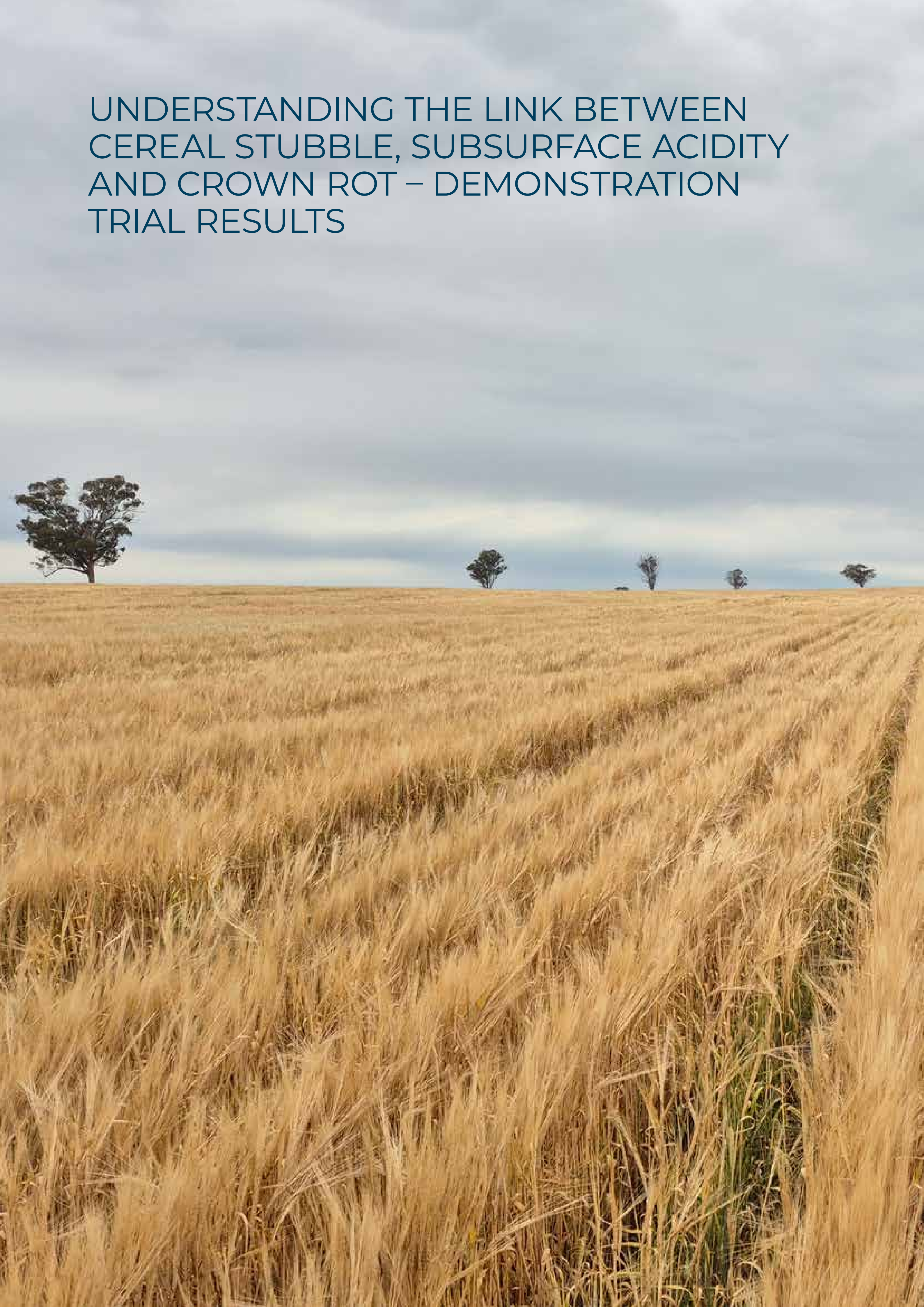
UNDERSTANDING THE LINK BETWEEN CEREAL STUBBLE, SUBSURFACE ACIDITY AND CROWN ROT – DEMONSTRATION TRIAL RESULTS



