Optimising Yield with Variable Rate Fertiliser Inputs

Lameroo 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 Lowbank district.

SNAPSHOT

Size: 1600 ha
Location: Lameroo, SA
Enterprises: Continuous Cropping
Rotation: Wheat, Barley Legume rotation with Oaten or Vetch Hay to control grasses
Rainfall: 385 mm
Soil types: Sandy Loams, Heavy Flats with Constrained Flats
Demonstration type: Various N x P inputs - Wheat
Fertiliser rates: Nil, 65 MAP (Grower Rate), 65 MAP/30 Urea, 65 MAP/75 Urea, 100 MAP MAP

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). Craig was keen to see crop responses to both N and P inputs and ran 5 different fertiliser programs/strips with various combinations of MAP and Urea on the western side of the paddock.

During the season plant tissue analysis was performed in and out of variable MAP strips at the three initial soil sampling points.

Harvest wheat yields were obtained for the fertiliser strip treatment with two harvest runs analysed within each treatment to increase robustness. Grain yields were smoothed every ~12m by taking the average of 8 harvest readings within the 12m.

RESULTS

This paddock was slightly more challenging with multiple soil types and topography variations. Main soil types were described by Google Earth and NDVI images with the lighter sand/high early NDVI identified at the southernmost point transitioning to grey/patchy low NDVI and a red flat/low NDVI at location 3 (photo 1).

Main soil descriptors indicated adequate P levels via Colwell P across all zones but P deficiency in zones 2 and 3 as measured by DGT. DGT P levels were 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 ranged from 72 kg N/ha (2) to 114 kg N/ha (3) and were unrelated to Organic Carbon levels or previous NDVI signatures.

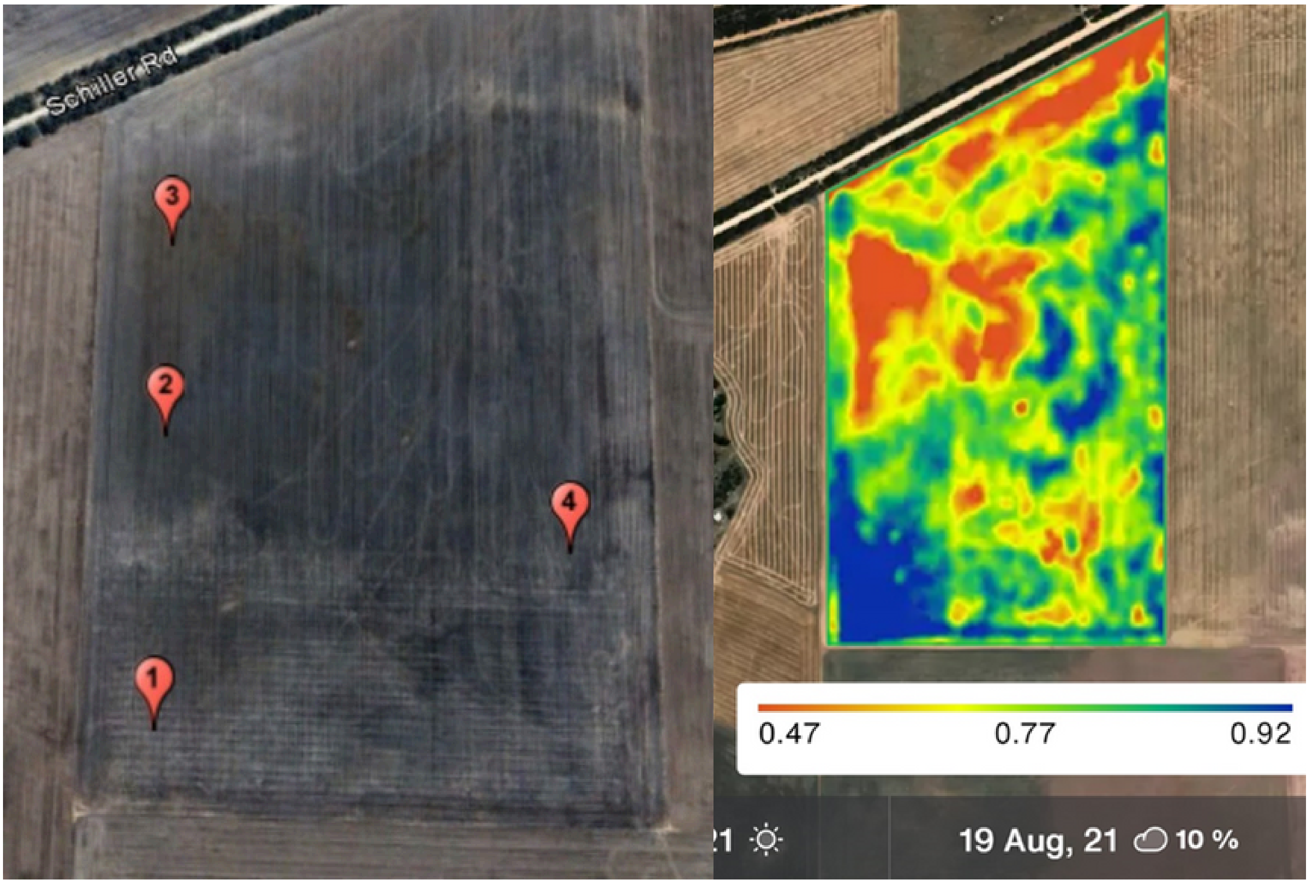

Photo 1: Google Earth image of focus paddock with associated sampling locations (table 1) - left and in season 2021 NDVI image using Data Farming (right).

