Fallow or Not: Balancing Soil Moisture and Cover Crop Trade-offs

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Key Messages

- This is the second year of a five-year factorial crop sequence x nitrogen management trial.
- There was a clear yield benefit associated with break crops and fallow.
- There was a protein increase associated with increased nitrogen; however, this also caused higher screenings.

Aim

This trial aims to address key uncertainties around crop rotation and nitrogen application, providing growers with practical insights to improve decision-making and mitigate risks. This trial forms part of the national GRDC RiskWi$e initiative, which seeks to engage grain producers in identifying and evaluating farm management strategies that carry inherent but uncertain risk-reward dynamics.

Background

This trial was established by the Liebe Group in 2023 after the question of "to fallow or not to fallow" came up during a bus tour in 2022. Growers often use fallow or break crops to improve soil health and increase production in the following seasons, benefiting from moisture retention, weed control, and nitrogen fixation. However, the risks and rewards of these practices are not always understood.

In its second year, this trial continues to evaluate the effects of various crop sequences: continuous wheat; low-risk, N mining (fallow incorporated into wheat crop rotation); low-risk, N building (brown manure legume incorporated into wheat crop rotation; high-risk, high return (grain legume incorporated into wheat crop rotation). Three nitrogen treatments (nil, low, and high risk) were randomised and applied to each crop sequence strategy.

Trial Details

Trial location	DW & GD McIlroy, Pithara
Plot size & replication	8.1m x 1.75m x 3 replications
Soil type	Loam over gravel
Paddock rotation	2021 wheat, 2022 wheat,
Sowing date	16/05/2024
Sowing rate	70 kg/ha Scepter wheat 100 kg/ha Jurien lupins 2 kg/ha Emu canola
Harvest date	30/10/2024

Inputs

Date	Wheat	Lupins	Fallow	Canola
Pre-Em 16/05/24	50 kg/ha Urea 100 kg/ha Macro Pro X 118 g/ha Sakura 200 mL/ha Voraxor 1.2 L/ha Avadex X 2 L/ha Trifluralin 800 mL/ha Chlorpyrifos 150 mL/ha Bifenthrin 2 L/ha Roundup DST	50 kg/ha Urea 100 kg/ha Macro Pro X 1 L/ha Propyzamide 2 L/ha Trifluralin 800 mL/ha Chlorpyrifos 150 mL/ha Bifenthrin 2 L/ha Roundup DST 750 mL/ha Reflex		50 kg/ha Urea 100 kg/ha Macro Pro X 1 L/ha Propyzamide 2 L/ha Trifluralin 800 mL/ha Chlorpyrifos 150 mL/ha Bifenthrin 2 L/ha Roundup DST
Post-Em 08/07/24	2.5 L/ha Boxer Gold 1 L/ha Velocity	200 mL/ha Brodal	1.5 L/ha Roundup DST 1 L/ha Velocity 100 mL/ha Velocity	1.3 L/ha Roundup DST
Post-Em 01/08/24		330 mL/ha Cletho 360 190 mL/ha Quizalofop		

*Brown Manure Lupin plots were sprayed out on 11/09/2024, 2 L/ha Roundup DST

Crop Sequence

Sequence Name	Crop Rotation
Continuous wheat	Wheat (1 phase)
Low risk, low return, N mining	Fallow–Wheat (3 phases)
Low risk, low return, N building	Brown Manure Lupins–Wheat (3 phases)
High risk, high return	Lupins–Wheat (3 phases)
Tactical	Lupins–Canola–Wheat (1 phase)

Nitrogen Treatments

Treatment	Nitrogen
Nil	No N fertiliser applied (other than 32 kg/ha N at sowing)
Low N	49 kg/ha N applied (including 32 kg/ha N at sowing). Based on a decile 5 season (Yield Prophet prediction).
High N	104 kg/ha N applied (including 32 kg/ha N at sowing). Based on a decile 5 season (Yield Prophet prediction).

