HYPER YIELDING CROPS

FOCUS PADDOCKS: 2021 AND 2022 UPDATED RESULTS

KEY POINTS

- **Focus paddock 1 – the application of excess levels of nitrogen in 2020 statistically increased the yield of wheat crops in 2021. This indicates the previous year's unused nitrogen can be "banked" for the current year's crop.**
- **Focus paddock 2 – lime was incorporated to target the subsurface acidity in 2021 and those areas had an increase in yield compared to areas where the lime was not incorporated. The incorporation increased pH values across the profile.**
- **Focus paddock 3 – the Green Area Index (GAI) can be used to quantify the size of the canopy and may be more accurate with rates and timings of nitrogen application. In 2021, using the GAI to determine the timing and rate of nitrogen application gave a significant yield benefit compared with the farmer 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 *Grains Research and Development Corporation (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 from 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 crops not achieving yield potential were inherent soil fertility, nitrogen levels, low soil pH in the root zone and variety (winter vs spring wheats).

The project will take a take a detailed look into these potential limitations and provide recommendations on how they can be managed. Results presented in the 2022 trial book were from demonstration strips only and were indicative results. The results presented in this report have been statistically analysed using a paired-t test.

FOCUS PADDOCK 1. DS BENNETT WHEAT: NITROGEN APPLICATION

AIM

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

METHOD

DS Bennett wheat was sown with tillage radish at Gerogery, on the 18 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 six weeks and stock were removed by the end of July. A total of 210kg/ha of urea (97kgn/ha) was applied to the paddock in three applications.

RESULTS AND DISCUSSION

Since the publication of last year's Trial Book, the yield results of this trial have been analysed (Table 1). The results show a significant yield increase in the wheat crop (2021) from the additional application of nitrogen in the canola crop (2020). An additional 36kgN/ha applied in 2020 to canola compared to Treatment 1, resulted an additional 0.44t/ha in wheat in 2021. With urea priced at $800/t at the time, the investment of $29/ha gave a benefit of $140/ha (wheat price $320/t). An additional 73kgN/ha applied in 2020 to canola compared to Treatment 1, resulted in an additional 0.65t/ha in wheat in 2021. With urea priced at $800/t, the investment of $58/ha gave a benefit of $208/ha (wheat price $320/t).

CONCLUSION

The data suggests that excess application of nitrogen to a canola crop is still available for the following year's wheat crop, provided the nitrogen is not lost due to waterlogging or leaching. In this case when soil nitrogen was assessed on 24 May 2021 it did not reveal the additional nitrogen in the soil. The reason it did not show up in the soil test is unknown. Based on the input and commodity price scenarios of 2020 and 2021 there was an economic return from the previous year's excess nitrogen. In 2022, fertiliser prices doubled, which makes it less economically viable to apply excess nitrogen. Also the extremely wet conditions have increased the potential for the nitrogen to be lost due to waterlogging conditions.

Table 1. Urea applied 2020 to Hytec Trophy and Deep N and plant counts Bennett 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)**	**Yield **(t/ha)**
Treatment 1 Target 2.5t/ha	217 (100)	12.86	2.73b	176	142	6.32(a)
Treatment 2 Target 2.95t/ha	296 (136)	9.63	2.86a	137	110	6.76(b)
Treatment 3 Target 3.41t/ha	2.73b	15.18	2.87a	153	137	6.97©

*Total nitrogen applied shown in brackets
** Yields were analysed using a paired T test (p=0.05). Yields with a different letter are statistically different from each other.

FOCUS PADDOCK 2. T4510 CANOLA: LIME INCORPORATION – UPDATED RESULTS

AIM

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

METHOD

The paddock was identified by the grower as having limitations, which he suspected were subsoil acidity. Maps of average crop vigour over a five-year period gave an indication that there were under-performing zones of the paddock, which can be seen in Figure 2. Sites one and two were in the high performing area, three and four in the low performing area with five and six in the medium area. The paddock was extensively soil tested through the *Cool Soil Initiative* project to gain an understanding of the limiting soil conditions.