KEY MESSAGES

- **Two years of break crops (faba bean followed by canola) reduced Fusarium crown rot levels from "high" to "below detection", demonstrating the benefit of crop rotation in controlling the disease.**
- **Predicta B testing in 2025 showed that 8 out of 14 paddocks tested as part of this project had a medium to high risk for Fusarium crown rot, indicating that the disease is still present at high levels across the Riverine Plains region.**
- **Soil acidity is thought to exacerbate Fusarium crown rot severity and soil tests showed 60 percent of paddocks tested as part of this project during 2025 had pH below 5 at a depth of 5–20 cm.**
- **Even though there were very few whiteheads in paddocks in 2024, Predicta B soil testing and stubble plating analysis showed Fusarium crown rot levels were still "high risk" in 2025. This highlights the importance of testing paddocks before sowing cereal crops as stem browning and whiteheads are not always reliable signs of Fusarium crown rot, with other pathogens causing similar symptoms.**
- **Unreplicated demonstration trials showed a trend to reduced levels of Fusarium crown rot following barley compared to after wheat, and when a higher seeding rate was used in 2024.**
- **Using a nitrification inhibitor (eNpower), which can maintain nitrogen in ammonia form for longer, also showed a trend to reduced levels of Fusarium crown rot, compared to urea in one year of unreplicated trials.**

BACKGROUND

Fusarium crown rot is an increasing concern for cereal growers in the Riverine Plains, yet its impact remains largely unrecognised. This is partly due to the masking of disease symptoms in recent seasons, with wet conditions minimising the expression of whiteheads and reduced yields typically associated with Fusarium crown rot, which mostly occur when crops are filling under moisture stress. However, these same wet conditions are likely to have contributed to a build-up and persistence of the disease in the soil.

In 2021, Riverine Plains conducted the *Improving Soils to Optimise Water Use on Farm* project, which studied the effects of cereal stubble management and subsurface acidity on yield at Murchison. Subsequent Predicta B testing of stubble treatments in January 2023 revealed a potential link between stubble management, subsurface acidity, Fusarium crown rot infection, and yield loss.

To further explore these findings, the Grains Research and Development Corporation (GRDC) and Riverine Plains launched the *Understanding the link between cereal stubble, subsurface acidity, and crown rot* project. This National Grower Network (NGN) initiative commenced in October 2023 and will continue through December 2026, aiming to provide growers with practical management strategies to mitigate the impact of Fusarium crown rot in cereal crops.

AIM

This project aims to determine how stubble management strategies and break crops can impact Fusarium crown rot pathogen levels over time. The project is also investigating the potential link between stubble management, subsurface acidity, and Fusarium crown rot in cereals over multiple seasons.

METHOD

Riverine Plains invited local farmers to test high-risk paddocks for Fusarium crown rot in January 2024—a high risk paddock was considered to be one that was intended for wheat or barley in 2024 and which also had a history of tight cereal rotations. From the 14 paddocks in the trial, Predicta B DNA testing identified nine of these paddocks as at high risk of damage from Fusarium crown rot.

In June 2024, two NSW farmers (Rand North West, Rand North) and one Victorian farmer (Murchison) with high-risk paddocks established demonstration strips trials to evaluate management strategies that could reduce the risk of damage. These strategies included limiting total available nitrate nitrogen (N) to the crop, using different crop rotations and using different seeding rates.

During late January 2025, Predicta B sampling was conducted across all trial sites, while cereal stubble was also collected for stubble plating analysis. Predicta B soil samples were sent to PIRSA:SARDI and cereal stubbles were sent to Dr Steven Simpfendorfer, NSW DPI, for analysis of Fusarium crown rot risk levels in soil and cereal stubble respectively.

SITE 1: RAND NORTH WEST – NITROGEN

TRIAL RATIONALE

Both local and overseas research has shown that having excessive nitrogen available in the soil in nitrate form (plant available) can worsen Fusarium crown rot compared to nitrogen in ammonium form (not plant available) (Eddine et al, 2020 and Buster et al, 2023). Nitrification inhibitors like 3,4-dimethylpyrazole phosphate (DMP) slow the conversion of ammonium to nitrate; this can help reduce nitrogen loss to the environment from volatilisation and leaching, while also slowing the release of fertiliser nitrogen to the plant. The Rand North West demonstration tested the effect of applying nitrification inhibitor treated urea (eNpower®), compared to regular urea and a high nitrogen treatment.