***Nitrogen applied to wheat phase only.**

Initial Soil Composition (sampled 05/05/2023)

Depth (cm)	pH ($CaCl_2$)	Col P (mg/kg)	Col K (mg/kg)	S (mg/kg)	N (NO_3) (mg/kg)	N (NH_4) (mg/kg)	EC (ds/m)	OC (%)
0-10	5.9	23	51	25.4	1	1	0.1	0.59
10-20	5.5	16	43	18.3	1	1	0.071	0.41
20-30	6.1	7	39	19	<1	<1	0.048	0.22

Soil Nitrogen (Sampled 14/5/2024)

Rotation Treatment (2023 crop – 2024 Crop)	2024 Crop	N Strategy	N (NO3) (t/ha) Depth 0-40cm	N (NH4) (t/ha) Depth 0-40cm	Total N (NO3 + NH4) (t/ha) Depth 0-40cm
Wheat–Wheat	Wheat	High	68	9.1	77.1
		Low	63.2	6.1	69.3
		Nil	61.3	5.1	66.4
Fallow–Wheat	Wheat	N/A	91.7	9.1	100.8
Brown Manure Lupins–Wheat	Wheat	N/A	78.9	6.9	85.8
Lupins–Wheat	Wheat	N/A	62.1	8.5	70.6
Lupins–Canola	Canola	N/A	64.8	9.6	74.4

Pithara monthly rainfall (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	GRS	Decile (GSR)	Total
2023	6	0	25	6	21	38	23	17	4	0	26	14	106	1	180
2024	0	16	60	6	5.5	58	70	49.25	6.5	1	0	0	196.25	3 - 4	272.25

Results

Yield

The highest yield was recorded in the brown manure lupin - wheat rotation (average 3.45 t/ha), followed by fallow–wheat (3.3 t/ha). Lupin–wheat yielded 2.9 t/ha, while continuous wheat had the lowest yield at 2.6 t/ha. Yield differences were significant ($p < 0.05$), with brown manure–wheat and fallow–wheat significantly outperforming lupin–wheat and continuous wheat (LSD = 0.31 t/ha).

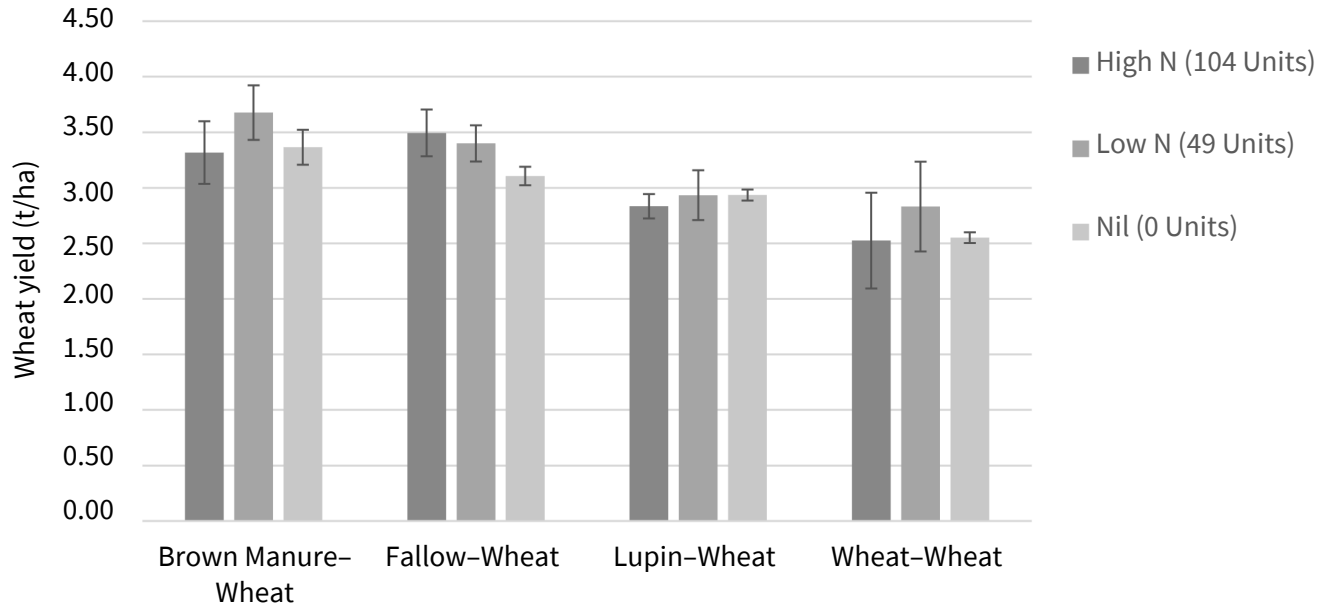

Figure 1. 2024 wheat yields (t/ha) following various rotations with three N strategies.

