HYPER YIELDING CROPS FOCUS PADDOCKS

KATE COFFEY - RIVERINE PLAINS INC.

JANE MCINNES - RIVERINE PLAINS INC.

JON MIDWOOD - TECHCROP

NICK POOLE - FAR AUSTRALIA.

KEY POINTS

Focus Paddock 1. Early lodging resulted in yield loss in the DS Bennett wheat. This was caused by several factors, including: very early sowing of a weak strawed variety, high levels of soil and applied nitrogen and grazing that had to be stopped early due to animal health issues.

Focus Paddock 2. Soil testing in 5cm increments identified extremely acid areas (pH CaCl2 of 3.90 -4.6) between 5 and 15cm. The lime was incorporated to target the subsurface acidity. Areas incorporated had an increase in yield compared to those that weren't. Incorporation is a long term investment.

Focus Paddock 3. With the current price of urea, consider the amount and timing of nitrogen (N) in canola to optimise profitability and yield. The Green Area Index (GAI) can be used to quantify the size of the canopy and may be a better way of being more accurate with rates and timings of N application.

The Hyper Yielding Focus paddocks provide an opportunity for farmers and advisors to evaluate Hyper Yielding Research results in a paddock situation.

Background

The GRDC Hyper Yielding Crops project, led by FAR Australia, is a research and extension project designed to push the boundaries of wheat, canola and barley yield in the higher rainfall zones of Australia. Under the guidance of Jon Midwood, TechCrop, Riverine Plains is engaging with local farmers, through focus and award paddocks, to benchmark and push yield potential based on research results.

Some of the causes of the crops not achieving their yield potential were identified as: inherent soil fertility, nitrogen levels, low soil pH in the root zone and variety (winter vs spring wheats).

The project will look in detail into these potential limitations and provide recommendations on how they can be managed. The results presented in this paper are from demonstration strips only and are indicative only. The results will be presented in more detail once statistical analysis has been completed.

Focus Paddock 1. DS Bennett wheat: Nitrogen application

Aim

To ascertain the impact of prior year nitrogen application on the yield of the current years crop.

Method

DS Bennett wheat was sown with Tillage Radish at Gerogery, on the 18th March 2021. Soil nitrogen was measured prior to sowing in 2021, following the application of different rates of nitrogen to canola during the previous year 's strip trials. The paddock was grazed by sheep and cattle for a period of approximately 6 weeks and stock were removed by the end of July. A total of 210kg/ha of urea was applied to the paddock in three applications.

Results and Discussion

Deep soil nitrogen testing, which was sampled from 0-30cm and 30-60cm, returned results from 137–176kgN/ha, which did not appear to correlate with nitrogen applied to canola in 2020 (Table 1). However subsequent NDVI analysis on 3rd December 2021 indicated higher biomass (green strips in the middle of the paddock, Figure 1) which correlated to the previous years higher rates of nitrogen). A conclusion on the impact of prior year nitrogen applications will be made once the yield map data has been analysed.

There was a problem with the grazing ewes going down (cast) in the paddock. The mineral feed test of the wheat (Appendix 1) indicated that potassium levels were above the maximum tolerable limit (pers. comm Katelyn Braine, Murray LLS). This can reduce the absorption of other key minerals such as calcium and magnesium from the diet. While the calcium and magnesium levels in the feed test results are just above the normal requirements for lactating ewes (calcium 0.38, magnesium 0.12), the ewes might not have been absorbing enough calcium and magnesium due to the excess potassium in the feed. This may have caused a low calcium/magnesium in their in their body causing the ewes to go down due to hypocalcaemia and/or hypomagnesaemia. (Note the mineral test was of the wheat plant only and did not include the tillage radish, which may have increased calcium and magnesium ratios). It is recommended to monitor lactating and pregnant animals grazing cereal crops and provide appropriate nutritional supplements.

The paddock yielded 6.5t/ha with 12.4% protein. The DS Bennett wheat started lodging at flowering, which resulted in yield loss compared to other paddocks on the farm. The high protein levels and early lodging at head emergence suggests there was excess nitrogen available to this crop. This was likely to be a result of very early sowing of a weak strawed variety and high levels of nitrogen. Although grazing of the paddock reduced crop height, this paddock was not grazed as heavily as other paddocks and was therefore more prone to lodging.

