Southern Precision Agriculture Association

PO Box 83 Strathalbyn | South Australia 5255
P 08 8536 3958 | **F** 08 8536 3734| **M** 0408 088 624
E info@spaa.com.au | **www.spaa.com.au**

Research Report

Project Title: Improvement of nutrient management through effective use of precision agriculture technologies in the southern Australian grains industry.

Final Report - Additional Pages

Funded by GRDC

Output 2

Results of large scale field experiments to assess the economic value of variable rate inputs.

Results

1. Urania, Lower Yorke Peninsula - nitrogen nutrition in barley

Paddock 146A at Urania is typical of the lighter soil paddocks of this part of Yorke Peninsula. It has loamy flats, with some subsoil sodicity and salinity, interspersed with lower fertility sand hills. Three zones of contrasting soil types were identified for paddock 146A using EM38, grain yield and elevation data. Nutrient analysis of cereal leaf tissue and grain in 2004 showed that zone 3 was deficient in copper and manganese. Available nitrogen and sulphur in the soil (0 to 60cm) was also much lower in zone 3 than in the other zones. Nitrogen was applied post emergence in large blocks (approx 40m x 100m) at 3 rates (20, 50 and 100kg/ha) with 2 replicates of each rate in each zone to wheat in 2004 and barley in 2005 and 2006.

In 2004, there was a grain yield response (of approx. 0.4t/ha) to applied nitrogen fertiliser in zone 3 (the sand hill) only. This zone had the lowest amount of available soil nitrogen and the lowest organic carbon. In contrast there was a yield decrease (of approx. 0.5t/ha) with applied nitrogen in the zone 2 (the flats) with the heavier soil type and higher soil nitrogen. There was no response to nitrogen in zone 1 (the transition zone).
In 2005 there was some grain yield response in barley to applied nitrogen fertiliser in all zones, with the greatest response in the heavier soil zone (approx. 0.6t/ha) and less response in the transition soil or the sand hill (approx. 0.2t/ha). Yields of the cereal crops were similar both years (approx. 3t/ha). A likely explanation of the greater response of barley than wheat in the flats is the greater tolerance of barley than wheat to salinity.

2. Yeelanna, Lower Eyre Peninsula - nitrogen nutrition in wheat & barley

Paddocks in lower Eyre Peninsula are typically undulating with big changes in soil types, from ironstone gravel to cracking clays to limestone, over relatively short distances. These paddocks may also contain sodic and saline areas. The paddock Front South West was zoned into 3 clusters based on an EM map and elevation. Three different nitrogen treatments were applied to wheat in strips 66m wide and 700m long and covering each of the 3 zones. Post emergent nitrogen treatments were applied at crop growth stage 33.

There was a trend for greater grain yield at the highest N rates but not with any specific timing.

In 2005, two nitrogen rates (14 and 37kgN/ha) were applied in large blocks 33m wide and 100m long) at sowing in zones 1 and 2 before sowing barley. The surrounding crop received 60kg N/ha. Available soil nitrogen (0 to 60cm) was much higher in the lower EM zone (zone 1) (159kg/ha) than in the higher EM zone (zone 2) (89kg/ha).

Higher rates of nitrogen produced a much higher crop biomass, but the highest grain yields were achieved with the intermediate nitrogen rate (Table 1). Grain yields and responses to nitrogen fertiliser were greatest in the lower EM zone than in the higher EM zone. The lower grain yield in zone 2 at the highest nitrogen rate was due to the higher crop biomass and greater lodging compared with lower rates or in the other zone.

Table 1. Grain yield (t/ha) of barley with different nitrogen rates at sowing, Front South West paddock, Yeelanna, 2005.

Nitrogen rate (kg/ha)	Zone 1 (lower EM)		Zone 2 (higher EM)	
	Grain yield (t/ha)	Relative to 14kgN/ha	Grain yield (t/ha)	Relative to 14kgN/ha
14	3.29		2.85	
37	3.72	+0.43	3.15	+0.30
60	3.53	+0.24	2.78	-0.07

3. Buckleboo, Upper Eyre Peninsula - subsoil ripping & fertiliser placement

The value of using EM38 mapping to zone typical lower rainfall undulating country with sand hills and shallower and heavier textured soils in the flats was tested in a paddock (Berkshires) at Buckleboo on Eyre Peninsula. Deep ripping treatments, with and without deep placement of P, N and Zn fertilisers, were applied across the zones to assess whether or not the benefits of these expensive treatments can be more accurately located according to the EM mapping.

