Southern Precision Agriculture Association

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Project Title: Increasing economic returns with precision agriculture in SA.
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RESEARCH REPORT Variable rate field trials

1. Tarlee, Mark Branson

The paddock Black Flat at Tarlee was described into 3 zones on the basis of elevation, an EM map and yield maps. The Colwell soil P levels were lower (26ppm) in the higher yielding areas (Classes 2 & 3) compared with that (42ppm) in the lower yielding area (Class 1) as a result of a uniform application of phosphorus fertiliser over many years and a relatively consistent pattern of uneven yields across the paddock. The average grain yield for 1999, 2000 & 2002 (when good yield maps were available) was 3.30t/ha for the Class 1 zone, 3.65t/ha for the Class 2 zone and 3.21t/ha for the Class 3 zone. The higher yielding areas had a higher cation exchange capacity and a greater water holding capacity than for the lower yielding area.

Different P rates (13, 26 & 39kg/ha) were applied to large strips in each zone to measure crop P response in each of the zones. Even though the soil P levels in one zone were relatively high (42ppm) there were still large grain yield responses to applied P in a higher yielding year (2005). In a lower yielding year (2003) there were no grain yield responses in any of the zones, indicating the seasonal nature of responses to applied phosphorus.

2. Snowtown, Richard Turner

Paddock No.41 at Snowtown was described into 3 zones on the basis of elevation, an EM map and yield maps. All zones had a similar soil texture in the surface 0 to 10cm but the lowest yielding zone (Class 2) had a much lower organic carbon content (0.6% vs. 1.1%) in the surface soil. The highest yielding zone (Class 1) had a lower boron & exchangeable sodium level than for the other 2 zones. Soil P levels did not differ much between zones (compared with the Tarlee & Crystal Brook sites). Also the available soil N levels in autumn 2003 were very similar for each zone.

The aim of the field trials in this paddock was to improve grain yields in the lower yielding zone (Class 2). Gypsum was applied at 5t/ha in 2 strips 100m wide across the 3 soil classes of the paddock. As well, part of the Class 2 zone was deep ripped.

Grain yield responses to the gypsum were only marginal and not in all years. They tended to be greater in the Class 1 zone but were not greater in the higher EM parts of the paddock than in the lower EM parts. Soil and plant sulphur contents were not low and plants in the gypsum treated areas had only marginally higher S contents than from the untreated areas.
Grain yield responses from deep ripping were also relatively small and inconsistent between years. They were greater in higher yielding years than in lower yielding years (Table 1).

Table 1. Grain yield (t/ha) responses of wheat in 2005 & 2006 where deep ripped in 2003, Paddock 41, Snowtown.

	2005		2006	
	Not ripped	Deep ripped	Not ripped	Deep ripped
Grain yield (kg/ha)	3.87	4.18	1.14	1.11
Yield increase (kg/ha) (& %)	0.31 (8%)		- 0.03 (-3%)	

3. Crystal Brook, Malcolm Sargent

The Road paddock at Crystal Brook was described into 2 zones on the basis of an EM map and yield maps. There was very little difference in elevation across the paddock. As a result of a uniform application of phosphorus fertiliser over many years and a relatively consistent pattern of uneven yields across the paddock (due to differences in the PAWC) the Colwell soil P levels were lower (27ppm) in the higher yielding area (Class 2) and much higher (57ppm) in the lower yielding area (Class 1) (Table 2).

Table 2. 0 to 10cm soil characteristics, nutrient levels and average grain yields (1998 to 2000) for the 2 zones, Road paddock, Crystal Brook.

	Class 1 zone	Class 2 zone
Clay % (0-10cm)	38	28
Clay % (10-30cm)	44	35
Clay % (30-60cm)	48	38
Available WHC (0-60cm) (mm)	69	80
Organic C %	1.0	1.1
Phosphorus ppm	57	27
Average grain yield (t/ha)	1.71	1.88

Different P rates (0, 7, 19 & 29kg/ha) were applied to large strips in each zone to measure crop P response in each of the zones over 4 years.

In nearly all cases applying phosphorus fertiliser to the Class 1 zone with a high soil P and lower potential production was uneconomic. In three of the four years the most economic rate of P was zero. In the Class 2 zone there was an economic response to applied P fertiliser in only two years (2003 & 2005) of the four years.

The effect of using a lower rate of P in the higher P (lower yielding) zone and a higher rate in the lower P (higher yielding) zone has been to even out the P level in the paddock.

The experiments were analysed for the economic value based on treating this paddock with a uniform application of 11kg P/ha (as was done before 2003) compared with using the economic optimum rate in the Class1 zone. If the economic optimum required by the crop was used in the Class 1 zone over the 4 years the extra economic return would have been $36/ha (Table 3).

Table 3. Economics of applying the economic optimum rate of phosphorus fertiliser compared with the district practice of 11kgP/ha, Road paddock, Crystal Brook.

Year	Crop	$ fertiliser over application in Class1	Value ($/ha)
2003	Wheat	100	36
2004	Peas	38	8
2005	Wheat	78	65
2006	Barley	100	33
	Average		$36/ha

If a base rate of P (7kg/ha) was used in the Class1 zone the increase in net income would have been $9/ha/year over the 4 years.

4. Buckleboo, Graeme Baldock

Soil type variability of Berkshires paddock, typical of the sand hill/flat country in the Buckleboo district, was mapped using an EM38. There was only a small difference in the available phosphorus between the 2 zones (28ppm in the higher EM zone (with the heavier soil type) compared with 24ppm in the lower EM zone (with the lighter soil type)).

To assess whether crop grain yields could be increased, especially in the flats, deep ripping treatments, with and without deep placement of P, N and zinc were applied from the flat up to the sand hill, covering the range of soil types and EM values. 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 4). There was no yield response to added fertiliser applied to depth when ripping.

Table 4. Grain yield responses in wheat to deep ripping and fertiliser placements in 3 zones, Berkshires paddock, Buckleboo, 2006.

	Grain yield of wheat (t//ha), 2006		
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

5. Waikerie, Allen Buckley

The paddock Kroehns Corner at Waikerie is typical of many in the Mallee region. It is a mix of shallow soil on flats and lighter soil on sand hills. Crop growth is thicker on these flat than on sand hills. Soil P levels do not vary markedly across the different soil types. In this case the average soil P is 19ppm for soil in the flats, 17ppm in the slopes and 11ppm in the sand hills. In this paddock the average grain yield over the four years (from 2000 to 2004) is 1.02t/ha on the flats and 1.25t/ha on the sand hills.

Different P treatments were applied in 2005 & 2006 to test the concept of reducing fertiliser 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 5). The most economic rate for both zones was 3kgP/ha.

Table 5. 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 fertiliser were compared for 3 different zones (flat, slope and hill) in this paddock. In each zone two rates were compared: a rate for an average year and a lower rate.
As in 2005, grain yields were lower on the flats than on the lighter and deeper soil on the slope and hill. However, in these lower yielding crops responses to P were less than in 2005. In only one case (triticale on the flats) did the yield increase cover the cost of the extra fertiliser.