METHOD

The site was inter-row sown to Sceptre wheat on 11 May 2024 (Table 1). The paddock was previously sown to canola, with the stubble Kelly-chained before sowing. The three treatments established at the site included a standard urea (control) treatment representing standard farmer practice, a nitrification inhibitor treatment (eNpower) and a high nitrogen treatment which included standard urea plus nitrification inhibitor (eNpower) treated urea. Each treatment was one seeder width wide by the length of the paddock, which was approximately 1.3 km.

All treatments received 60 kg/ha MAP and 50 kg/ha urea as starter fertiliser at sowing, as well as an early season application of 60 kg/ha urea on 25 June. On 26 August, the standard urea (control) treatment received an additional 80 kg/ha urea and the nitrification inhibitor treatment received 80 kg/ha eNpower urea, while the high nitrogen treatment received 80 kg/ha urea + 80 kg/ha eNpower (Table 2).

Table 1 Site details for the Riverine Plains Fusarium crown rot demonstration site at Rand North West, 2024.

TREATMENT	DETAILS	
Sowing date:	11 May, 2024	
Variety:	Scepter wheat	
Sowing rate:	60 kg/ha	
Starter fertiliser (May):	MAP at 60 kg/ha (incl Flutriafol), urea at 50 kg/ha	
Growing season rainfall:	190 mm	
Treatments (nitrogen delivery):	1. Standard area (control): urea at 190 kg/ha 2. Nitrification inhibitor: 110 kg/ha urea + 80 kg/ha eNpower urea 3. High nitrogen: 190 kg/ha urea + 80 kg/ha eNpower urea	
Harvest date:	25 November, 2024	
Soil test results:		
Predicta B:	**High** Fusarium risk level (January 2024)	
Soil pH:	Sample depth	pH
	0-5 cm	5.5
	5-10 cm	4.6
	10-15 cm	4.7
	15-20 cm	5.1

Table 2 Trial treatment details for the Riverine Plains Rand North West Fusarium crown rot demonstration site, 2024

TREATMENT	STARTER FERTILISER		EARLY NITROGEN	MID-SEASON NITROGEN		TOTAL N APPLIED*
Timing	11 May		25 June	26 August		
Fertiliser input	MAP (kg/ha)	Urea (kg/ha)	Urea (kg/ha)	Product	Rate (kg/ha)	(kg N/ha)
Standard urea (control)	60	50	60	Urea	80	94
Nitrification inhibitor treated urea (eNpower)	60	50	60	eNpower urea	80	94
High nitrogen	60	50	60	Urea + eNpower urea	80+80	130

*The nitrogen content of both urea and eNpower urea is 46 percent

RESULTS & DISCUSSION

The highest plant counts at establishment (59 plants/m^2) and head counts at milky dough (265 heads/m^2) were observed in the high nitrogen treatment, while the lowest counts were observed in the nitrification inhibitor treated urea treatment (44 plants/m^2 and 199 heads/m^2, respectively (Table 3). However, all three treatments in this trial tillered similarly, ranging from 4.5 to 4.8 tillers/plant. This suggests that the differences observed in plant and head counts may be due to paddock variation, rather than treatment differences.

When measurements were taken at medium milk maturity (GS74) on 23 October, there were no whiteheads visible in any treatment.

Basal stem browning—a common indicator of Fusarium crown rot—was assessed visually, with slightly higher stem browning in the nitrification inhibitor treatment (48 percent) compared to the standard urea (control) (32 percent) and high nitrogen treatments (35 percent). Soil analysis indicated the presence of other potential pathogens, including Pythium, Sclerotina, Macrophomina phaseolina and nematodes, all of which are known to cause similar stem browning symptoms to Fusarium crown rot in wheat. Therefore, the high incidence of basal browning observed in the nitrification inhibitor treatment may be due to the combined effects of these pathogens, rather than just crown rot alone. The application of nitrification inhibited urea (eNpower) also occurred later than anticipated (during late August, due to logistical issues), which may have impacted the basal browning results. Random environmental variability may also be at play, noting that this is difficult to establish given the unreplicated nature of the trial.