Figure 1: NDVI taken on 3 December 2021

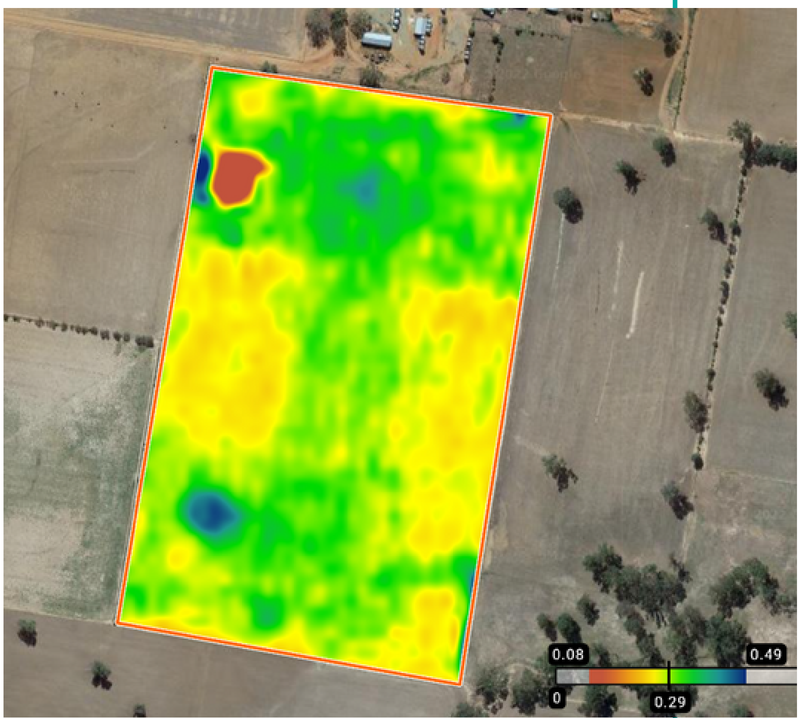

Table 1: Urea applied 2020 to Hytec Trophy and Deep N and Plant counts Bennet 2021

	2020 Canola			2021 Wheat	
	Urea applied* kg/ha	DM Harvest (t/ha)	Yield **(t/ha)	Soil N 0-60cm (kgN/ha)	Plant counts (plants/m2)
Treatment 1 Target 2.5t/ha	217 (100)	12.86	2.73b	176	142
Treatment 2 Target 2.95t/ha	296 (136)	9.63	2.86a	137	110
Treatment 3 Target 3.41t/ha	376 (173)	15.18	2.87a	153	137

*Total nitrogen applied shown in brackets

** Yields were analysed using a paired T test. Yields with a different letter are statistically different from each other.

Focus Paddock 2. T4510 Canola: Lime Incorporation

Aim

To ascertain the impact of ameliorating sub-surface acidity by incorporation of lime.

Method

The paddock was identified by the grower as having limitations that he suspected were subsoil acidity. Maps of average crop vigour over a 5 year period gave an indication that there were under performing zones of the paddock and can be seen in Figure 2. Sites 1 and 2 were in the high performing area, 3 and 4 in the low performing area with 5 and 6 in the medium area. The paddock was then extensively soil tested through the Cool Soil Initiative project to gain an understanding of the limiting soil conditions. The mapping and soil testing identified soil acidity at 5–15cm depth as shown in Table 2.

Figure 2: Average crop vigour in the paddock from 2016-2020.