Protein

Protein was unaffected by rotational treatment ($p > 0.05$) but significantly influenced by nitrogen rate ($p < 0.05$). The high N treatment resulted in an average protein of 12%, Low N averaged 10% and Nil N averaged 9%; all differences are statistically significant (LSD = 0.7%).

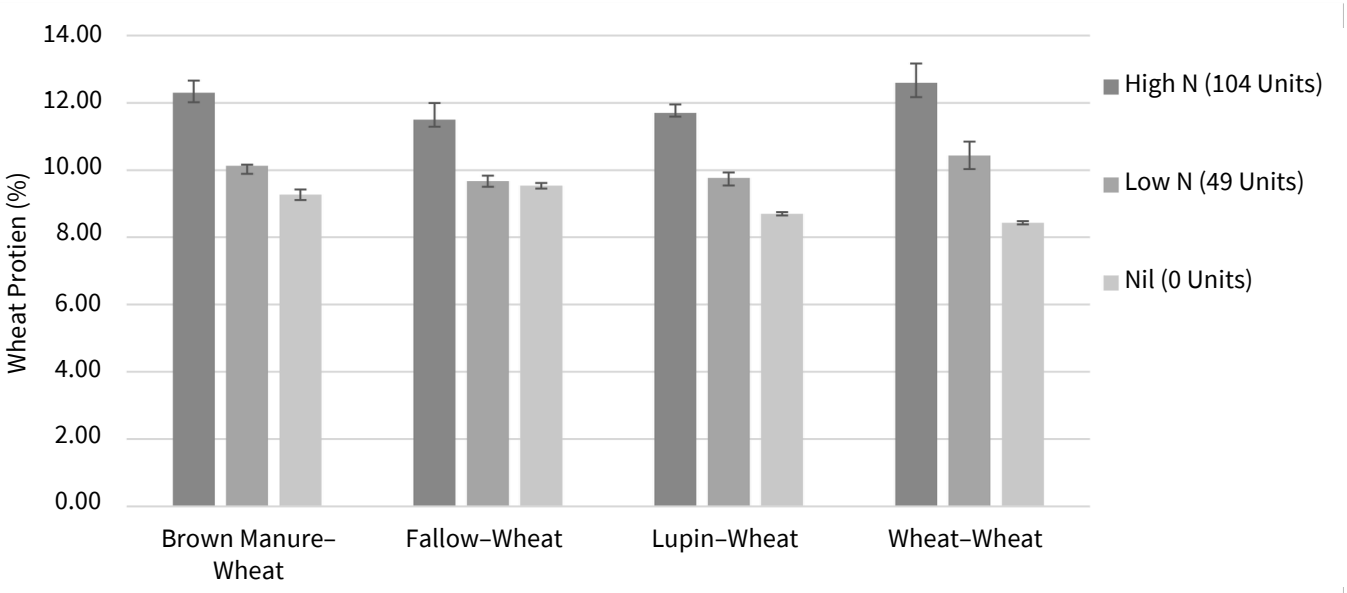

Figure 2. 2024 wheat protein following various rotations with three N strategies.

Screenings

Nitrogen rates significantly increased screenings ($p > 0.05$). The high nitrogen rate had an average screening of 15%, which is significantly higher than the other two treatments. The low N rate had an average screening of 11.7%, and Nil Nitrogen averaged 9.4% (LSD = 3.5%). While the rotation had no significant effect on screenings ($p > 0.05$) there is a clear trend, rotations with higher soil nitrogen had lower screenings.

