The impact of nitrogen plus micronutrients on crop yield

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Facilitated action learning groups to support profitable irrigated farming systems in the northern and southern regions.

KEY MESSAGES

- No significant differences were recorded from the addition of zinc, copper, and manganese. However, when removing large grain yields there will be large levels of removal from the soil. This needs to be replaced to avoid over mining the soils.
- Nitrogen is still he major element which controls yield and grain protein. Need to ensure that the crop is fed to the yield potential to maximise both.
- Know your starting base of nitrogen within the soil is important to determine nitrogen fertiliser rates. When we have Urea at over $1500/t you want to be using it strategically.

Background

There has been a strong focus on nitrogen rate and application timing to achieve high yielding grain crops such as wheat and barley. When nitrogen fertilisers are applied in large volumes, there is some research that suggests it can limit the availability of some micronutrients such as zinc and copper, which are important in plant growth and development.

Based on this we seen the opportunity to try and look a bit further and see if we could push yield any further with well-timed applications of foliar sprays as well as pre seeding applications of micronutrients.

Through the GRDC Optimising Irrigated Grains project, the facilitated action learning group at Frances has conducted a replicated trial looking at varying a standard rate of nitrogen in conjunction with the addition and subtraction of foliar and pre harvest applications of micronutrients. The main micronutrients targeted were zinc, copper, and manganese. This was compared to the standard farmer practise to see if we could observe any differences.

The trials were sown on the 19th of May 2022 on a centre pivot site at Frances, which was previously been sown to beans. Starting nitrogen levels within the site were around 165 kg N/ha, which was a significant starting base.

Activities

Treatment variables consisted of +/- foliar application of trace elements as well as +/- the addition of a non-chemical organic product Humates FF50 as a source of nutrients.
We also had a farmer practice treatment to reflect what is happening in the paddock as a comparison.

All plots (with exception of the farmer practise and the nil plots) received the same nitrogen treatments with 118kg/ha of N applied. Farmer practice plots received 256kg/ha of N. this was applied in the form of urea and DAP (down the tube at seeding). Farmer practise plots also received 3l/ha of smart trace triple foliar spray.

Nutritional analysis of the foliar and humate products are outlined below in ***tables*** *1 and 2*.

Table 1: Humates FF50 nutritional analysis.

Nutrient	Analysis	Nutrient per 500kg/ha application	Nutrient per 250kg/ha application
Nitrogen	1.20%	6 kg/ha	3 kg/ha
Potassium	0.45%	2.25 kg/ha	1.13 kg/ha
Sulphur	1.45%	7 kg/ha	3.5 kg/ha
Copper	27 mg/kg	6.75 g/ha	3.38 g/ha
Zinc	73 mg/kg	18.25 g/ha	9.13 g/ha
Manganese	249 mg/kg	62.25 g/ha	31.13 g/ha

Table 2: nutritional analysis of the foliar trace-element application

Nutrient	International W/W%	Nutrient (g) per 3L/ha application
Zinc	3.15	94.50
Manganese	3.94	118.20
Copper	1.18	35.40
Sulphur	3.86	115.80

A pre seeding soil analysis was conducted to determine the starting level of nitrogen within the soil. Samples were collected to a depth of 90cm across the trial site. Results of this soil test can be seen below in ***table*** *3.*

Table 3: Deep soil nitrogen test results. Averaged out across different sample depths.

Depth	NO_3 mg/kg	NH_4 mg/kg	Total Deep N kg/ha
0-90cm	12.68	2.67	166

Over the course of the season the site received 641.6mm of annual rainfall. 428mm of this fell within the growing season. 115.4mm fell within the harvest period of November and December resulting in no additional irrigation water applied.

