located between the treatments. Samples were collected from the grain tank and analysed at a Vitera grain receiver site.

Figure 4. Harvesting the N Rich treatment strips

Normalised Differential Vegetation Index (NDVI) was also assessed using two methods. A Greenseeker was used to map treatment strips on the 5th of September. Satellite (Landsat) NDVI data was also generated to show biomass growth differences the paddocks scale.

Results:

Soil testing prior to sowing revealed that most soil parameters were highly variable between the three soil types assessed. Phosphorus levels were marginal on the dune (Colwell P = 15), but were much higher on the midslope (36) and swale (34) (Table 1). Soil mineral nitrogen levels were also very low in the dune soil in comparison with the other two soil types. Subsoil constraints were evident on the midslope and swale, while no chemical constraints were found on the dune. It is estimated that boron and electrical conductivity may limit rooting depth to 75cm on the midslope and 60cm on the swale.

Table 1. Topsoil soil test results for the dune, midslope and swale sampling locations

Top Soil Analysis				
Test		Dune	Midslope	Swale
		0-10	0-10	0-10
Ammonium N	mg/Kg	< 1	2	1
Nitrate N	mg/Kg	5	43	35
P (Colwell)	mg/Kg	15	36	34
K (Colwell)	mg/Kg	298	518	737
S	mg/Kg	3.2	6.3	7.1
Conductivity	dS/m	0.091	0.186	0.218
pH ($CaCl_2$)	pH	7.9	7.9	7.8
PBI		36.1	94.7	128.4

Table 2. Subsoil (0-120cm) soil test results for the dune, midslope and swale sampling locations

Subsoil Analysis					
Soil Type		**Depth Layer**			
Dune		10-30	30-60	60-90	90-120
Ammonium N	mg/Kg	< 1	< 1	< 1	< 1
Nitrate N	mg/Kg	1	< 1	3	2
Conductivity	dS/m	0.095	0.081	0.183	0.098
pH ($CaCl_2$)	pH	8	8	8.2	8.1
Boron Hot $CaCl_2$	mg/Kg	0.49	0.54	1.94	0.83
Chloride	mg/Kg	< 1	< 1	< 1	< 1
Midslope		10-30	30-60	60-90	90-120
Ammonium N	mg/Kg	< 1	3	1	1
Nitrate N	mg/Kg	9	4	6	6
Conductivity	dS/m	0.189	0.353	6.11	2.67
pH ($CaCl_2$)	pH	8	8.1	8.1	8
Boron Hot $CaCl_2$	mg/Kg	1.3	5.9	16.23	26.16
Chloride	mg/Kg	< 1	< 1	8.3	260.8
Swale		10-30	30-60	60-90	90-120
Ammonium N	mg/Kg	< 1	< 1	< 1	1
Nitrate N	mg/Kg	6	4	10	20
Conductivity	dS/m	0.264	0.363	1.795	5.625
pH ($CaCl_2$)	pH	8.1	8.1	8	8
Boron Hot $CaCl_2$	mg/Kg	2.73	12.13	23.84	36.79
Chloride	mg/Kg	13.4	14.3	166.6	629.3

The focus paddock yields were highly variable and ranged from 0.9 – 3.3 t/ha in the area where the N Rich strips where implemented (Figure 3). The highest yielding zone in the paddock was the midslope followed by the swale with the sandiest parts of the paddock generally performing the worst in 2011. The 2011 season was characterised by record summer rainfall followed by a dry growing season. However, the summer rainfall resulted in high sub-soil moisture levels prior to seeding, especially on the heavier soil types; the high summer rainfall also caused low nitrogen levels on the sands as a result of leaching.

Figure 5 compares the yields in the 100 kg/ha of urea N Rich strip to the average yield of two strips either side where no in-crop fertiliser was applied. In 2011, grain yield was not increased by the application of urea (with a possible exception of the sandy rise at the north end of the paddock). However, protein was increased in the N Rich strips compared to where no nitrogen was applied. The urea was applied on the 27th of July 2011 ahead of forecast rain; however, rainfall did not eventuate for another fortnight. As the variety was Axe which has a short growing season, the delay in the urea being washed into the soil and therefore the nitrogen being available to the crop may have limited the capacity for the additional nitrogen to promote growth and yield. Despite this, the nitrogen was still taken up by the crop and this increased grain protein.