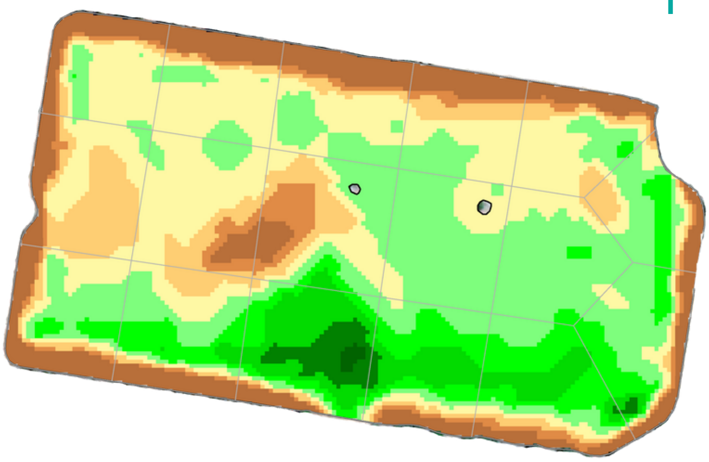

Table 2: Soil test results for paired sampling sites across Brockelsby paddock. ~Electrical Conductivity, ^Cation Exchange Capacity, *Aluminium Saturation

Sample Name	Sample Depth From	Sample Depth To	pH (1:5 CaCl2)	EC~ (1:5 water)	C.E.C.^	Al Sat*
	cm	cm		dS/m	cmol(+)/kg	%
SV-1a	0	5	4.6	0.11	5.2	4.6
SV-1b	5	10	4.1	0.05	3.7	34
SV-1c	10	15	4.2	0.04	3.2	28
SV-1d	15	20	4.7	0.03	3.8	6.9
SV-2a	0	5	4.7	0.4	6.4	3.6
SV-2b	5	10	4	0.05	3.2	36
SV-2c	10	15	4.1	0.04	2.6	35
SV-2d	15	20	4.3	0.04	4.2	15
SV-3a	0	5	4.1	0.15	3.9	22
SV-3b	5	10	3.9	0.06	2.9	53
SV-3c	10	15	3.9	0.04	2.8	59
SV-3d	15	20	4.1	0.03	2.4	42
SV-4a	0	5	4.4	0.14	4.3	10
SV-4b	5	10	4	0.05	3	41
SV-4c	10	15	4.1	0.04	2.8	33
SV-4d	15	20	4.4	0.03	2.6	20
SV-5a	0	5	4.5	0.13	5.5	5.6
SV-5b	5	10	4.1	0.07	4.6	22
SV-5c	10	15	4.4	0.06	5.2	10
SV-5d	15	20	4.9	0.05	5.6	3.7
SV-6a	0	5	4.3	0.16	5.1	9.7
SV-6b	5	10	4.1	0.09	4.2	23
SV-6c	10	15	4.3	0.07	4.5	14
SV-6d	15	20	4.8	0.07	5.5	5.3

A Lemken Rubin 12 was used to incorporate variable rates of lime (rather than just leave it as surface applied), targeting a pH (CaCl2) of 5.8 in the top 10cm. (The NSW DPI pH (CaCl2) target of 5.8, ensures there is sufficient lime applied to address acidity in the 0-10cm layer, as well as allowing for some lime to penetrate below 10cm). The lime was variable rate applied with a range of 2.5t/ha to 4.5t/ha and an average application rate of 3.4t/ha. Three areas were left uncultivated, to test the benefit of incorporating lime compared to surface application. Figure 3 illustrates the trial design with the black boxes representing the area where no incorporation took place. The paddock was sown to T4510 Canola at Brocklesby, on the 30 April 2021. Throughout the season a total of 162kgN/ha was applied to the paddock in 4 applications: 8kgN/ha at sowing, 37kgN/ha on the 20 April 2021; 25kgN/ha on the 20 May 2021, 46kgN/ha on the 9 July 2021 and 46kgN/ha on the 9 August 2021.

Figure 3: Surface (0-10cm) pH (CaCl2) values with the sampling sites and incorporation areas (black boxes).

Figure 4: NDVI of canola (10 August 2021)

Results and Discussion

The cultivation took place shortly before sowing. As a result of the soil disturbance, the seeder had trouble sowing the seed at the correct depth. The variable depth of seed placement impacted on the canola germination, causing lower numbers than expected. Throughout the season, the NDVI showed that the small areas of surface applied lime had less dry matter compared to the incorporated areas (surface applied areas are located inside the squares in Figure 4).