The greatest wheat yield response to ripping was in the lowest EM zone (with the lightest soil) and the least response was in the highest EM zone (the heaviest soil) (Table 2). There was no yield response to added fertiliser applied to depth when ripping.

There was only a small difference in the available phosphorus between the two EM zones (28ppm in the higher EM zone (the heavier soil type) compared with 24ppm in the lower EM zone (the lighter soil type)). However, leaf tissue P was higher in wheat grown on the flats (2180mg/kg) compared with the sand hill (1680mg/kg) suggesting the opportunity for economic use of differential P applications in future.

Table 2. Grain yield responses in wheat to deep ripping and fertiliser placements in 3 zones, Berkshires paddock, Buckleboo, 2006.

	Grain yield of wheat (t//ha)		
Treatment	Low EM zone (hill)	Medium EM zone (slope)	High EM zone (flat)
No ripping or extra fertiliser	0.68	0.45	0.18
Deep rip only	1.11	0.68	0.21
Deep rip + granular fertiliser	1.09	0.65	0.28
Deep rip + fluid fertiliser	1.06	0.63	0.19
Average of ripping treatments	1.08	0.65	0.19
Yield response to deep ripping	0.40	0.20	0.01

4. Waikerie, Murray Mallee - cereal types and phosphorus replacement

At a second lower rainfall site, at Waikerie, in the Murray Mallee, the differences in soil depth were far greater than at Buckleboo. In this paddock (Kroehns Corner) the soil on the flats was very shallow over subsoil high in boron and sodicity and interspersed with limestone rock whereas the hills had a deeper lighter textured soil with less boron and sodicity. Crop growth on the flats is typically thicker than on sand hills but grain yields are less most years. Soil P levels (0 to 10cm) do not vary markedly across the different soil types: 19ppm for soil in the flats, 17ppm in the slopes and 11ppm in the sand hills.

Different P treatments were applied in 2005 & 2006 to test the concept of reducing rates where the crop is likely to yield lower (on the flats) and possibly increasing them where the crop is likely to yield more. As well, in 2005, the value of growing a different cereal crop on the flats (triticale) compared with the sand hill (barley) was also tested.

Grain yield responses in 2005 to applied P were greater in the lighter soil zone (sand hill) than in the heavier soil zone (flat) (Table 3). The most economic rate for both zones was 3kgP/ha. A higher rate of P (11kg/ha) increased grain yield on the lighter soil (zone 2) more than on the heavier shallow soil (zone 1). This is consistent with lower leaf tissue P from the crop on the sand hill (3,000mg/kg) than on the flat (3,700mg/kg).

Table 3. Grain yield responses in barley to different P fertiliser rates in 2 zones, Kroehns Corner paddock, Waikerie, 2005.

	Grain yield (t/ha)		Yield increase (t/ha) needed for the cost of the extra fertiliser
P rate (kg/ha)	Flat (heavy soil)	Hill (light soil)	
0	1.23	1.33	
3	1.28	1.40	0.04
11	1.07	1.49	0.16

In this trial the grain yield of triticale was the same on the flats (1.3t/ha) as on the sand hill. Likewise, the barley grain yield was also similar on the flats (1.47t/ha) as on the sand hill (1.48t/ha).

In 2006, grain yield responses of barley and triticale to different rates of P and N fertiliser were compared for 3 different zones (flat, slope and hill) in this paddock. In each zone two rates were compared, one rate for an average year and a lower rate.

As in 2005, grain yields were lower on the flats than on the sand hills. However, in these lower yielding crops grain yield responses to P and N were relatively small. In only two cases for triticale (on the flats and hills) did yield increases cover the cost of the extra fertiliser (0.07t/ha) within a zone and in one case (in the transition zone) for the barley (0.06t/ha).

5. Rupanyup, Victorian Wimmera

a). Phosphorus replacement

The concept of applying phosphorus rates according to a yield map of the previous crop was tested in a wheat crop in paddock WEP20 at Rupanyup in 2005. The canola crop the previous year had two distinct seed yield zones, due to differences in the paddock management in 2003. This was most likely due to differences in available soil water after medic in part of the paddock was cut for hay and in another part was spray fallowed later that season. Three rates of P fertiliser (0, 5.5 and 11kg/ha) were applied to blocks in each zone.