Results and Discussion

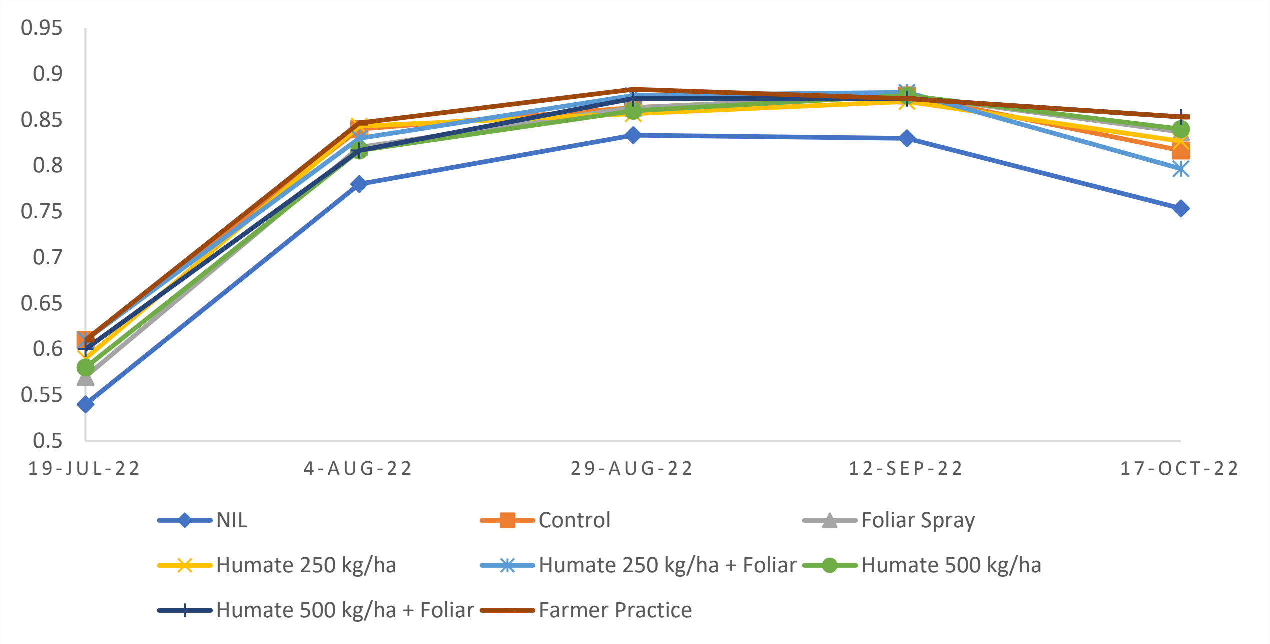

Figure 1: Impact of the addition of micro-nutrients in varying forms on wheat NDVI readings.

Normalised Difference Vegetation Index (NDVI) readings were conducted at five different times throughout the growing season. This measures the presence of green in the vegetation. Results from the NDVI readings are outlines in Figure 1 above. We observed a significant difference between the nil treatment and all other treatment at each stage the analysis was conducted. The was a result of the fact that the nil treatment didn't receive any fertiliser or trace elements. The nil treatment was thinner and less vigorous which can be seen in photos 1 and 2.

Photo 1: Nil treatment at the trial site *(13th September 2022, Brendan Wallis – Pinion Advisory).*

Photo 2: Farmer Practice treatment at the trial site *(13th September 2022, Brendan Wallis – Pinion Advisory).*

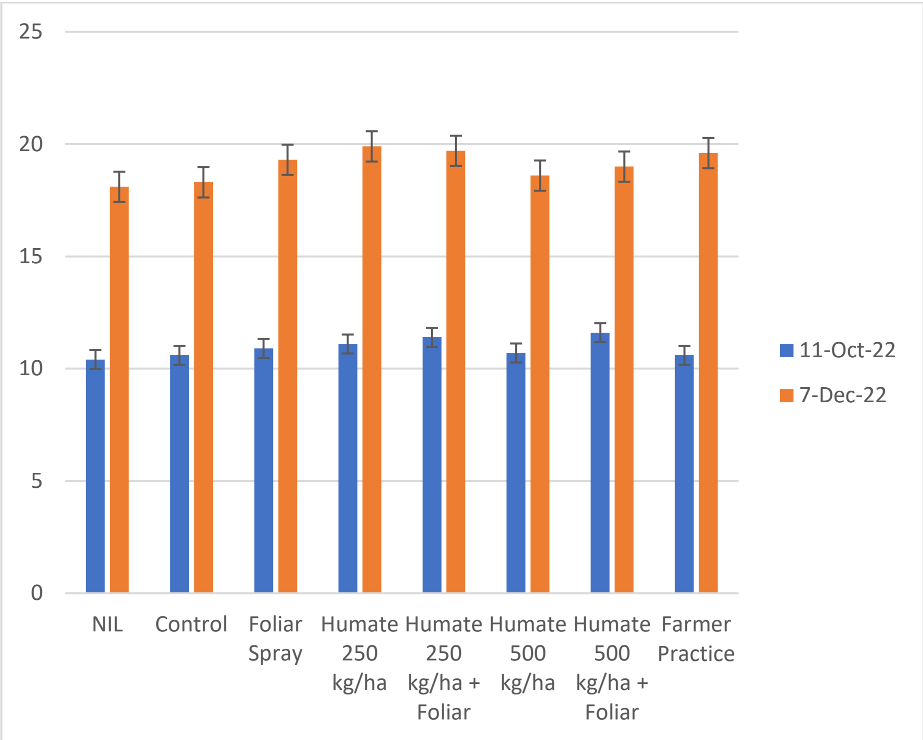

Figure 2: impact on foliar and pre spread micro-nutrients on dry matter production at Frances. No significance recorded.

Dry matter cuts were taken on the 11th of October and again prior to harvest on the 7th of December. No significant difference was recorded between the different treatments. We seen dry matter production top out at 19.9t/ha with treatment 4 (250kg/ha Humates).