The whole paddock yielded an average of 3.4t/ha. The incorporated vs non incorporated areas were visible in harvest yield maps (data not available at time of printing) and indicated that the incorporated areas yielded 0.5t/ha higher.

The impact of the incorporated lime on ameliorating sub-surface acidity will be measured by soil testing through the Cool Soil Imitative in 2022 and 2023. Lime incorporation is a long term solution and is it is expected that the benefits of the lime will improve production in the years following the year of incorporation.

Focus Paddock 3. Raptor Canola, Nitrogen Rates

Aim

To Determine the optimum rate of Nitrogen for canola.

Method

The paddock was sown to Raptor Canola on the 26 April, 2021. The demonstration (Figure 5), based on farmer input, included 5 treatments with varying rates and timings of nitrogen application (Table 1). The Green Area Index (GAI) method, trialled by Jon Midwood (TechCrop) used soil N measurements and drone technology to assess the amount nitrogen required. GAI is the ratio of green leaf and stem area to the area of ground on which the crop is growing. The GAI protocols are based on a target of 5t/ha dry matter, which equates to a GAI of 3.5 at early flowering to optimise yield. It takes 50 – 60kgN/ha to make 1 GAI, therefore 3.5 GAI equates to 175 – 210kgN/ha. The GAI is measured at set growth stages in the season, to enable nitrogen rates to be adjusted to ensure the dry matter target is reached (Tables 3 and 4).

Figure 5: Paddock Treatments Canola Nitrogen Demonstration.