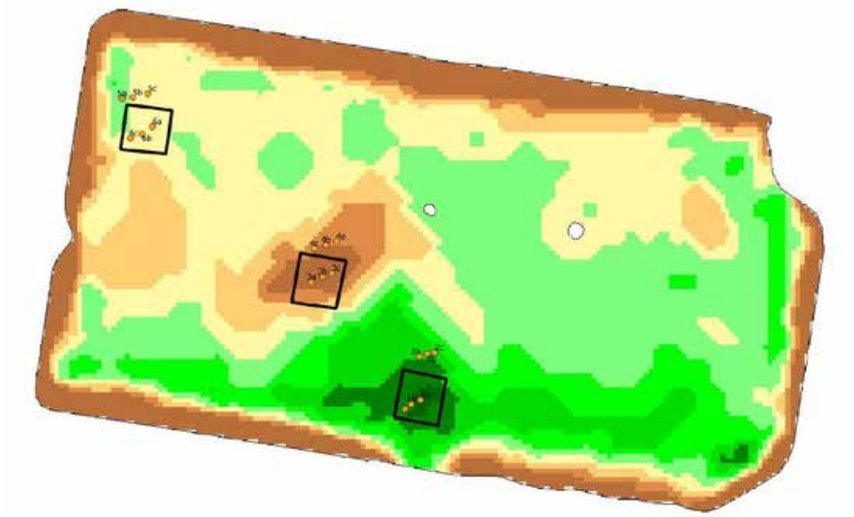


Figure 2. Average crop vigour in the paddock from 2016-2020.

A Lemken Rubin 12 was used to incorporate variable rates of lime (rather than applying to the surface) targeting a pH (CaCl2) of 5.8 in the top 10cm. The NSW Department of Primary Industries 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 applied at a variable rate 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 2021 season a total of 162kgN/ha was applied to the paddock in four applications: 8kgN/ha at sowing, 37kgN/ha on the 20/04/21; 25kgN/ha on the 20/05/21, 46kgN/ha on the 09/07/21 and 46kgN/ha on the 9 August 2021. In 2022 the paddock was sown to wheat.

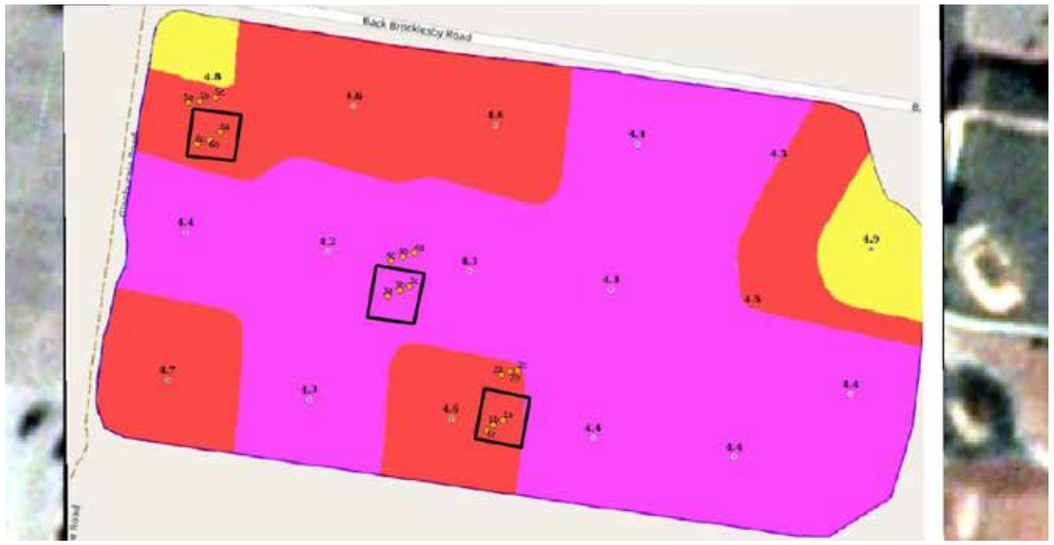
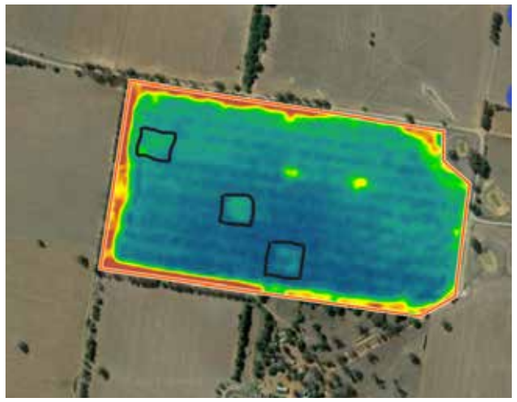


Figure 3. Surface (0-10cm) pH (CaCl2) values with the sampling sites and incorporation areas (black boxes).

RESULTS AND DISCUSSION

2021 results can be found in the previous Trial Book. Comprehensive soil testing was re-done in September 2022, due to the very wet season, the sampling was postponed from April. Results indicate that the lime has been incorporated where the treatment was applied. Throughout the 2021 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 5). During 2022 this re-occurred, while not as obvious, the low yield unincorporated area was visible to have lower biomass and slower growth in the paddock (Figure 4) however yield maps were unavailable. NDVI imagery from 2022 showed similar results to 2021. A comparison between years can be seen in Figure 5.

