Utilising Precision Agriculture Technologies to manage climate variability and improve nutrient use efficiency

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Key Messages

- AFGRI demonstrated machinery that has the technology for VRT application, which worked successfully.
- Varied inputs to suit requirements of management zones and soil types were effectively implemented through the use of VRT technology.
- Test runs were incorporated to see if the rates were correct for the season and what level of inputs were potentially 'wasted' or production was lost.
- The results that were obtained from the harvest data indicated that each input zone reacted according to the hypothesis that yield would plateau at its ideal rate of input.
- Both the medium and high input zones reached the expected yield based on units of P supplied.
- The demonstration was adversely affected by frost rendering the results inconclusive.

Aim

To demonstrate new machinery that is capable of delivering prescriptions via Variable Rate Technology (VRT) in 2016.

Background

The ability to maximise production potential is becoming more attainable with the rapid adoption of Variable Rate Technology (VRT). The Liebe Group, in collaboration with AFGRI Equipment Australia and Tek Ag, implemented a 145 hectare Variable Rate Technology (VRT) demonstration on Michael Dodd's property at Buntine. The paddock is a broad scale demonstration of the environmental, agronomic and economic benefits of VRT.

The paddock selected has three distinct soil types which were identified from aerial imaging, grower knowledge and was soil tested to ground truth the production zones. Tek Ag generated a prescription map from soil test and yield data, to establish the required rates for each of the treatment runs. Muriate of Potash (MOP) ranged from 0 kg/ha, 15 kg/ha and 30 kg/ha and, Mono-ammonium phosphate (MAP) rates ranged from 0 kg/ha, 30 kg/ha and 60 kg/ha.

Urea was also included as a separate prescription within the paddock and was applied using a Marshall Multi-spreader. Due to the application of Urea ammonium nitrate (UAN) prior to Urea spreading, all urea prescriptions were reduced by 40 kg/ha. No low treatments were conducted due to the lack of low production zone soil available for the demonstration. The low production zones were already allocated to MAP and MOP treatments.

The demonstration was seeded with a 12m (40 ft) Equaliser bar and a three bin John Deere air cart equipped with VRT and section control. The demonstration was harvested using the grower's Case IH 8240 with a 40ft McDon front.

Trial Details

Property	Niribi – Buntine W.A.
Plot size & replication	MAP: 0.24 ha x 18 MOP: 0.24 ha x 9 Urea: 0.48 ha x 9
Soil type	Sand – Gravel – Loam – Clay Loam
Colwell Potassium (av.)*	0-10cm: 94.9 10-20cm: 62.1
Soil pH ($CaCl_2$) (av.)	0-10cm: 6.0 10-20cm: 5.2 20-30cm: 5.3
EC (dS/m)	0-10cm: 0.039 10-20cm: 0.0514 20-30cm: 0.0581
Paddock rotation:	2013: Wheat 2014: Wheat 2015: Wheat 2016: Wheat
Sowing date	6th, 7th and 8th May 2016
Sowing rate	65kg Mace
Fertiliser	MAP: Low – 0 kg/ha Medium – 30 kg/ha High – 60 kg/ha MOP: Low – 0 kg/ha Medium – 15 kg/ha High – 30 kg/ha Urea: Low – 25 kg/ha Medium – 45 kg/ha High – 60 kg/ha 02/06/2016: 40 L/ha Flexi-N 12/07/2016: 42kg/ha Urea (for VRT runs)
Herbicides, insecticides & fungicides	1.8L Treflan Pre Seeding 08/06/2016: 400mL Paragon
Growing season rainfall	231mm

Results

The purpose of this demonstration was to maximise yield and quality potential through the adoption of VRT. Prescription maps were used to administer specific treatments of MAP, MOP and Urea across each input/production zone; low, medium and high.

Soil tests were taken from ten locations (Table 1), to a depth of 30 cm across a variety of soil types which were then used, along with aerial imaging, to determine the VRT production zones (Figure 1).