Cereal stubble plating and Predicta B soil analysis were both conducted after the 2024 harvest. Stubble plating analysis showed a trend to lower rates of crown infection in the nitrogen inhibitor treatment (13 percent) compared to the standard urea (36 percent) and high nitrogen (20 percent) treatments. The nitrification inhibitor treatment also returned the lowest overall infection level (low–medium), while the high nitrogen treatment had medium infection, and the standard urea had medium–high infection. However, Predicta B testing returned a high Fusarium crown rot risk reading for all treatments. The difference between the Predicta B and stubble plating results may be due to the nature of the tests; stubble plating relies on culturing live Fusarium from plant tissue, but its results can underestimate Fusarium crown rot if beneficial microbes like Trichoderma suppress pathogen growth, especially after a wet fallow. In contrast, Predicta B, a DNA-based test, is more sensitive and can detect Fusarium crown rot from both viable and non-viable sources, which can overestimate risk if the detected DNA comes from decomposed or inactive residues. While the risk ratings may vary, both Predicta B and stubble plating are considered reliable indicators of the disease risk.

No other differences were observed between treatments, including for yield, protein or grain quality parameters. Further research is needed on the effects of using nitrification inhibitors for Fusarium crown rot management to draw any conclusions.

Table 3 Plant development, Fusarium crown rot and yield results, Rand North West, 2024

MEASUREMENTS	CONTROL (STANDARD UREA)	NITRIFICATION INHIBITOR (ENPOWER UREA)	HIGH NITROGEN
Plants/m²	53	44	59
Heads/m²	259	199	265
Whiteheads (%)	0	0	0
Brown stems (%) /metre row	32	48	35
Growth stage, 23 October	Medium milk	Medium milk	Medium milk
Yield (t/ha)	3.9	3.5	3.8
Protein (%)	10.9	10.1	10.6
Screenings (%)	<1	<1	<1
Moisture (%)	9	9	9
Predicta B risk rating (post-harvest 2025)	**High**	**High**	**High**
Stubble plating results			
Crown Infection* (%)	36	13	20
Stem Infection* (%)	16	5	10
Infection level*	**Medium–high**	**Low–medium**	**Medium**

*Stubble plating results courtesy of Steven Simpfendorfer, NSW DPI

SITE TWO: RAND NORTH – CEREAL ROTATIONS

TRIAL RATIONALE

Although barley is susceptible to Fusarium crown rot, it generally, has a shorter growing season than wheat, which often allows it to avoid the moisture stress associated with Fusarium crown rot infection during grain-fill. This means that barley is less likely to produce the typical whiteheads associated with Fusarium crown rot, while also being less likely to suffer yield loss, compared to wheat.

To test this theory, the Rand North demonstration site compared two barley varieties, Neo and Planet, to a farmer control sown to Coota wheat (Table 4).

METHOD

Each treatment was one seeder width wide, and the length of the paddock, which was approximately 1.2 km. The wheat was sown on April 24, 2024, and both barley varieties were sown the next day. The treatments were sown into burnt wheat stubble from the previous crop, into the same row.

Table 4 Site and treatment details for the Riverine Plains Rand North Fusarium crown rot demonstration, 2024.

TREATMENT	DETAILS	
Sowing date:	Barley: April 25	
	Wheat: April 24	
Treatments (cereal rotation):	1. Control (Coota wheat), sown at 75 kg/ha 2. Neo barley, sown at 60 kg/ha 3. Planet barley, sown at 70 kg/ha	
Fertiliser:	April: 75 kg/ha MAP June: 100 kg/ha urea August: 100/ha kg urea	
Growing season rainfall:	210 mm	
Harvest date:	Barley: 8 December	
	Wheat: 14 December	
Soil test results (January 2024)		
Predicta B:	**High** Fusarium risk level (January 2024)	
Soil pH:	Depth	pH
	0-5 cm	5.1
	5-10 cm	5
	10-15 cm	4.9
	15-20 cm	5.2

RESULTS AND DISCUSSION

In this trial, wheat had the lowest (2.9) tillers/plant followed by Neo barley (7.8) tillers/plant and Planet barley (9.12) tillers/plant (Table 5).