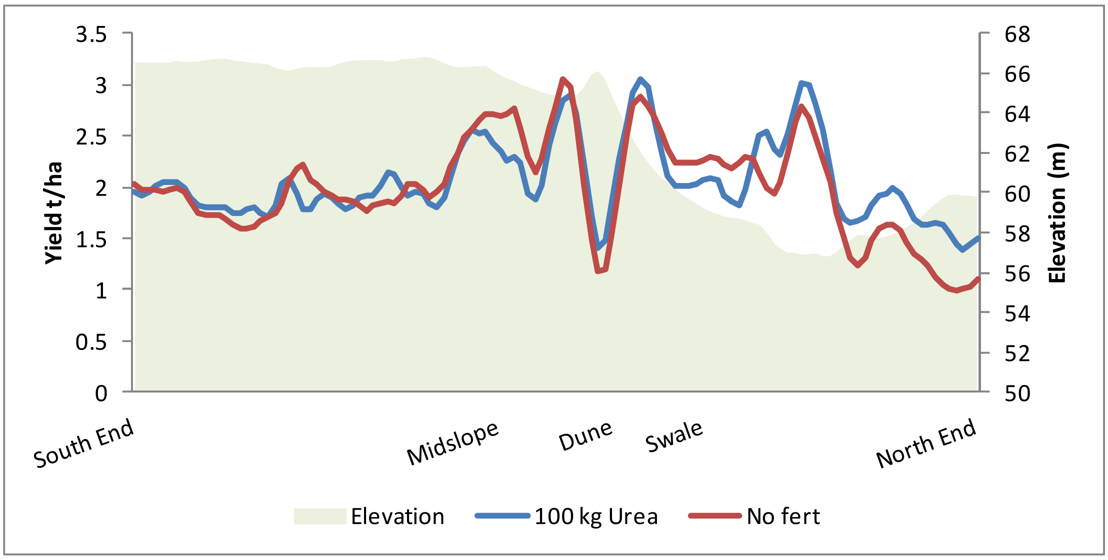

Figure 5. Yields of the 100 kg/ha urea treatment along the trial strip compared to the average yield of the two no fertiliser treatments either side. Yields were averaged for 20m blocks of one header width in the middle of the treatment. Each 20m block was then averaged with the two blocks either side to create a moving average of 60m. Elevation recorded by the header (RTK 2cm) has been plotted in the background.

Figure 6 shows the six protein sampling locations; the protein analysis results are provided in Table 3. Averaged across all sampling locations, protein levels increased by 0.6% in the 50kg/ha of urea treatment and by 1% in the 100kg/ha of urea treatment relative to the nil in-crop fertiliser strip. This increase in protein was enough to improve grain quality from Australian Standard White (ASW) to Australian Premium White (APW) at four of the six sampling locations (Table 4). On the day of harvest at the nearest grain receiver site (Yelta), the ASW silo cash price was \$127/t and APW was \$158/t. At a urea cost of \$620/t, the application of 50 kg/ha of urea costs \$31/ha (fertiliser cost only). Therefore, at the four sites where grain quality was improved, a small profit was made (15 – 55 \$/ha) with the application of 50 kg/ha of fertiliser. However, at one third of the protein sampling sites, a loss of \$31/ha was incurred as there was no difference in grain quality between the treatments.