Table 1: Soil Test results

Depth	Site	1	2	3	4	5	6	7	8	9	10
0-10 cm	pH	6.2	5.85	6.3	6.4	6.1	5.6	5.6	6.1	7.1	5.3
	EC	0.032	0.026	0.021	0.032	0.039	0.037	0.053	0.048	0.052	0.048
	OC	0.86	0.59	0.46	0.73	1.05	0.54	0.79	0.79	0.62	0.83
	NO3+	4	6	4	5	10	4	7	11	4	10
	NH4+	1	2	1	<1	<1	1	<1	<1	<1	2
	P	24	32	26	24	29	30	27	24	21	40
	K	157	59	40	164	165	38	104	59	191	72
	PBI	32.1	26.6	32.6	27.4	62.0	27.4	37.2	32.8	57.3	31.0
10-20 cm	pH	5	4.7	4.5	6.6	5.2	4.5	4.7	4.9	7.4	4.6
	EC	0.038	0.039	0.043	0.051	0.061	0.051	0.082	0.055	0.042	0.053
	P	7	16	4	6	9	5	10	10	2	14
	K	162	49	28	187	32	29	81	51	43	39
20-30 cm	pH	5.3	4.9	4.3	7.9	4.4	5.1	4.8	4.7	7.5	4.4
	EC	0.044	0.039	0.050	0.136	0.039	0.042	0.057	0.058	0.060	0.056

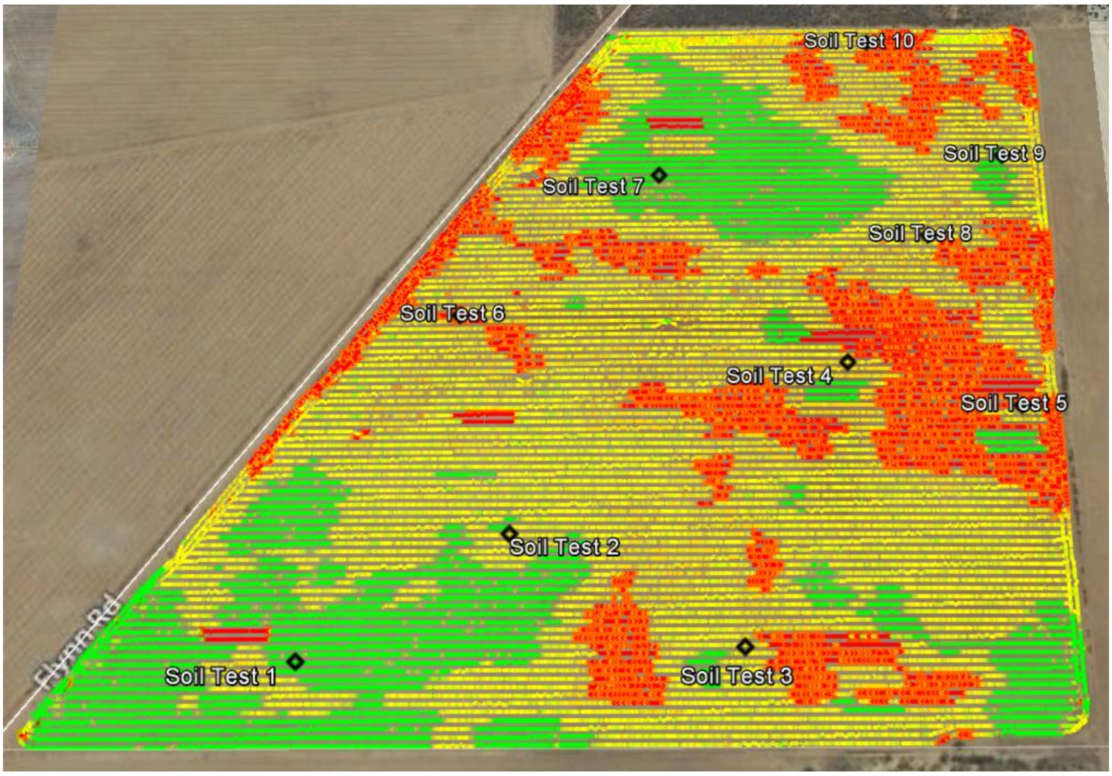

Figure 1: Soil test sites with overlay of VRT map

Application data was collected from the seeder and spreader, along with yield from the grower's harvester. A frost event in spring caused variable yield losses across the paddock, including the demonstration runs.

When the demonstration was seeded, a 1.5m drift in GPS location of each run occurred. This error was unable to be mitigated completely at harvest. Yield results were obtained using seeding GPS data as a reference for which areas were appropriate for harvesting and collection of yield data. An economic analysis has not been completed for this demonstration however; continuation of the demonstration in subsequent years will provide scope for economic analysis.

The results that were obtained from the harvest data did indicate that each input zone reacted according to the hypothesis that yield would plateau at its ideal rate of input.

Figure 2 provides a comparison of results for applications of MAP across each input zone. The rates of MAP (0, 30 and 60 kg/ha) were selected using 2015 yield data and calculating replacement phosphorus (P). Working on the rule of thumb that 1t of wheat uses 3.5 units of P (Summit, 2017), it was expected the prescribed rates were sufficient for crop growth and expected yield, whilst retaining current soil P bank.