No whiteheads were observed in any of the treatments during assessments on 23 October at the medium milk stage (GS75), likely because plants did not experience sufficient stress to trigger their expression. However, the absence of whiteheads does not necessarily indicate the absence of disease, as yield losses can still occur even without visible symptoms.

Predicta B analysis identified the paddock as high risk for disease in 2024, and at the medium milk stage (GS75), Planet barley showed the highest incidence of brown stems (8 percent), followed by Neo barley (7 percent) compared to just 1 percent in wheat. The presence of high levels of pathogens like Pyrenophora, Pythium, nematodes and pratylenchus likely contributed to the browning observed in the stems and crowns and the paddock also experienced significant frost damage, which can also cause stem browning. As a result, the typical visual stem and crown browning symptoms could not be used as a reliable indicator of crown rot infection in this trial last year. It is also worth noting that barley is still susceptible to Fusarium crown rot and can act to increase inoculum levels in the paddock for a following cereal crop.

Neo barley had the highest yield (4 t/ha), compared to Planet barley (3.5 t/ha) and wheat (3.5 t/ha). Barley, and Neo in particular, was observed to perform especially well across the Riverine Plains in 2024, and these results are consistent with farmer experiences in the context of frost damage and dry spring conditions experienced this season.

Table 5 Plant development, Fusarium crown rot and yield results, Rand North, 2024

MEASUREMENTS	CONTROL COOTA WHEAT	NEO BARLEY	PLANET BARLEY
Plants/m²	144	82	87
Heads/m²	424	646	794
White heads (%)	0	0	0
Brown stems/metre row (%)	1	7	8
Growth stage, 23 October	Medium milk	Medium milk	Medium milk
Yield (t/ha)	3.5	4	3.5
Protein (%)	10.9	11.5	11.8
Screenings (%)	<1	<2	<2
Moisture (%)	11.4	11.3	10.5
Predicta B risk rating (post-Harvest 2025)	**High**	**Medium**	**Low**
Stubble plating results			
Crown infection* (%)	0	4	14
Stem infection* (%)	2	12	10
Infection level*	**Low**	**Low–medium**	**Low–medium**

*Stubble plating results courtesy of Steven Simpfendorfer, NSW DPI

SITE 3: MURCHISON – SOWING RATES

TRIAL RATIONALE

Research conducted in Central West NSW during 2023 indicated that a high seeding rate may have reduced the impact of Fusarium crown rot. It's theorised that a high seeding rate may deplete soil moisture faster, hastening crop maturity so that the crop avoids severe heat stress and the effects of Fusarium crown rot. However, as this work represents only one year of research, it was decided to test the theory by establishing a demonstration trial at Murchison during 2024, to compare the standard farmer seeding rate (control) to both a higher and lower seeding rate.

METHOD

The Murchison site was sown to wheat Scepter wheat on 2 May (Table 6) into a retained wheat stubble (inter-row sown).

The demonstration included a farmer control of 68 kg seed/ha, representing local farmer practice, as well as a high seeding rate of 100 kg/ha and a low seeding rate of 50 kg/ha. Each strip was three seeder-widths wide by the length of the paddock, about 1.2 km.

Table 6 Site and treatment details for the Riverine Plains Murchison Fusarium crown rot demonstration site, 2024

TREATMENT	DETAILS	
Sowing date:	2 May	
Treatments (seeding rates):	1. Control (farmer practice): 68 kg/ha 2. Low seeding rate: 50 kg/ha 3. High seeding rate: 100 kg/ha	
Starter fertiliser:	March: MAP 100kg/ha (incl 400ml/ha Flutriafol)	
Soil mineral nitrogen (June):	128 kg N/ha	
In-season fertiliser application:	June: 58 kg N/ha urea Early August: 46 kg N/ha urea Late August: 46 kg N/ha urea (minimal rain post-application)	
Growing season rainfall:	208 mm (plus 130 mm summer rain)	
Harvest date:	10 December	
Soil test results:		
Predicta B:	**High** fusarium risk level (January 2024)	
Soil pH:	**Depth**	**pH**
	0-5 cm	6.2
	5-10 cm	5.6
	10-15 cm	5.5
	15-20 cm	5.3