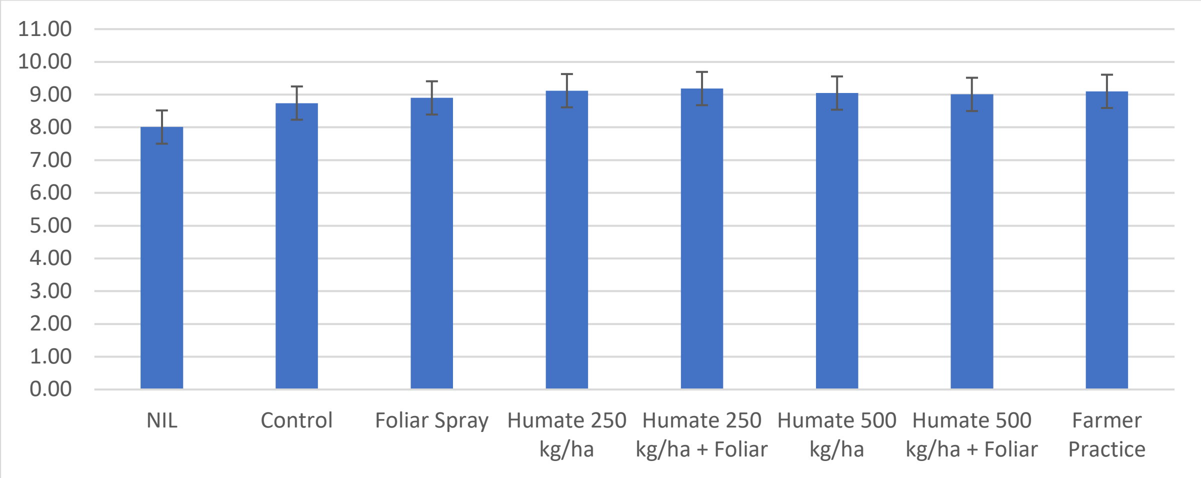

Figure 3: impact on foliar and pre spread micro-nutrients on grain yield at Frances.

Grain yield was very consistent across the different treatments with yields ranging between 8.1t/ha and 9.19t/ha. We did observe a significance with all treatments significantly higher than the nil treatment. When we overlay this with the grain protein results in **figure 4,** this result is likely due to additional nitrogen being applied to all treatments. No other significances were recorded.

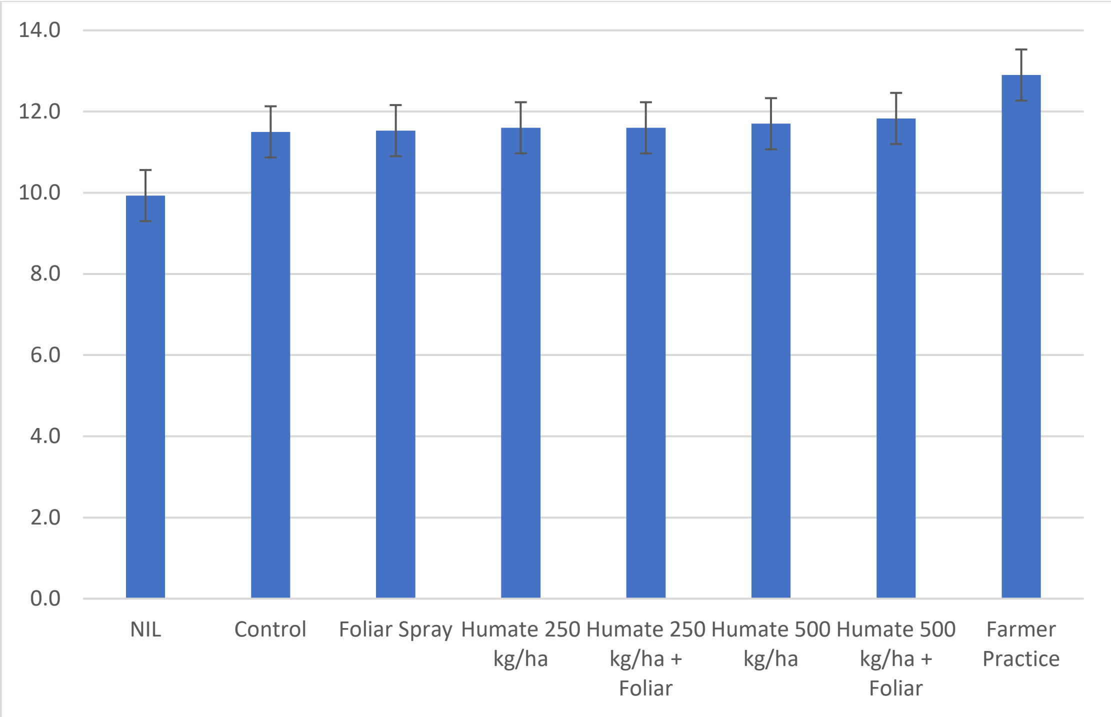

Figure 4: Impact of varying treatments had on grain protein at Frances in 2022 (LSD 0.05=0.63), 2020 (NS) and 2021 (LSD 0.05=29.7) respectively.

