Precision in Practice - Fine-tuning MAP Rates to Maximise Wheat Potential

Murray Plains Case Study

BACKGROUND

This project aimed to build on work produced in 2022 across three farmer groups in the SA mallee region where variability in crop responses to Nitrogen (N) and Phosphorus (P) applications across paddocks were demonstrated through multiple replicated small plot trials.

Growers were asked to select a paddock of interest and create different soil and therefore management zones through publicly available satellite and NDVI data. Growers were then encouraged to implement fertiliser strip trials by adjusting fertiliser rates (50% down, 50% up compared to grower practice) across these zones. Assessments of crop behaviour to different fertiliser programs across zones will assist growers to start the journey of implementing VRT.

The following reports on results obtained from a focus paddock in the Murray Plains district.

SNAPSHOT

Size: 7000 acres holding, 5500 acres farmed

Location: Sanderston North or Cambrai South

Enterprises: Cropping & Sheep

Rotation: Continuous Cropping Rotation: Vetch, Canola, Wheat, Wheat, Barley

Rainfall: 330 mm

Soil types: Grey calcareous soils grading to red loams

Demonstration type: Various P inputs (N topped up) - Wheat

Fertiliser rates: 30 kg MAP/ha vs 55 kg MAP/ha, 80 Kg MAP/ha

METHODS

The selected paddock was viewed in Google Earth and Data Farming to outline potential soil types driving crop production. Both platforms are free with the ability to go back through previous seasons to assess NDVI patterns with crop rotations.

NDVI patterns during early growth stages were the focus as this has been shown to be particularly useful for identifying P responsive areas on YP and Mid-North regions. In this example we had access to an EM38 map which can be an important additional layer to look at soil profiles and potential behaviour regarding constraints and water storing capabilities.

From these zones soil samples were collected (0-10, 10-30, 30-50cm) and fully characterised where expected responses to N and P inputs were predicted (table 1). In response to these zone locations three fertiliser strips were implemented (1.2km x 36m) at 30, 55 and 80 kg MAP/ha where 55 kg MAP ha is the base grower rate. Urea was spread soon after crop emergence to negate the imbalance of applied N with increasing MAP rates.

During the season plant tissue analysis was performed across all treatments and the three zones. Harvest wheat yields were obtained for each fertiliser strip treatment with two harvest runs analysed within each treatment to increase robustness. Grain yield recordings were smoothed for each 20m increment (smoothed = average yield recordings within 20m increment).

RESULTS

Two main soil types were described by Google Earth and NDVI images with the grey soil zones which are identified as Calcareous resulting in low relative NDVI values and red loams associated with high in season NDVI values (photo 1). Main soil descriptors indicated adequate P levels via Colwell P across all zones but P deficiency in zones 1 and 2 (grey Calcareous) as measured by DGT. DGT P levels were highly related to soil Phosphorus Buffering Index (PBI) which is a measure of the soil's ability to complex and fix P forms. Profile N values were very similar but ultimately underestimated in zones 1 and 2 with stones restricting coring to 30cm.