RESULTS AND DISCUSSION

Plant density was 106 plants/m² for the farmer control treatment and 158 plants/m² for the higher seeding rate treatment. The higher seeding rate treatment also achieved a higher head count of 414 heads/m², which was in line with expectations given the greater plant establishment in this treatment (Table 7).

In this demonstration, the higher seeding rate treatment (100 kg/ha) did not have visible whiteheads when assessed on 23 October at the medium milk growth stage (GS75). However, the lower seeding rate and control treatment both showed white heads in low numbers (less than one percent).

The percentage of plants showing stem browning was highest in the control treatment (standard seeding rate), however stem browning was low overall (less than 10 percent) at this site. There appeared to be a slight difference in maturity between growth stages of the different seeding rates, likely due to the influence of seeding rate on crop development.

Results of stubble plating analysis showed the high seeding rate treatment had lower rates of stem infection and crown infection (12 and two percent respectively) compared to the standard seeding rate and low seeding rate treatments. This translated to a low–medium infection level for this treatment, compared to a medium infection level for the low seeding rate and a medium–high infection level for the standard seeding rate.

The higher seeding rate treatment also had the highest yield compared to other treatments.

Table 7 Plant development, Fusarium crown rot and yield results, Murchison, 2024

MEASUREMENTS	CONTROL	LOW SEEDING RATE	HIGH SEEDING RATE
Plant/m²	106	72	158
Heads/m²	312	331	414
Whiteheads (%)	<1	<1	0%
Brown stems/meter row (%)	10%	2%	3%
Growth stage, 23 October	Early milk	Medium milk	Medium milk
Yield (t/ha)	5.9	6.2	6.2
Protein (%)	11.71	11.14	11.48
Screenings (%)	<1	<1	<1
Moisture (%)	12.0	12.6	12.7
Predicta B (post-Harvest 2024)	**High**	**High**	**High**
Stubble plating results			
Crown Infection* (%)	16	16	2
Stem Infection* (%)	32	18	12
Infection level*	**Medium–high**	**Medium**	**Low–medium**

*Stubble plating results courtesy of Steven Simpfendorfer, NSW DPI

Overall, Fusarium crown rot symptoms are lower than expected across all treatments at this site given that Predicta B testing indicated this paddock as high risk at the start of 2024. A possible explanation is that the paddock was inter-row sown, creating distance between the new crop and the old crop, reducing the chance of cross-infection. Alternatively, the retained stubble in this paddock may have experienced more consistent residue decomposition, promoting colonisation by beneficial microbes like Trichoderma spp. which can suppress Fusarium activity. Environmental conditions during early crop development and grain fill, including low soil moisture or cooler temperatures, may have also limited disease development, despite the presence of pathogen DNA in the soil.

These results are inconclusive as to whether a higher seeding rate used up soil moisture more quickly than the other treatments and if this brought maturity forward, reducing the impact of this disease.

MURCHISON LONG-TERM DEMONSTRATION SITE

The Murchison demonstration site is providing long-term data on how rotation, stubble management strategies and soil acidity influence Fusarium crown rot.

METHOD

This site was sown to Hyola canola in 2024. The stubble treatments (Table 8) were originally implemented after a wheat crop in 2021, prior to sowing a consecutive wheat crop in 2022. All treatments received an application of 6.7 t/ha of lime in March 2022, with the two deep incorporation treatments (harvest cut high deep incorporation of stubble and harvest cut low deep incorporation of stubble) incorporated to a depth of approximately 15 cm.

RESULTS AND DISCUSSION

At the start of 2023, stubble plating tests through NSW DPI showed all treatments to be high risk for Fusarium crown rot. As such, the wheat stubble in all treatments was burnt to reduce inoculum and faba beans were sown in 2023, followed by canola in 2024. Predicta B testing in 2025 for Fusarium crown rot showed that six out of the eight treatments were below detection, while two treatments were low risk.

