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IDENTIFYING THE LEGACY EFFECTS ON CANOLA AND/OR WHEAT FOLLOWING PULSE CROPS

2025 BARELLAN, NSW

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

GRDC Investment from National Grower Network (AGG2403-001RTX)

2024-2026

Identifying the legacy effects of pulses

KEY POINTS

- **Drought conditions were experienced in the 2025 season, with dry, warm, and windy weather persisting for much of the season. The trial received less than 150mm of growing season rainfall, with 45mm of this rain falling from mid September.**
- **Pulse species differed in nitrogen fixation, with N fixation data from the 2023 pulse species showing field peas (136kg N) fixing the highest amount of N, followed by lupins (130kg N), while chickpeas (58kg N) and lentils (75kg N) fixed the least.**
- **2025 was the second year of the project, with some differences observed in legacy effects between pulse species. Barley following vetch showed the strongest legacy response in 2025, with higher NDVI and grain yield of barley following vetch compared to the other pulse species.**
- **Disease and soil-borne pathogen risks were generally low across all pulse species, with minimal risk of carryover to the subsequent barley crop.**

BACKGROUND

This project is a GRDC National Grower Network (NGN) investment. Growers at NGN forums at Narromine and Barellan identified an interest in better understanding the legacy effects pulse crops provide for following wheat or canola crops, as many growers do not fully understand the legacy benefits pulse crops provide.

Some of the legacy effects pulses provide include increased soil nitrogen, reduced soil borne disease pressure, reduced grass weed seed bank and higher soil water status. Growers in lower rainfall environments are interested in better quantifying these benefits to account for the pulse contribution when making crop sequence choices, with Barellan growers keen to establish locally relevant trials to quantify this benefit in their region.

The Barellan trial was set up to determine the legacy benefits of a pulse crop to the following crop in the rotation, and in particular which pulse species leaves the best legacy in terms of nitrogen benefit, disease pressure, water use efficiency as well as crop sequence gross margins. 2025 was the second year of this three year project.

TRIAL DETAILS

2025 was the second year of this project, with the trial established in May 2024 at Barellan, approximately 54km east of Griffith. In 2023 a pulse trial consisting of 6 pulse species (chickpeas, faba beans, field peas, lupins, lentils and vetch) replicated 4 times was established at the site and was used as the foundation for this trial in 2024. Table 1 shows the setup of the trial.

Table 1: Trial treatment list consisting of pulse species grown 2023 and rotation crops 2024 and 2025.

Trt No.	2023 Pulse Species	2024 Rotation crop	2025 Rotation Crop
1	Lentils	Wheat	Barley
2	Vetch	Wheat	Barley
3	Field Pea	Wheat	Barley
4	Lupin	Wheat	Barley
5	Faba bean	Wheat	Barley
6	Chickpeas	Wheat	Barley

As part of the paddock rotation barley was sown at the site in 2025. Neo CL barley was sown on 28th May 2025 at 35kg/ha with 80 kg/ha DAP. As per commercial practice, appropriate pest, disease and weed control was undertaken pre-emergence and in crop.

The trial was harvested on 20th November 2025. No urea was applied to the trial in 2025 to enhance any nitrogen benefits from the previous pulse crop.

Seasonal Conditions 2025

Conditions for the first 4 months of the year were very dry, with below average rainfall and above average temperatures. Warm and dry conditions persisted into May, with some much-needed rain towards the end of the month, table 2. Follow up rain occurred mid-late June, before the crop accessed stored moisture.

With warmer, windy days and frosts impacting topsoil moisture, below average rainfall continued throughout June, July and August as drought conditions strengthened. Much needed rain occurred in early September.

The Barellan trial received 148.4 mm growing season rainfall (GSR) from April–October (263.6mm GSR average) with 45 mm of this rainfall received in September and October.

Table 2: 2025 Rainfall and Growing Season Rainfall (GSR) for Barellan, compared to long term rainfall and Griffith (nearest MET stations).