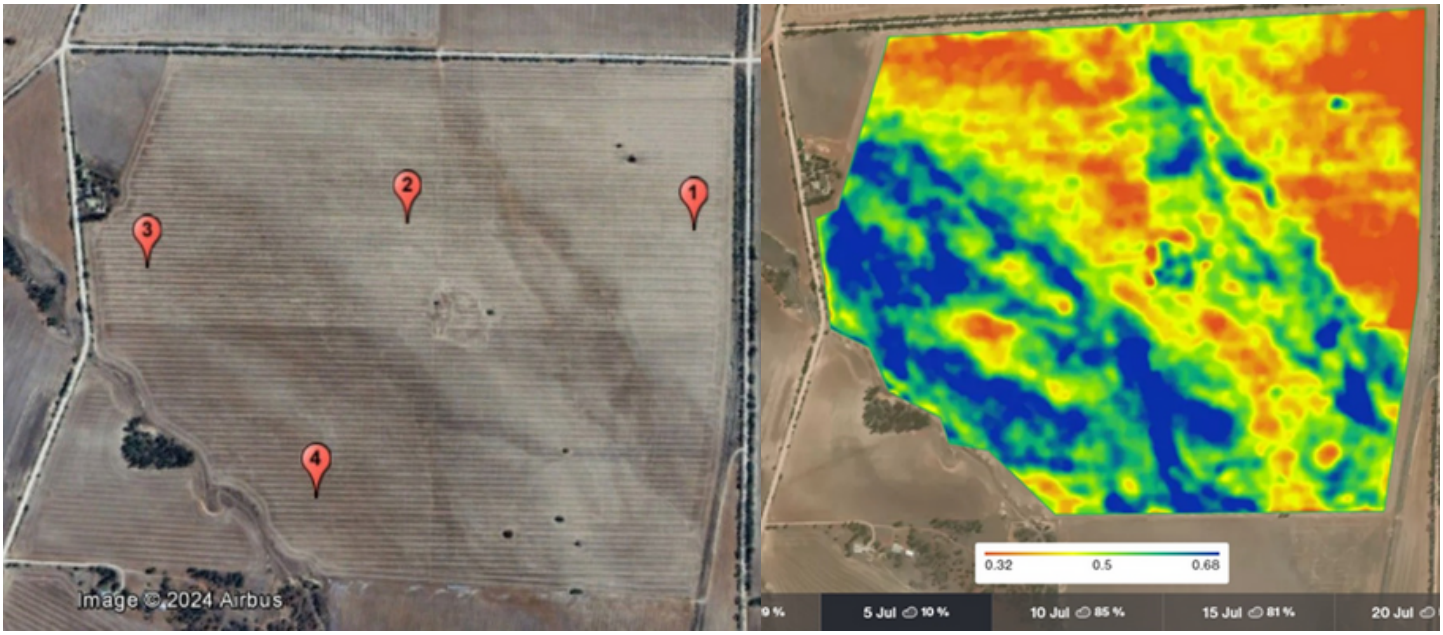

Photo 1: Google Earth image of focus paddock with associated sampling locations (table 1) - left and in season 2023 NDVI image using Data Farming (right).

Table 1: Zone main soil characteristics. Profile N was calculated via mineral N values with depth. Target Colwell P values can be expressed either via PBI using relationship developed in Moody 2007* or Speirs et al. 2013 with critical values of 34 mg/kg for calcareous soils or 25 mg/kg for all other soils. Critical DGT P values have been established as 67 ug/L (58-77 Critical Range) regardless of soil type.

Zone (sample)	Description	OC (%)	Profile N (kg/ha)	Colwell P (mg/kg)	PBI	Target Colwell P* (mg/kg)	DGT P (ug/L)
1	Grey/Low NDVI	1.93	56	36	84	26	45
2	Grey/Low NDVI	2.09	54	44	104	29	49
3	Red Loam/High NDVI	1.24	59	57	40	20	180
4	Red Loam/High NDVI	1.27	59	30	50	21	120

Grain yields for the average of two runs smoothed to 20cm intervals within each treatment ranged from 1.6 t/ha to 3.0 t/ha and were quite variable for certain sections of the paddock. The full paddock runs from West to East were segmented based of soil type as illustrated via Google Earth (Image 1). Mean grain yields for each treatment within soil descriptors are presented in table 2 and associated Partial Gross Margins (PGM) using 2023 pricing for grain and fertiliser prices.

There was no benefit at increasing MAP rates beyond 30 kg/ha in the first red loam zone which is in line with good P reserves (table 1, sample 3) but incremental yield benefits occurred up to 80 kg/ha MAP when the soil transition to the grey calcareous soil type with higher fixation potential (PBI) and lower P reserves (DGT P) (sample 2). The response was not as prominent in the further east grey calcareous section (sample 3). Calculating PGM there was a clear benefit of reducing MAP rates in the high P zones and increasing P rates above grower rate in the first grey calcareous soil type.

Implementation of a simple VRT program across each run is outlined in table 2 which allocated 30 kg MAP/ha to the red loams with good P reserves and low PBI compared to applying 80 kg MAP/ha on the high PBI/low DGT zones. PGM increases ranged from $21-32/ha by either decreasing or increasing MAP rates triggered by zone characteristics compared to the standard grower rate (55 kg MAP/ha).

The second short red loam zone was highly variable and returned some weird yield trends possibly due to the NW-SE soil type trend across the paddock. Overall, by implementing a VRT program in a single season based on soil type behaviour and adjusting P rates accordingly returns were $31/ha.