Figure 4. The untreated area is visible in the paddock. Photo taken (05/09/2022)



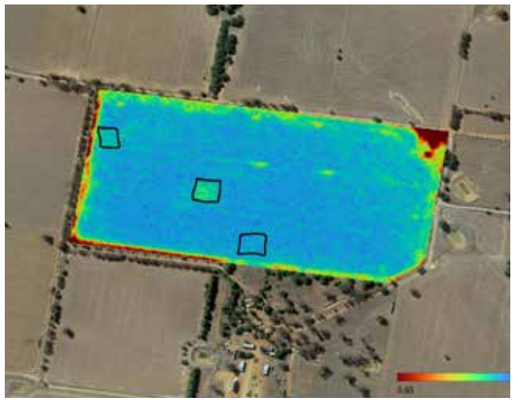


Figure 5. a) NDVI of canola (10 August 2021) *b) NDVI of wheat (8th August 2022)*

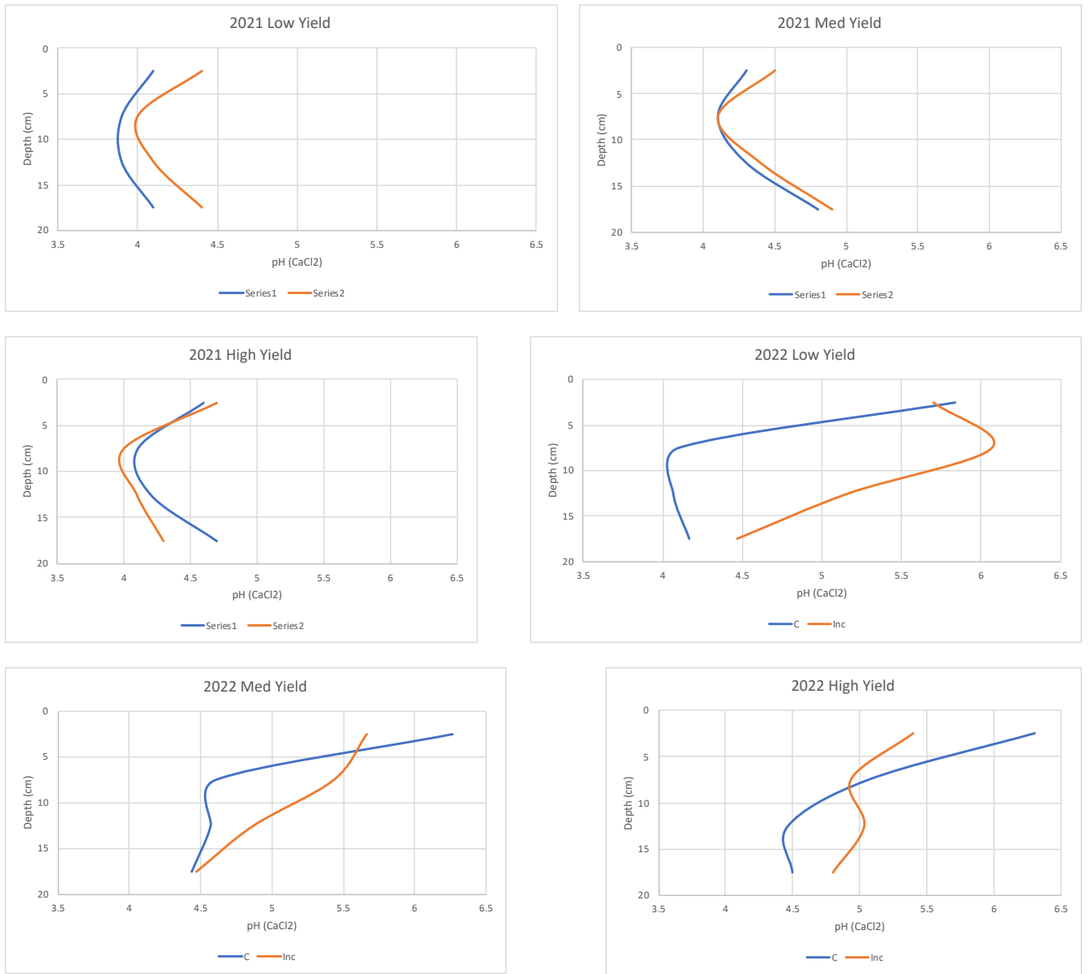


Figure 6. Comparison of original detailed soil sampling and samples taken in September 2022.

TRIAL RESULTS

The soil testing completed in 2022 was analysed in 5cm increments from 0-20cm. Figure 6 shows where the lime was incorporated has increased the pH of the profile down to 15cm. The pH values at 20cm show little increase meaning the incorporation did not reach this depth. The incorporation mixed the lime through the profile, removing the stratification of pH. The increase in pH down to 15cm will provide significant benefit to microbial activity and nutrient availability in that zone, while reducing aluminium below toxic levels. Some lime will continue to move down to 20cm depth, especially in the low yielding zone, where there is excess alkalinity in the 5-10cm zone.