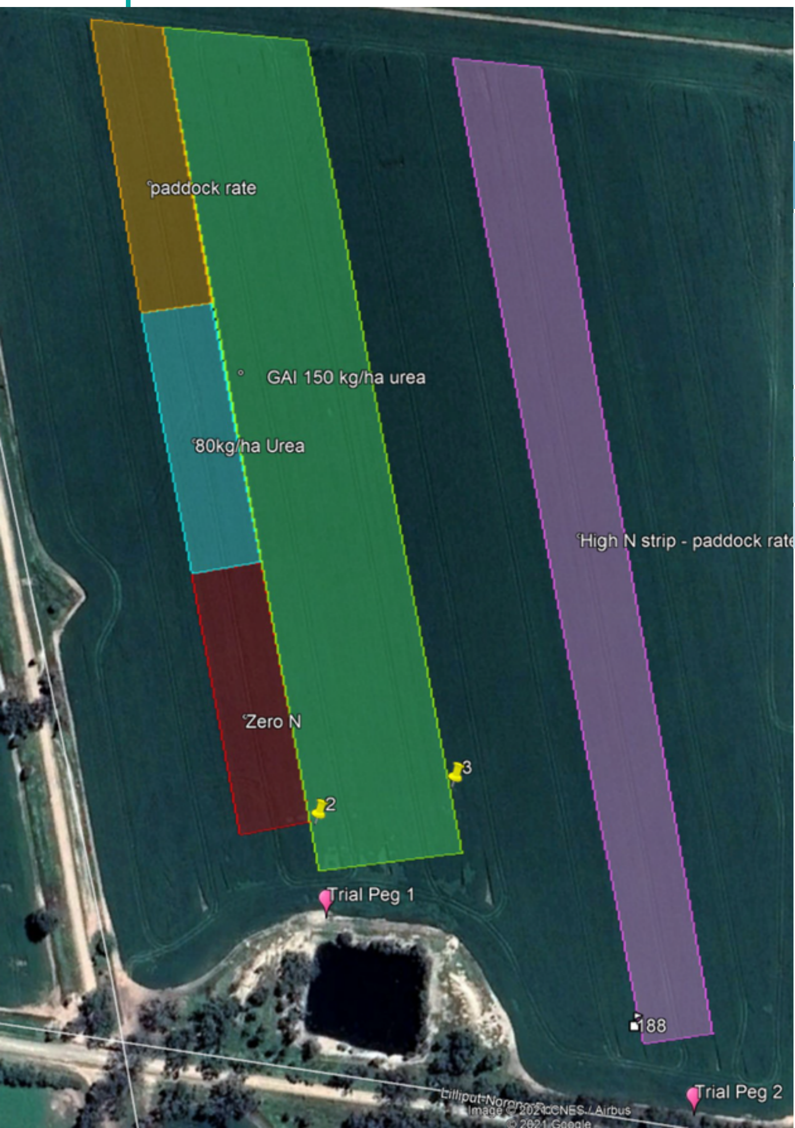

Table 3: Nitrogen Treatments Raptor Canola

Treatment	Urea At Sowing kg/ha	Urea Mid July kg/ha	Urea 9 August kg/ha	Total N to date kg/ha	Dry Matter Start of Flowering t/ha
Paddock Control	80	100	100	129	3.0
ON	0	0	0	0	0.4
37 N	80	0	0	37	0.8
GAI 147 N	80	150	90	147	3.0
N Rich 175 N	80	200	200	221	3.1

Table 4: Target GAI levels based on sowing canola in 3rd week of April

Growth Stage	Target GAI	Actual GAI Focus Paddock
Mid-late June	0.8	0.45 (2 June 2021)
Mid July	1.6	0.88 (range 0.41 - 1.48) (6 July 2021)
Early green bud mid to late July	2.3	
Yellow Bud	3.0	
Mid Flowering	4.0	

Table 5: Calculation of Nitrogen application

Calculation		Focus Paddock (kg N/ha)
Deep N test result (ideally at same time as GAI photo)	(a)	55
GAI in mid-June		0.45
Crop Nitrogen content in June = GAI x 50	(b)	23
Nitrogen supply (a) + (b) = (c)	(c)	78
Target Nitrogen needed in crop at flowering (3.5 GAI)	(d)	175
Shortfall for optimum canopy	(d-c)	97
Nitrogen fertiliser required to be applied by flowering, assumes 60% uptake efficiency (97/ 0.6)		162
Subtract mineralisation estimated at 50kgN/ha (162 – 50)		112
Urea application (46% N) kg/ha		242

Calculations for nitrogen application on the focus paddock (Table 5), indicated that 112kgN/ha was required for optimum yield. The GAI of the focus paddock taken the 6 July 2021 was below the target of 1.6. As such, more nitrogen was applied earlier at green bud (69kgN/ha targeting a GAI of 2.3) and less at the yellow bud stage (42kgN/ha targeting a GAI of 3.0) as shown in Table 4.

Results and Discussion

The paddock had variable germination due to dry sowing conditions. Deep soil N, taken from 0-30cm and 30-60cm prior to sowing was 55kg/ha. The dry matter at flowering ranged from 0.4t/ha in the nil treatment to 3.1t/ha in the N Rich treatment (Table 3). The dry matter did not reach the GAI target of 5t/ha, which was mainly due to poor crop germination in the dry conditions.

The NDVI showed a clear relationship between urea rate and biomass production (the dark blue strips relate to the GAI and N Rich treatment, while the red strip relates to the 0N and 37N treatments Figure 6). The impact of treatments on yield will be analysed to ascertain the optimum nitrogen rate.

Figure 6: NDVI Raptor canola 25 August 2021.

Appendix 1: Mineral Feed test

Element	Unit	Limit of Reporting	Wheat Sample
Aluminium	mg/kg	5.0	280
Arsenic	mg/kg	5.0	<5
Boron	mg/kg	4.0	4.6
Calcium	%	0.001	0.41
Cadmium	mg/kg	0.2	<0.2
Cobolt*	mg/kg	0.05	0.085
Chromium	mg/kg	0.2	0.53
Copper	mg/kg	0.2	7.0
Iron	mg/kg	0.6	210
Potassium	%	0.0004	4.3
Magnesium	%	0.001	0.16
Manganese	mg/kg	0.1	51
Molybdenum*	mg/kg	0.1	51
Sodium	%	0.0005	0.016
Nickel	mg/kg	0.7	<0.7
Phosphorus	%	0.001	0.46
Lead	mg/kg	2	<2
Sulfur	%	0.0006	0.35
Selenium*	mg/kg	0.05	0.06
Zinc	mg/kg	0.8	25

*Test were performed using ICPMS

Acknowledgements

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