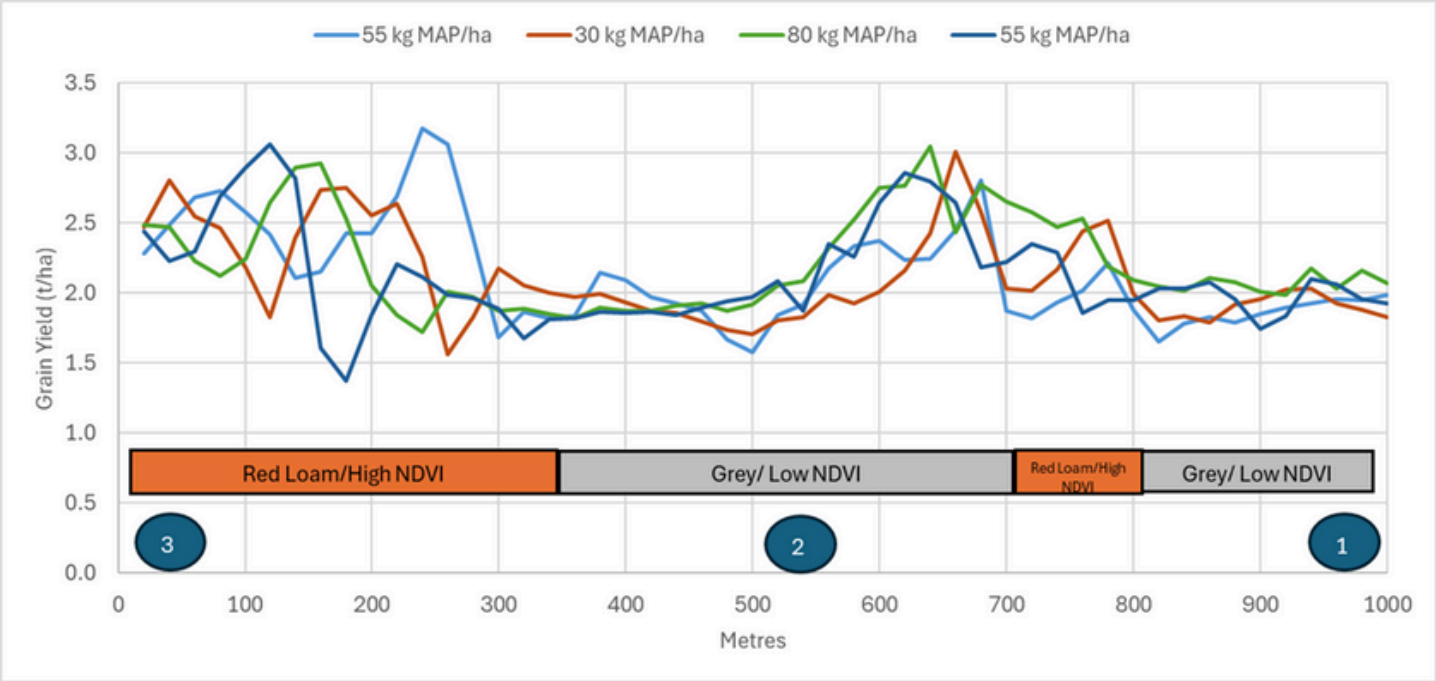

Figure 1: Grain yields (t/ha) obtained for each 20m interval from West to East for the 4 treatments including the south and north grower rate runs at 55 kg MAP/ha. Soil descriptors associated with soil types are outlined using photo 1. Soil sampling locations relating to Table 1 are marked 1-3.

Table 2: Mean Grain yields for the zones illustrated in Figure 1 for each treatment rate of MAP (left) with the south and north grower rate of 55 kg/ha combined and resulting PGM obtained using wheat grain price of $350/t and MAP at $1000/t (right). VRT PGM was calculated using a low MAP rate in high P zones and a high MAP rate in low P zones with overall yields weighted for the length of each soil type description.

		Grain Yield (t/ha)			PGM ($/ha)				
	Zone	55 kg/ha	30 kg/ha	80 kg/ha	55 kg/ha	30 kg/ha	80 kg/ha	VRT (kg/ha)	30-80 kg/ha)
West	Red/High NDVI	2.29	2.31	2.22	$747	$779	$697	30	$779
	Grey/Low NDVI	2.12	2.03	2.25	$687	$681	$708	80	$708
	Red/High NDVI	2.00	2.16	2.32	$643	$726	$732	30	$726
East	Grey/Low NDVI	1.93	1.94	2.07	$621	$649	$645	80	$645
	Full run	2.08	2.11	2.22	$690	$709	$695	55	$721

CONCLUSIONS

By using relatively simple data layers which are easily accessible to generate soil type x early production zones, informed soil sampling programs helped developed a VRT program that returned between $21-$32/ha for each zone and an overall weighted return of $31/ha using current grain and fertiliser prices.

The informed VRT program is an improvement on typical replacement P programs where the lower yielding grey, but P responsive zones would typically see lower inputs due to lower P removal with grain. Growers are encouraged to at the very least investigate poor performing parts of their paddocks to assess whether the constraint could be profitable to overcome e.g., in this case through increased MAP rates. Not all poor relative NDVI readings will be attribute to P, therefore soil sampling/testing to depth is recommended.

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PROJECT INFORMATION

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Demonstrating Soil Zone Mapping for Variable Rate Nutrition Management - DN4_23_05
Website Link: https://msfp.org.au/projects/demonstrating-soil-zone-mapping/

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