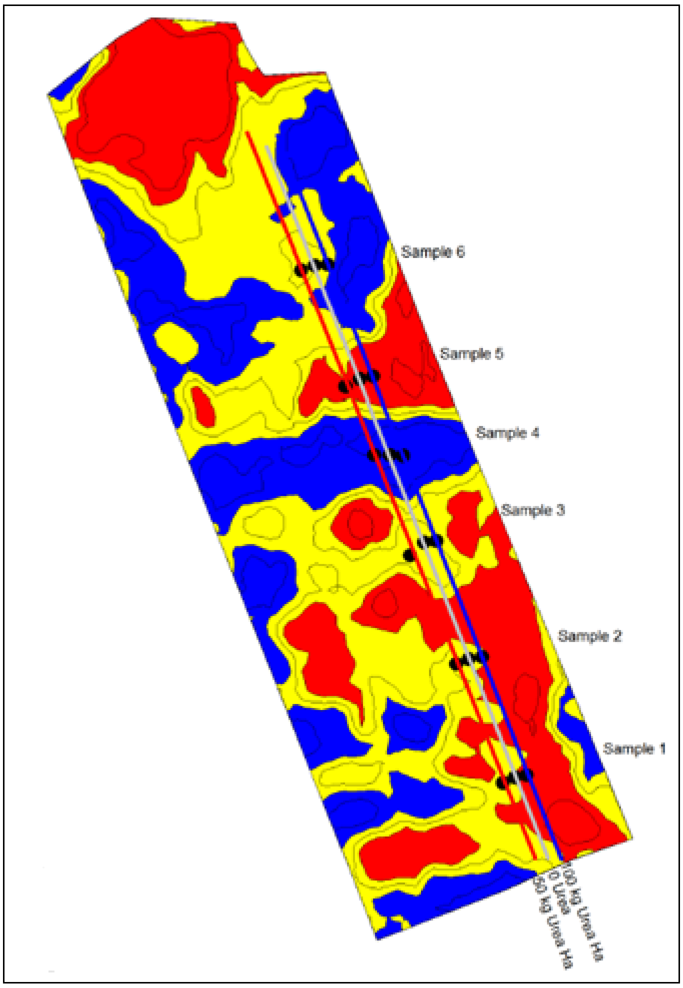

Figure 6. The six protein sample locations

Table 3. Protein sample results at 6 sampling locations for the two N Rich Strips (50 and 100 kg Urea/ha) and the nil in-crop fertiliser strip between the two treatments. The average yield across all three treatments at each sampling location is also provided.

Sample Location	Sample Point Yield (t/ha)	Treatment and Protein %		
		Nil Fertiliser	50 kg/ha Urea	100 kg/ha Urea
1	1.8	10.3	10.7	11.2
2	1.7	10.2	10.8	11.0
3	2.8	9.9	10.5	11.0
4	1.3	9.1	10.1	10.4
5	2.2	10.9	11.0	11.5
6	1.5	9.4	10.5	10.9

Table 4. Grain quality grade at 6 sampling locations for the two N Rich Strips (50 and 100 kg Urea/ha) and the nil in-crop fertiliser strip between the two treatments.

Sample Location	Treatment		
	Nil Fertiliser	50 kg/ha Urea	100 kg/ha Urea
1	ASW	APW	APW
2	ASW	APW	APW
3	ASW	APW	APW
4	ASW	ASW	ASW
5	APW	APW	APW
6	ASW	APW	APW

The NDVI of the two N Rich strips and a control strip was measured with a GreenSeeker on the 7th of September (Figure 7). The NDVI is related to crop biomass and greenness. The NDVI in September was positively correlated with the final grain yield (r^2=0.75). Furthermore, no crop response to the N Rich strips was evident through the GreenSeeker data.

Satellite NDVI imagery was also sourced for the paddock (Figure 8). The NDVI imagery captured on the 23rd of August aligns closely with the zone map generated for the paddock (Figure 2) and the 2011 yield map for the trial strip area (Figure 3). Therefore satellite NDVI imagery is a cheap and effective data layer that could be used for defining production zones in this paddock. The satellite NDVI data was purchased from PA Source (www.pasource.com.au).