MONTH	Barellan Post Office 2025	Barellan Post Office Long Term (1878 to 2025)	Griffith Airport 2025	Griffith Airport Long Term (1958 to 2025)
January	17	38.7	4.4	36.3
February	15.7	33.9	23.6	28
March	29	37.9	25	35.3
April	*0.2*	*34.5*	*12.4*	*29.3*
May	*31*	*37.6*	*14.8*	*36.1*
June	*31.2*	*40.2*	*29*	*35.1*
July	*28*	*36.4*	*22.4*	*32.4*
August	*13*	*37.8*	*17*	*34.9*
September	*36.4*	*34.9*	*32.8*	*32.7*
October	*8.6*	*42.2*	7.2	39.4
November	9.8	35.2	21.2	36.3
December *		31.6	10.2*	32.7
TOTAL	**219.9**	**440.9**	**220**	**408.5**
GSR (April - Oct)	***148.4***	***263.6***	***135.6***	***239.9***

** to 16th December*

2023 Legume N fixation

To determine nitrogen fixation and nitrogen balance of the various pulse species, samples were taken in 2023 and sent for analysis, as part of the pulse project, table 3. Total N fixation in 2023 was greatest for field peas followed by lupins. Chickpeas and lentils fixed the least amount of N out of the pulse species in 2023.

Table 3: 2023 Barellan Pulse species nitrogen fixation and N balance.

Pulse Species	Total N-fix (kg/ha)	N Balance (kg/ha)	Peak Biomass (t/ha)
Chickpea	58	3	3.8
Faba bean	123	63	4.5
Field pea	136	68	6.1
Lentil	75	34	3.7
Lupin	130	34	5.9
Vetch	121	56	6.5

Soil Testing 2025

Soil water prior to sowing of the 2025 crop

Soil water was not assessed prior to sowing the 2025 as conditions were very dry leading up to sowing.

Soil Nitrogen (N) at sowing

Soil sampling for N was undertaken in February 2025 to assess any additional N benefits from each pulse species carrying over to the 2025 season, although not all N following pulse crops is captured in soil N testing. Total soil mineral N (0-60cm) for each pulse species grown in 2023 and sampled at the start of the 2025 season are shown in table 4. There were no differences in soil mineral N between species for the 0-10cm and 10-60cm sampling depths. For the total soil mineral N (0-60cm) field peas had the lowest soil N at sowing.

Table 4: Total soil mineral N (0-60cm) at sowing 2025 for each species grown in 2023, February 2025.

2023 Pulse Species	2025 Total Soil N 0-60cm	*Sig Diff*
Chickpeas	39.73	*a*
Fabas	46.93	*a*
Lentils	42.38	*a*
Lupins	44.59	*a*
Peas	33.06	*b*
Vetch	42.59	*a*
mean	41.55	
LSD(p=0.05)	***9.07***	

Means followed by same letter do not significantly differ

PredictaB testing

Predicta B tests were taken in February 2025 to detect any benefit from each 2023 pulse species in terms of their effect on soil borne diseases such as crown rot, Rhizoctonia root rot and take-all. Disease risk categories and population density categories for soil borne disease detected in 2025 are shown in table 5.

Take-all was below detection limits (BDL) and Pratylenchus neglectus was a low risk for all pulse species. Crown Rot was also low risk to below detection limit for all pulse species.

Rhizoctonia was categorised as low risk following chickpeas, peas and vetch and medium risk following faba beans, lentils and lupins.

In the population categories Pythium and Yellow Leaf spot were categorised as low, whilst Sclerotinia was categorised as medium for lentils, lupins, peas and vetch. All pulse species were also categorised as medium for Macrophomina phaseolina (charcoal rot).

Table 5. Results from PredictaB testing conducted prior to sowing the 2025 barley crop.

Disease Risk categories

Crop Type	Take-all (wheat + oat strains) pgDNA/g Sample*	R. solani AG8 pgDNA/g Sample*	**Crown Rot log(pg DNA/g soil)*	Pratylenchus neglectus nematodes / g sample
Chickpeas	*BDL*	*Low*	*Low*	*Low*
Fabas	*BDL*	*Medium*	*Low*	*Low*
Lentils	*BDL*	*Medium*	*Low*	*Low*
Lupins	*BDL*	*Medium*	*Low*	*Low*
Peas	*BDL*	*Low*	*Low*	*Low*
Vetch	*BDL*	*Low*	*BDL*	*Low*

Disease Risk - These tests are reported with a disease risk, which indicates the risk of yield loss associated with the level of pathogen DNA detected in the soil.