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	Light Dune/High NDVI	1.11	101	57	38	19	257
2	Grey/Low NDVI	1.9	72	34	66	24	44
3	Red Flat/Low NDVI	1.47	114	31	81	26	59
4	Grey/Moderate NDVI	0.82	77	31	23	16	114

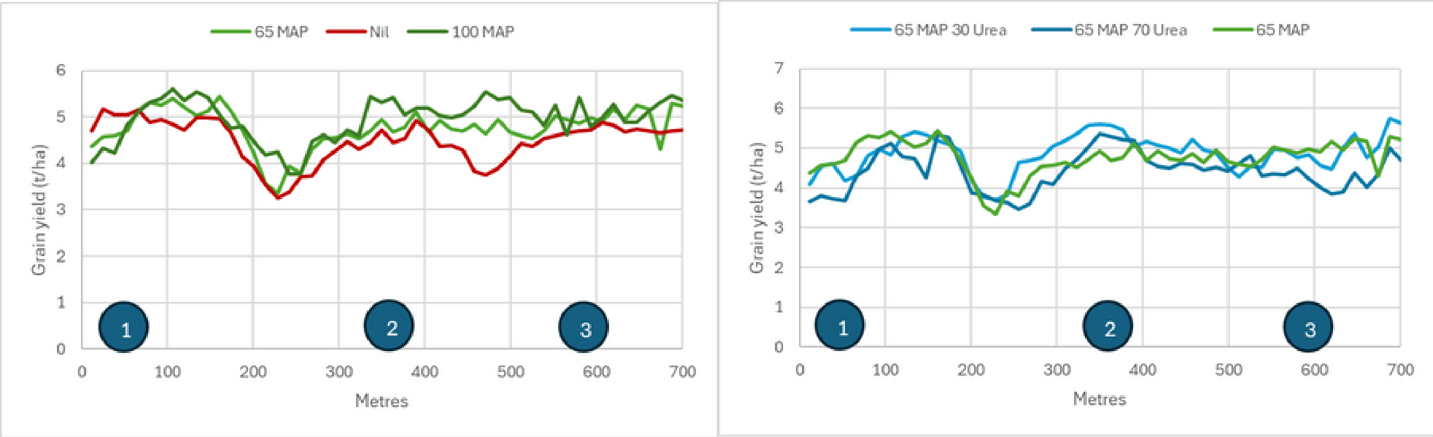

Figure 1: Average wheat grain yields (t/ha) smoothed every 12m from South (left) to North (right) for the variations of MAP inputs compared to nil (top) and variations of urea applications (bottom). Soil sampling locations relating to table 1 are marked 1-3 along the trial strip.

Wheat grain yields for the average runs on the western side of the paddock ranged between 3.2 and 5.5 t/ha. Mean grain yields for each treatment run outlined the greatest yielding treatment was 100 kg MAP/ha closely followed by 65 MAP + 30 urea as kg/ha (table 2).

Breaking down full strip yields into zones explained, by soil sampling, the benefit of extra MAP was driven by zones 2 and 3 with extra urea additions providing benefit in zone 2. Zone 1 was nonresponsive to either N or P which was explained well by soil test results as did explain P deficiency (by DGT) in zones 2-3 with the benefit of applied MAP to yield.

Responses to N were most prominent in zone 2 explained by low relative profile N levels. Poor grain yields with the highest urea application were generally caused by fertiliser toxicity which was evident very early growth stages even when Craig sowed fertiliser treatments below the seed into marginal moisture. The lightest soil most prone to fertiliser toxicity effects is best explained by zone 1.

Table 2: Mean Grain yields for the full run of each treatment together with 100m zones around soil sampling points 1-3 (top) in addition to PGM obtained using wheat grain price of $350/t and MAP at $1000/t, urea @ $700/ha (bottom).

Treatment	Grain Yield (t/ha)			
MAP/Urea (kg/ha)	Full Strip	Sample point 1	Sample point 2	Sample point 3
65/30	4.865	4.545	5.371	4.834
65/70	4.421	4.218	4.999	4.145
65/0	4.763	4.915	4.756	5.030
0/0	4.483	4.971	4.567	4.732
100/0	4.954	4.852	5.112	4.994

Treatment	PGM ($/ha)			
MAP/Urea (kg/ha)	Full Strip	Sample point 1	Sample point 2	Sample point 3
65/30	1617	1505	1794	1606
65/70	1433	1362	1636	1337
65/0	1602	1655	1600	1696
0/0	1569	1740	1599	1656
100/0	1634	1598	1689	1648

Calculated Partial Gross Margins (PGM) using 2023 pricing for grain and fertiliser prices outlined the 100 kg MAP/ha as the most profitable overall but further PGM improvements could be made if VRT was adopted based off soil testing results. For example using 0/0 in zone 1, 65/30 MAP/urea in zone 2, 65 MAP in zone 3 to address NP deficiencies (best case scenario) would have returned $1743/ha compared to $1635/ha, $1650/ha, $1665/ha for flat rates of 65/30, 65/0, 0/0 rates of MAP/urea respectively.

CONCLUSIONS

- Profitable increases in wheat grain yield were obtained in certain paddock zones through increasing P rates through MAP and the addition of small amounts of urea.
- Zones that demonstrated the greatest response to extra P addition were identified through Google Earth and low relative NDVI signatures.
- Growers and advisors are encouraged to use zonal paddock approaches to identify different performing areas and investigate poor performing parts of the paddock before starting replacement fertiliser programs.
- Recent work has outlined that poor NDVI areas can be often associated with poor P reserves and can return a bounce in yield with increasing P inputs compared to the strategy of decreasing P inputs with overly simplified replacement P programs.
- Zone allocation for informed soil sampling programs and analysis can provide significant benefits to refining fertiliser strategies and implementation of VRT programs.

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PROJECT INFORMATION

Thanks to the Needs family for hosting the trial.

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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