Incorporating and applying lime has a long-term benefit, aiding the movement of lime beyond the surface. This demonstration shows that the incorporation has distributed the lime through the profile, increasing the pH.

The key learning from this methodology was that the machinery used for incorporation can leave the paddock rough and can cause some issues with sowing and post incorporation. Adjustments have since been made by the grower to put a grader board on the machinery to level and firm up the surface after mixing. Yield is a stand out benefit for incorporation and could be visibly seen in the two years following 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 26 April 2021. The demonstration (Figure 5), based on farmer input, included five treatments with varying rates and timings of nitrogen application (Table 1). The Green Area Index (GAI) method trialled by Jon Midwood from TechCrop used soil nitrogen 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. For further information on how the GAI was calculated and nitrogen rates determined, refer to Riverine Plains Trial Book, 2022.

RESULTS AND DISCUSSION

A range of nitrogen application rates were tested in consultation with the host farmer, including application using the GAI index to determine application rates. Deep soil Nitrogen (0-60cm), taken prior to sowing (5/04/21) showed soil levels between 33 and 54kgN/ha. Compared to the paddock control, representing farmer practice, the applications 0kgN/ha and 37kgN/ha were significantly lower yielding and less profitable (Table 3).

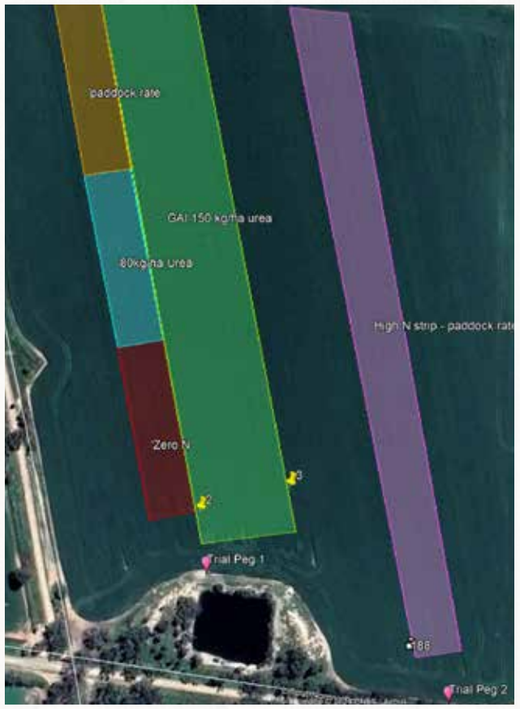


Figure 5. Paddock treatments canola nitrogen demonstration.

The highest yielding treatment was 221kgN/ha, however it was less profitable than the GAI treatment (147kgN/ha, in three applications). Even though the treatments did not reach the dry matter target of 5t/ha at the start of flowering, the favourable seasonal conditions at flowering meant that high yields were still achieved on the GAI and nitrogen rich treatments.

This paddock has been monitored in 2022, to ascertain if the additional nitrogen applied in 2021 will have an impact on the wheat crop in 2022.

Table 3. Nitrogen treatments Raptor Canola

TREATMENT	UREA AT SOWING) KG/HA	UREA MID JUL KG/HA	UREA 9 AUG KG/HA	TOTAL N TO DATE KG/HA	DRY MATTER START OF FLOWERING T/HA	YIELD T/HA		ADDITIONAL GROSS MARGIN COMPARED TO CONTROL * $/HA
Paddock Control	80	100	100	129	3.0	3.41	c	
ON	0	0	0	0	0.4	1.78	d	-916
37 N	80	0	0	37	0.8	2.30	d	-617
GAI 147 N	80	150	90	147	3.0	3.79	b	235
N Rich 221 N	80	200	200	221	3.1	3.96	a	225

*Based on 2021 Urea price of $800/t and canola price of $700/t

** Yields were analysed using a paired T test. Yields with a different letter are statistically different (p=0.05) from each other.

CONCLUSION

The *Hyper yielding crops project* demonstrates the yield possibilities in wheat, canola and barley paddocks. This on-farm demonstration shows that nitrogen is a key driver of high yielding crops. However there is a point where the cost of applying additional inputs becomes uneconomical. In this demonstration, that point was reached with the application of 221kgN/ha, based on 2021 prices and inputs. This paddock was monitored in 2022 to identify if any of the nitrogen applied in 2021 carried over to benefit the wheat crop in 2022 (results not available at time of printing).

ACKNOWLEDGEMENTS

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Authors: Kate Coffey, Riverine Plains; Jane McInnes, Riverine Plains; Jon Midwood, TechCrop; Nick Poole, FAR Australia; Cassandra Schefe, AgriSci Pty Ltd.