Population Density Category

Crop Type	Pyrenophora tritici-repentis (YLS) kDNA copies/g Sample*	Pythium clade F pgDNA/g Sample*	Macrophomina phaseolina kDNA copies/g Sample*	Sclerotinia sclerotiorum/S. minor kDNA copies/g Sample*
Chickpeas	*Low*	*Low*	*Medium*	*Not detected*
Fabas	*Not detected*	*Low*	*Medium*	*Not detected*
Lentils	*Low*	*Low*	*Medium*	*Medium*
Lupins	*Low*	*Low*	*Medium*	*Medium*
Peas	*Low*	*Low*	*Medium*	*Medium*
Vetch	*Low*	*Low*	*Medium*	*Medium*

Tests under evaluation - These tests will be reported as relative population densities, rather than a disease risk, as the level of yield loss associated with the pathogen DNA level has yet to be determined. Results can be used to rank levels of inoculum in different paddocks, monitor changes in inoculum during different phases of the cropping sequence and confirm disease diagnosis.

A Predicta B soil test may indicate if Sclerotinia DNA is present to identify paddocks at risk, and petal testing (for research purposes only) will identify whether spores of S. sclerotinia are present during canola flowering. However, these methods are only indicators of pathogen presence and do not determine subsequent Sclerotinia disease infection, as this is reliant on conducive environmental conditions.

RESULTS

Establishment, NDVI, grain yield, and grain quality were assessed on the trial.

Establishment:

Establishment was evaluated at the end of June, at the 3-leaf stage, figure 1. Both an establishment score and plant counts were undertaken in the trial. Each plot was scored on a scale from 0 to 9, where 0 represented poor establishment and 9 indicated very even establishment.

No differences in barley establishment scores were observed between the different 2023 pulse species, with an average establishment score of 7.8. Additionally, there were no significant differences in plant numbers, with an average plant count of 71 plants/m².

Figure 1: Trial establishment, June 2025.

NDVI:

An NDVI measurement to capture growth differences was obtained using a handheld GreenSeeker crop sensor. A reading was taken at booting early September 2025. figure 2.

Figure 2: NDVI September 2025.

The only barley treatment to have a significantly greater NDVI than all other treatments was where barley was grown following vetch, table 6. The average NDVI reading was 0.53.

Table 6: Barley NDVI taken September 2025.

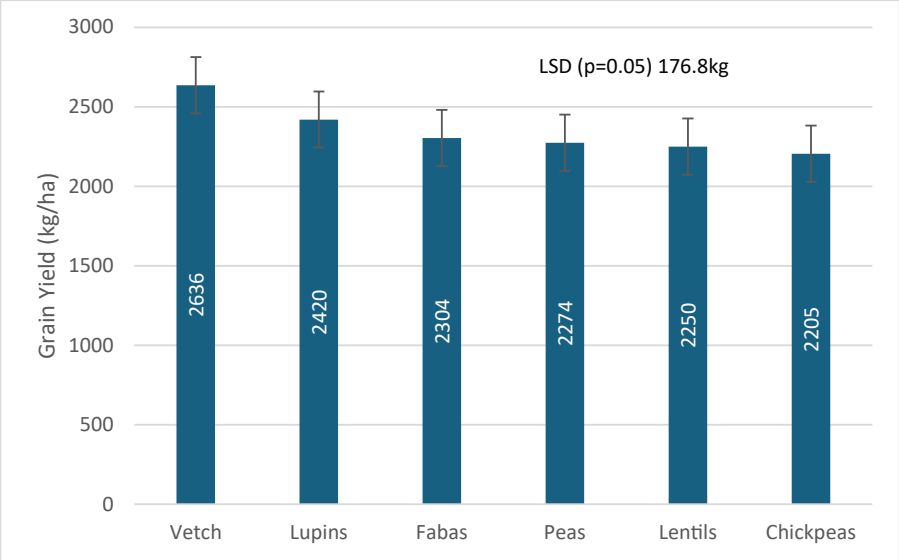
2023 Pulse Species	NDVI Value	*Sig Diff*
Chickpeas	0.51	*b*
Fabas	0.53	*b*
Lentils	0.51	*b*
Lupins	0.51	*b*
Peas	0.53	*b*
Vetch	0.59	*a*
mean	***0.53***	
LSD(p=0.05)	***0.046***	

Means followed by same letter do not significantly differ

Grain Yield:

The average grain yield of the trial was 2348 kg/ha. Barley following vetch in 2023 had a significantly greater yield than barley following all other pulse species in 2023, figure 3.