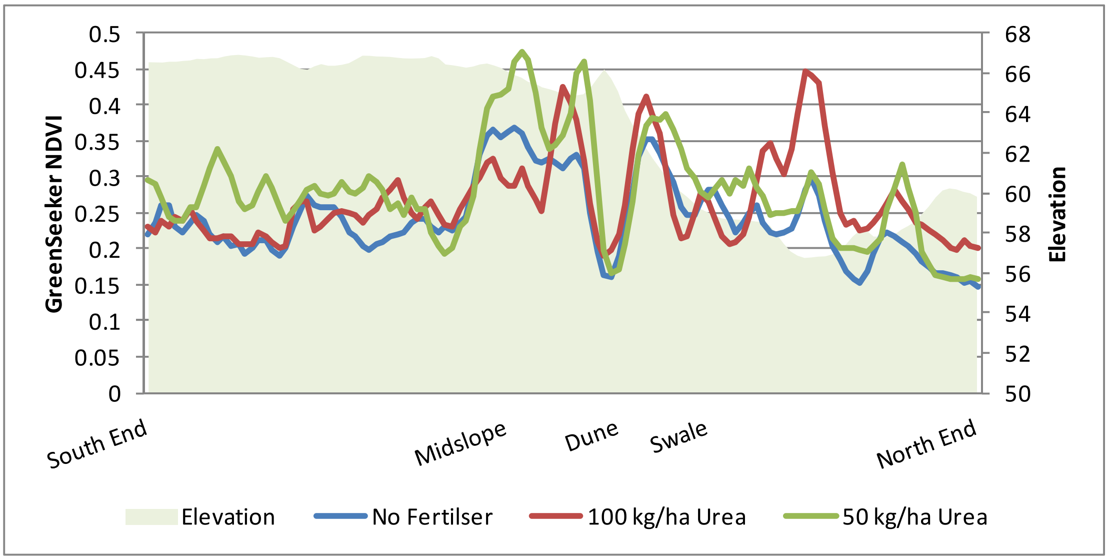

Figure 7. Normalised Differential Vegetation Index (NDVI) measured with a GreenSeeker on the 7th of September 2011. NDVI was averaged for 20m blocks for each treatment and each 20m block was then averaged with the two blocks either side to create a moving average of 60m. Elevation recorded by the header has been plotted in the background.

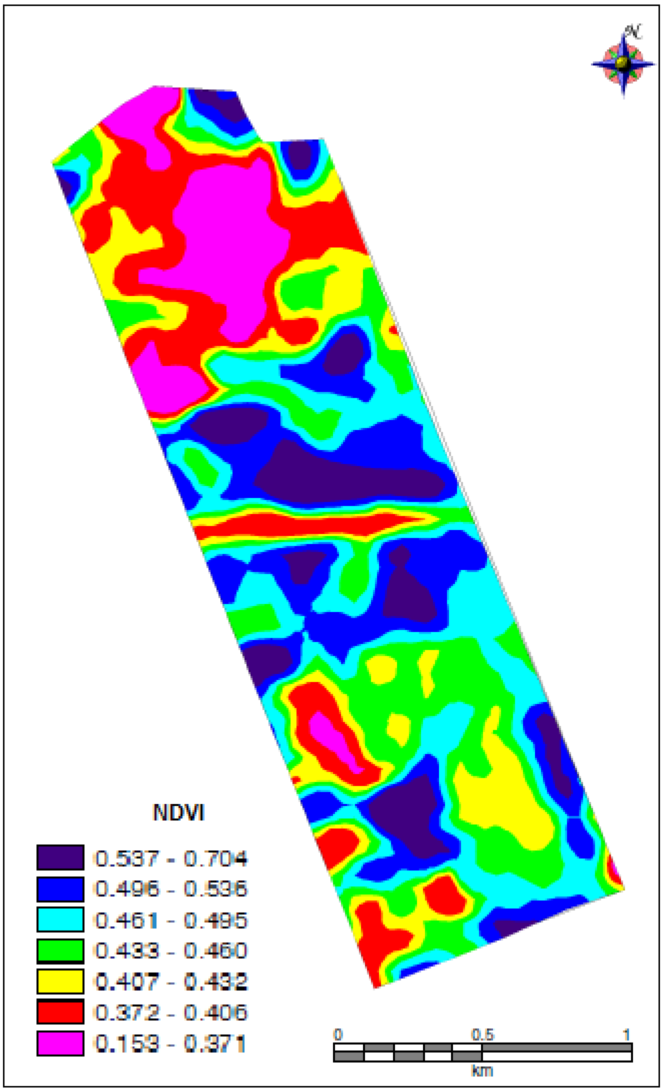

Figure 8. Additional yield generated through the application of nitrogen fertiliser (Urea/SOA treatment).

Who was involved?

Colin and Chris Hunt, Collaborating farmers, Mildura

Michael Moodie, Mallee Sustainable Farming

Grower/Regional feedback:

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