The demonstration shows how the use of two consecutive break crops can drastically reduce the risk of Fusarium crown rot.

Soil pH testing was not conducted in 2025 because the site was cultivated with an offset disc to a depth of approximately 10 cm as part of a drainage plan for the paddock, which would have interfered with results. However, soil testing in 2024 showed that a high rate of lime applied in March 2022 increased pH across the 0–5cm and 5–10 cm levels. At the 10–15 cm depth, where there was elevated aluminum, only the deep incorporation treatments alleviated the effect of toxic aluminium levels.

Although it was expected that deep incorporation treatments would be the highest yielding in 2025 (due to lime incorporation), this was not the case. Also, there did not appear to be a correlation between plant counts and canola yield, as the treatments with the highest and lowest plant counts (harvest cut high, shallow incorporation of stubble, and harvest cut low, shallow incorporation of stubble) had similar yields. It was concluded that other factors such as paddock variation in soil pH, nutrient availability, moisture and rainfall were influencing the yield results between treatments.

The average grain analysis results for canola in 2024 were: protein 21.5 percent, moisture content 4.5 percent, oil 45.3 percent, and test weight 65.9 kg/hL.

Table 8 Emergence counts, yield, grain quality and PredictaB results at the Riverine Plains Murchison long-term demonstration site, 2024

STUBBLE TREATMENTS APPLIED POST-HARVEST 2021 *	CANOLA ESTABLISHMENT (PLANTS/M²)	AVERAGE YIELD ± SD (T/HA)	PREDICTA B (POST-HARVEST 2024)
1-Harvest cut high and bale	15	3.30 ± 0.15	Below detection
2-Harvest cut low	12	3.40 ± 0.14	Below detection
3-Harvest cut high, deep in-corporation of stubble	16	3.30 ± 0.19	Low
4-Harvest cut low, deep in-corporation of stubble	12	3.10 ± 0.22	Below detection
5-Harvest cut high, flail mulch stubble	10	3.10 ± 0.23	Low
6-Harvest cut high, shallow incorporation of stubble	5	3.25 ± 0.18	Below detection
7-Harvest cut low, shallow incorporation of stubble	20	3.22 ± 0.19	Below detection
8-Burn	13	3.11 ± 0.14	Below detection

*Note: Standard deviation (SD) is a measure of how much yield varied between data points of the same treatment. A low SD means the yield results were very similar across the data points, which gives more confidence that the treatment had a consistent effect. A higher SD suggests more variation between each data points, so while the average yield may look good, the results were less consistent.

OBSERVATIONS AND COMMENTS

During a tight spring with heat stress, Fusarium crown rot fungi restrict the flow of water and nutrients to developing heads, which can result in pinched grain or heads with no grain. This can lead to “whiteheads” in the crop, but these don’t always occur reliably and can be confused with frost, mice or insect damage and moisture stress.

Despite dry conditions during spring, there were not many whiteheads visible at any of the trial sites during 2024. There were generally good reserves of stored soil moisture across the region, and timely rain at grain filling during October potentially meant plants may have avoided moisture stress and the triggering of whiteheads. Many of the plants were observed to have frost damage, with shrivelled grain at all three demonstration trial sites, due to a frosting event in mid-September. The Rand North site experienced more severe frosting in lower elevation areas than the other sites.

SUMMARY

The demonstration site has clearly shown that the use of break crops, such as faba beans and canola are very effective at reducing Fusarium crown rot inoculum levels.

The unreplicated demonstration trials showed a trend to reduced levels of Fusarium crown rot following barley compared to wheat and when a higher seeding rate was used. There was also a trend towards lower levels of disease when a nitrogen inhibitor (eNpower) was used to maintain soil nitrogen in ammonia form compared to nitrate form of nitrogen (urea).

Predicta B testing in 2025 also showed that Fusarium Crown Rot is prevalent at varying levels across the Riverine Plains.

Riverine Plains will continue to assess different management strategies as part of this project in 2025, including the effects of rotation and seed treatment.

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