Figure 3: 2025 barley grain yield following pulses in 2023.



Grain Quality:

Grain protein, screenings and test weight are shown in table 7.

The average protein content of the trial was 7.9%, with barley sown after faba beans having the highest grain protein of 8.3%, similar to barley grown after lentils, vetch and lupins. Barley grown after chickpeas had the lowest grain protein with 7.4%.

Screenings were minimal in the trial, with the average screenings at 2.6%. There were no differences in screenings between barley sown after the various pulse species in 2025.

There were also no differences in test weights between barley sown after the various pulse species in 2025, with the average test weight for the trial being 65.6 kg/HL.

Table 7: Barley after 2023 pulse crop grain quality 2025.

2023 Pulse Species	Protein (%)	*Sig diff*	Screenings (%)	Test Weight (kg/hL)
Faba bean	8.28	*a*	2.8	65.76
Vetch	8.05	*a*	2.5	66.10
Lentils	7.98	*a*	2.8	65.60
Lupin	7.97	*a*	2.5	65.51
Field Pea	7.52	*c*	2.5	65.47
Chickpeas	7.35	*d*	2.3	65.27
mean	***7.86***		***2.6***	***65.62***
LSD(p=0.05)	***0.407***		***ns***	***ns***

DISCUSSION:

The pulse legacy trial demonstrated some differences among pulse species in their contribution to nitrogen fixation and subsequent barley performance in the second year, with barley sown in 2025 following wheat in 2024 and pulse crops in 2023.

Total nitrogen fixation in 2023 varied between pulse species, with field peas fixing the greatest amount of N, followed by lupins. In contrast, chickpeas and lentils fixed the least nitrogen of the pulse species assessed. Despite these differences, there were no detectable differences in soil mineral N between pulse species at either the 0–10 cm or 10–60 cm soil depths at sampling in 2025. However, when total soil mineral N (0–60 cm) was considered, field peas had the lowest total soil mineral N at sowing, suggesting that higher N fixation did not necessarily translate into higher residual mineral N at the commencement of the 2025 season. This may reflect differences in N removal, mineralisation timing, or in-season N dynamics.

Disease and soil-borne pathogen risk profiles were generally low across all pulse species. Take-all was below detection limits, Pratylenchus neglectus populations were categorised as low risk and Crown Rot was also low risk to below detection limit for all pulse species, suggesting negligible carryover risk to the subsequent cereal phase. Rhizoctonia risk, although varied slightly among pulses, was not significant. Other disease risk assessments showed that Pythium and Yellow Leaf Spot were categorised as low, while Sclerotinia risk was medium for lentils, lupins, peas and vetch. All pulse species were also classified as medium risk for Macrophomina phaseolina (charcoal rot), highlighting a common disease consideration for following crops regardless of pulse choice.

The results from 2025 suggest that vetch provided the most beneficial legacy effect for barley. The only treatment to exhibit a significantly greater NDVI than all others was barley sown following vetch, indicating improved early biomass and crop vigour. This translated into grain yield, with barley sown after vetch in 2023 producing a significantly greater grain yield than barley sown after all other pulse species. Despite these yield differences, there were no significant differences in test weight or screenings. However, barley sown after faba beans recorded the highest grain protein among treatments, consistent with enhanced N availability during grain filling.

Overall, the results highlight that while pulse species differed in N fixation capacity and disease risk profiles, the agronomic legacy benefits to barley were most evident following vetch. This emphasises the importance of pulse species selection not only for in season benefits, but also for optimising productivity and grain quality in subsequent cereal crops.

The trial will continue in 2026, further quantifying the legacy effects of pulses on subsequent crops in the rotation such as N benefit, disease benefit and crop sequence gross margins.

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