Protein results varied across the site, with a range from 9.9% to 12.9%. there were some significances within this. The nil treatment was significantly lower than all other treatments reaching 9.9%, which is a ASW quality profile, while the farmer practice was significantly higher thank all other treatments reaching 12.9%, which is a H2 quality profile.

Nitrogen rates are likely to have contributed to this difference. Over the treatments, the nil treatment received 0kg/ha of N, while the farmer practice treatment received 256kg/ha of N. all other treatments received 118kg/ha of N. This variation in nitrogen rate has influenced yield, while also contributing to additional protein in the farmer practice treatment. This also shows that yield was maximised with 118kg/ha of N.

Table 4: economic outcomes based on the treatments and different input costs. *

Treatment	Yield (t/ha)	Grade	Price ($/t)	Gross Income ($/ha)	Total Expense ($/ha)	Net Income ($/ha)
Humate 250 kg/ha + Foliar	9.186	H2	$ 400.00	$ 3,674.40	$ 601.90	$ 3,072.50
Humate 250 kg/ha	9.12	H2	$ 400.00	$ 3,648.00	$ 580.00	$ 3,068.00
NIL	8.01	ASW	$ 380.00	$ 3,043.80	$ -	$ 3,043.80
Humate 500 kg/ha	9.048	H2	$ 400.00	$ 3,619.20	$ 610.00	$ 3,009.20
Foliar Spray	8.9	H2	$ 400.00	$ 3,560.00	$ 560.90	$ 2,999.10
Humate 500 kg/ha + Foliar	9.007	H2	$ 400.00	$ 3,602.80	$ 631.90	$ 2,970.90
Control	8.742	H2	$ 400.00	$ 3,496.80	$ 542.00	$ 2,954.80
Farmer Practice	9.1	H2	$ 400.00	$ 3,640.00	$ 1,023.90	$ 2,616.10

**Assumptions made around cost of spreading and spraying*

Based on the harvest data we have compiled an economics table. This factors in some assumptions around fertiliser price, contract spreading and spraying rates and grain prices based on the quality achieved. The results are in order of highest to lowest net income per hectare.

Conclusions

Through the trial we did not find any evidence to suggest that the addition of zinc, manganese and copper made a significant difference on grain yield. Whilst we didn't see an impact on yield, we didn't conduct any plant tissue tests in season to determine the levels within the pants. It is still important to be monitoring crops for signs of stress as you don't want to be getting symptoms of deficiency.

When we are dealing with high yielding crops (8.01t/ha to 9.19t/ha) we need to be aware of the product removal. For major nutrients such as nitrogen and phosphorus this can be as much as 20kg/t of wheat grain yield and 3 kg/t of wheat grain yield respectively. We don't see the same level of nutrient removal with micronutrients such as zinc, copper and manganese, however there is still a draw down on soil reserves. This could be as much as 16g/t of wheat grain yield, 7g/t of wheat grain yield and 40g/t of wheat grain yield respectively.

Through the trial we have seen a nitrogen response. This is in the form of yield gain with all plots yielding significantly higher than the nil treatment. We have also seen a nitrogen response in the form of protein, with the farmer practise treatment having a significantly higher protein level in the grain compared to other treatments.

When making the decisions of applying nitrogen, you need to determine what you are targeting. Is it yield or is it protein. Then overlaying this with a fertiliser plan. Through this trial all pots except for the nil treatment received 220kg/ha of urea. The farmer practice treatment then received an additional 300kg of urea totalling 520kg/ha. The expense ($450/ha) in applying extra nitrogen did not result in additional yield and only a protein gain. When looking at the economics this has not been a strategic use of nitrogen as the expense has well exceeded the return.

One aspect of matching nitrogen requirements to crop yield potential is the starting level of available nitrogen within the soils. One way of getting a guide is the use of strategic soil samples to measure starting nitrogen levels. This is not always possible on the Limestone Coast of South Australia due to varying depths of soils; however, some form of gauge is better than none.

ACKNOWLEDGEMENTS

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This GRDC funded Project "Facilitated action learning groups to support profitable irrigated farming systems in the northern and southern regions" includes 8 irrigation discussion groups. The ICC are partnering with IREC, Southern Growers, Riverine Plains, the Maize Association, MFMG, Southern Farming Systems to facilitate discussion groups in Griffith, Coleambally, Finely, Mulwala, Kerang, Corop, Frances and Longford.