The high yield of 2.03 t/ha for the high input zones and nil fertiliser treatment were not as expected. The general hypothesis for a high performing area of the paddock which is supplied nil fertiliser is; yield will be compromised considerably without adequate nutrition. The seasonal conditions at the site were such that this expected drop in yield did not occur in the high input zones where yields reached 2.01 and 1.97 t/ha respectively in each input zone with 30 kg/ha and 60 kg/ha. The 0.3 t/ha yield penalty across the high input zone and 60 kg/ha fertiliser rate was due to frost affect.

If the yield potential was near 3 t/ha before the frost event, it could be hypothesised that the high input zone and high fertiliser rate could have yielded greater than 1.97 t/ha. It is suggested however, by the Department of Agriculture and Food WA, to avoid high fertiliser inputs on frost prone areas as the loss in yield is far greater than if a conservative level of inputs were applied (Biddulph, 2017).

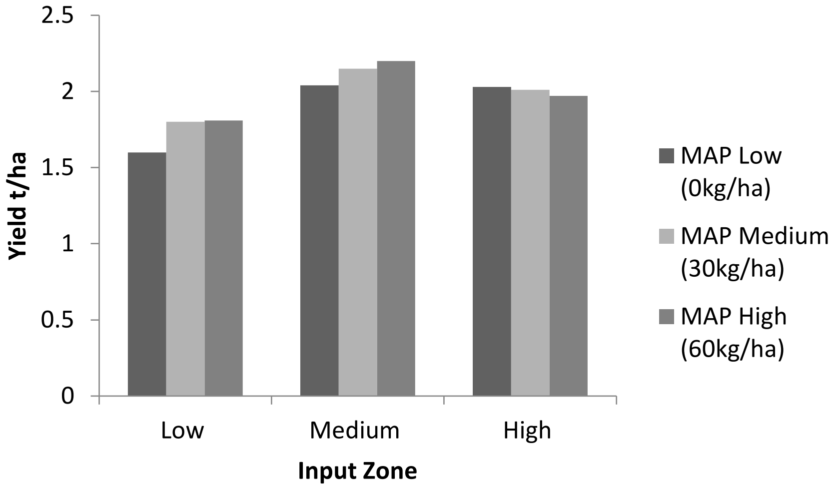

Figure 2: MAP yield (t/ha) across each input zone

Both the low and medium input zones indicated a positive trend toward yield improvement with increasing MAP supply. Low input zone increased yield from 1.6 t/ha with nil MAP to 1.81 t/ha with 60 kg/ha applied MAP. The Medium input zones reacted similarly where yields improved from 2.04 t/ha with nil MAP to 2.2 t/ha at 60 kg/ha MAP.

Soil test results (Table 1) indicate that potassium (K) is not limited at this demonstration site however; some individual sites such as sites 3, 5 and 6 did indicate marginal level of K between 28 and 32 mg/kg at a depth of 10-20 cm which was managed accordingly. While this is the case, the role of potassium in producing plants with stronger cell walls, improves regulation of stomata and water use efficiency (Anderson & Garlinge 2000), is critical. Potassium does not limit yield directly, yet affects peak biomass, dry matter produced in the upper internodes (stem area between nodes) and ears, which contributes to the formation of grains (Anderson & Garlinge, 2000) in each wheat head.

Potassium is similarly managed to Nitrogen in that the crop uses similar quantities during the season and it is important to replace these nutrients as they are used. Typically, a wheat crop will use 4 units of K per tonne of grain harvested (Summit, 2017). Applications of potassium come in the form of MOP and Sulphate of Potash (SOP). This demonstration used MOP to manage crop removal of K, supplying rates of 7.5 units for medium rates of application and 13 units at the higher rate. Together with soil K reserves, it was calculated by Tek Ag that 7.5 units of K, applied as 15 kg/ha MOP would suffice for the medium rate fertiliser treatments and, approximately double this for the high rate of 30 kg/ha.

Yield results (Figure 3) were only taken where all treatments of fertiliser were applied. As Potassium was not limiting at all soil sample sites, the medium input zone was not adversely affected by not having MOP applied (Figure 3). Yields in the medium input zone saw a range between 2.75 t/ha with nil MOP and 2.57 t/ha with 30 kg/ha MOP. The slight drop in yield was due to some frost affect. Due to the improved soil type in the high input zone, yield was affected by the lack of MOP in the nil treatments where the crop relied heavily on soil K reserves. This zone only yielded 1.68 t/ha compared to 1.94 and 1.81 t/ha in those treatments which received 15 and 30 kg/ha MOP respectively. Frost affect must also be considered for the poor yield result in the high input zone which received medium and high rates of MOP.