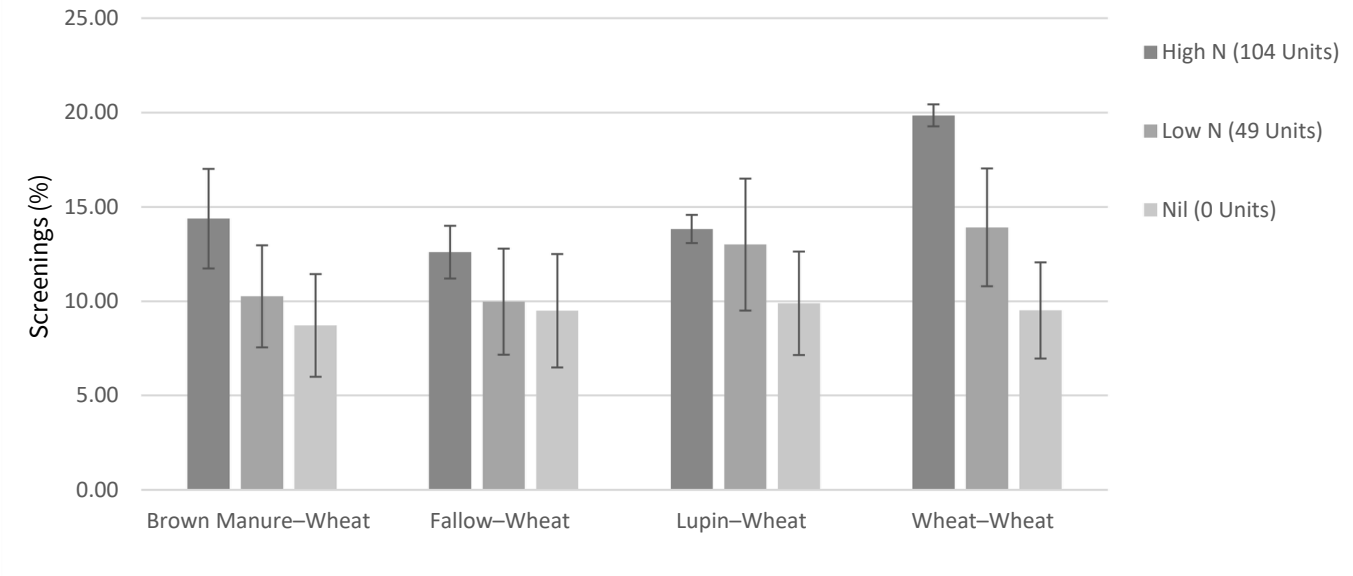

Figure 3. 2024 wheat screenings following various rotations with three N strategies

Comments

With the trial now in its second year, wheat yields across strategies can start to be compared. This year, the site received 180mm of growing season rainfall. The trial has demonstrated the influence of crop rotation and nitrogen application on yield, protein and screenings.

Yield results revealed that brown manure – wheat rotation and fallow – wheat rotation achieved significantly higher yields than the lupin – wheat rotation and continuous wheat (Figure 1), with continuous wheat resulting in the lowest yield. This result illustrates the benefits of incorporating a break crop or fallow, which benefit the soil moisture and nutrient availability, improving nitrogen reserves for the subsequent crops.

The effects of nitrogen banking were particularly evident given the dry season last year; any extra moisture in the fallow and brown manure systems over the summer of 2023 may have affected the mineralisation of nitrogen in the soil, which increased the availability of stored nitrogen in 2024. Soil moisture testing prior to seeding indicated there was no moisture differences between the different rotations (data not shown), however it is likely that the fallow plot did store extra moisture at some stage, which would account for the extra N mineralisation but due to the extremely hot and dry summer, this had evaporated come sampling time.

Protein content was significantly increased by nitrogen application (Figure 2) and crop rotation had no significant effect, which indicates that nitrogen availability was the primary driver. Nitrogen is a critical component of amino acids and plays a direct role in protein synthesis within the plant. When nitrogen availability is higher, plants can allocate more resources to protein production in the grain. In this trial, the increased nitrogen treatments provided the required nutrients to drive this process.

Screenings were significantly impacted by nitrogen application, increasing with higher application rates. This can likely be attributed to haying off late in the season. High nitrogen availability causes excessive growth, which leads to moisture stress during grain filling, especially in years with a dry finish. This results in smaller, shrivelled grains and higher screenings. Rotation also had an affect on screenings, though less significant. Rotations which had the highest soil N, such as fallow – wheat (total soil N 108 t/ha) had much lower screenings compared to the same nitrogen treatment in rotations with lower soil N such as continuous wheat.

Overall, the findings demonstrate the importance of crop rotation and nutrient management for optimal crop growth. These strategies can mitigate risk and have shown clear benefits for productivity.

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