Leaf tissue P at growth stage 15 was similar for all treatments and zones. All treatments, including nil P had adequate levels of tissue P. Also, there were negligible differences in grain yield of wheat with different P rates in each zone.

b). Applying Yield Prophet to zones within paddocks

The value of Yield Prophet to assist with post emergent nitrogen fertiliser decisions in zones was tested in a paddock (WEP1095) at Rupanyup, in the Victorian Wimmera in 2006. This paddock was classed into two zones based on grain yields and a gamma radiometric survey. These zones were consistent with the two distinct soil types in the paddock, a Wimmera grey clay and a red loam. The available N in the soil profile was similar between the zones although Colwell P was lower in the grey clay zone than in the red loam zone due in part to greater crop removal in the grey clay zone.

Harvested grain yield of Gairdner barley in 2006 was the same for both zones. Due to the dry conditions no post emergent nitrogen treatments were applied to test for any differential responses in the two zones. A biomass map of this paddock using the N-Sensor showed a lower biomass in zone 1 compared with zone 2, possibly due to less PAW and lower N and P in the soil in zone 1.

6. Donald, Victorian Wimmera - ryegrass control

The concept of zone management of weeds was investigated at Donald, Victoria. Effects of different soil residual herbicides and sowing rates on ryegrass plant numbers and grain yield of wheat were compared.

The addition of Avadex to trifluralin generally halved the ryegrass plant and head numbers and increasing sowing rate reduced head numbers at the narrower but not at the wider row spacing (Table 4). This reduction in ryegrass with extra herbicide increased grain yield whereas increasing sowing rate without the additional herbicide did not increase grain yield.

Table 4. Ryegrass plant and head numbers and grain yield of wheat with additional herbicide and a higher sowing rate, Donald, Victoria, 2005.

Herbicide	Sowing rate (kg/ha)	Ryegrass numbers/sq m Plants (2 Sept)	 Heads (2 Nov)	Wheat grain yield (t/ha)
Trifluralin 1L/ha	75	60	112	1.75
	150	35	40	1.75
Trifluralin 1L/ha + Avadex 1.5l/ha	75	45	52	2.15
	150	14	19	2.05

Output 3

Assess the practical application of the N-Sensor for variable rate N application.

Field experiments were conducted in 2004 and 2005 to assess the value of the N-Sensor for variable rate N application. In these experiments crop yields were compared where a variable rate of nitrogen fertiliser was applied with those where a constant rate of the same total amount of nitrogen fertiliser was used.

The mean yield increases of wheat in 2004 and 2005 with variable rate nitrogen compared with the same total amount applied at a constant rate at 10 sites was 0.7% (Table 5). The range of responses was from -1.5% to + 5.7%.

Table 5. N-Sensor trial results, wheat, 2004 & 2005 (Mean of 10 trials)

Year	Location	Paddock	% grain yield difference (kg/ha & %) between variable rate of N and constant rate of N	Mean grain yield of the paddock
2004	Clare	Quarry	+170kg/ha (+3.9%)	4.43t/ha
2004	Urania	146B	+40kg/ha (+1.3%)	3.10t/ha
2004	Yeelanna	FrontSW	-20kg/ha (-0.6%)	3.09t/ha
2005	Clare	Turners House	+20kg/ha (+0.3%)	5.65t/ha
2005	Clare	Knuts	-50kg/ha (-0.1%)	5.56t/ha
2005	Clare	Pinks	-220kg/ha (-3.5%)	4.57t/ha
2005	Stockport	Hill	+70kg/ha (+1.4%)	5.01t/ha
2005	Stockport	Jumbos	+275kg/ha +5.7%	4.82t/ha
2005	Urania	146C	0kg/ha (0%)	2.49t/ha
2005	Urania	146D	-40kg/ha (-1.5%)	2.60t/ha
Mean response			+25kg/ha (+0.7%)	

In 2004 the N-Sensor was also used by growers and researchers for crop scanning in other GRDC funded projects in the SIP09 program, including the Birchip site (DAV00030) and by growers in northern NSW and SA (US00017).

Due to very dry conditions during the growing season in 2006, when crop responses to post-emergent N fertiliser were unlikely, other uses of the N-Sensor were explored. These included the possibility of mapping weeds. Crops with patches of thick weeds were scanned and the reflectance and weed and crop biomasses from different areas within these crops were compared. Maps using other scanning instruments (the GreenSeeker and Crop Circle) were also compared with those of the N-Sensor.