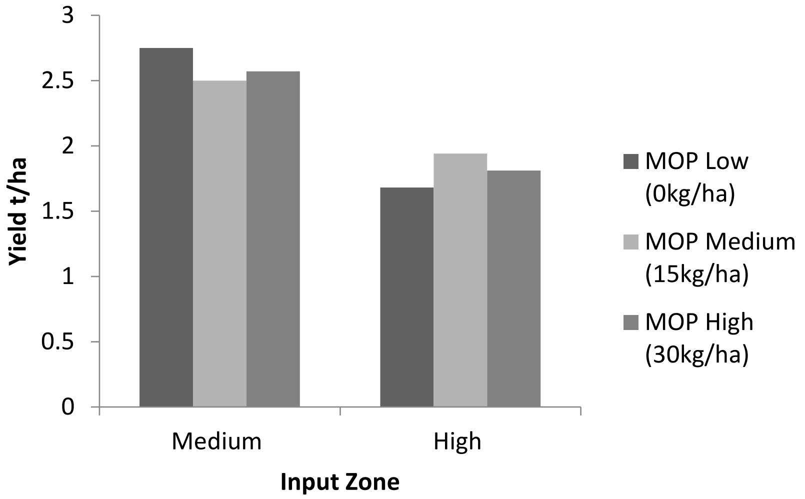

Figure 3: MOP yield (t/ha) across each input zone. No comparison was made in low input zone due to lack of soil type available for demonstration runs.

As suggested by the Department of Agriculture and Food WA (Biddulph, 2017), increasing inputs can adversely affect yield in years where frost events occurred during flowering or grain fill. The results for Urea treatments, when compared across each input zone, were inconclusive as there was a yield decrease however; when assessed just on single input zone and urea rate applied, there was a positive trend in yield improvement (Figure 4).

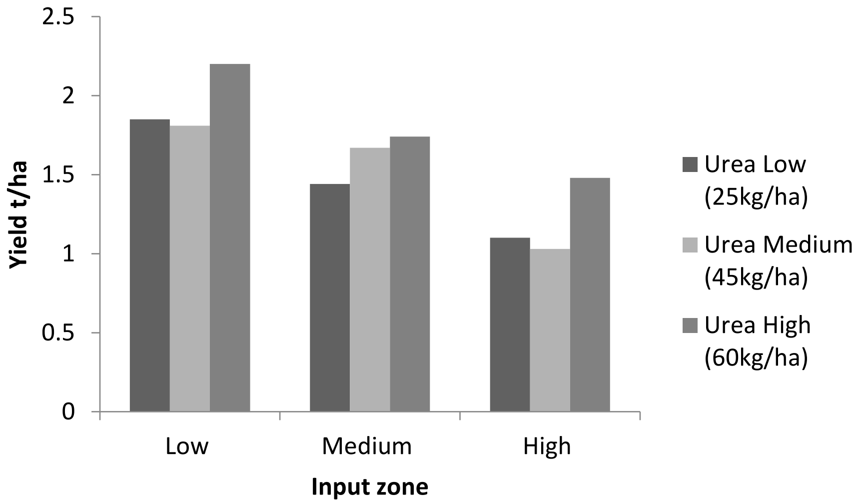

Figure 4: Urea yield (t/ha) across each input zone

Yield in the low input zone responded to increasing application of urea where nil urea yielded 1.85 t/ha and the high urea rate of 60 kg/ha yielded 2.2 t/ha. This was an improvement of 0.35 t/ha across that one input zone. A similar pattern occurred across the medium and high input zones where the yield with nil urea in the medium input zone only reached 1.44 t/ha and then improved by 0.3 t/ha to 1.74 t/ha, when urea was increased to 60 kg/ha. While the high input zone was affected by frost, causing yields to be lower than those in the low and medium input zones, the positive trend in yield due to increasing urea rate remained. With nil urea, the crop in the high input zone would have relied on mineralised soil N, causing yield to only reach 1.1 t/ha compared to those treatments receiving 45 and 60 kg/ha urea which yielded 1.03 and 1.48 t/ha respectively.

Comments
Due to effects of frost, reliable yield data was not obtained. With frost, as is with drought, nutrition is not usually the limiting factor as can be seen in the figures above.

Afgri Equipment's seeding demonstration worked both in the field establishing the crop and delivering the fertiliser inputs to where they were prescribed, this was checked through the application data.
The same can be said for the spreading of urea through the Marshall spreader.

The demonstration runs and VRT machinery demonstration will aim to be continued in subsequent years, allowing for economic analysis over time.

References

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