UNDERSTANDING THE LINK BETWEEN CEREAL STUBBLE, SUBSURFACE ACIDITY AND CROWN ROT

KEY MESSAGES

- **Predicta B testing across the Riverine Plains during February 2024 showed that 79% of samples collected had medium to high levels of Fusarium crown rot present**
- **A demonstration site sown to wheat for two years (2021-2022), had high levels of Fusarium crown rot — burning the wheat stubble and planting faba beans in 2023 reduced levels to low within a 12 month period**
- **Segmented soil tests conducted across Riverine Plains revealed 64% of paddocks tested had pH less than 5 in the 5-10cm layer, with 50 % of the paddocks showing pH below 5 in the 10-15cm layer**
- **An acid layer, between 5 and 15cm, can affect production of acid-sensitive crops, as well as nodulation by legume species; if an acid layer is present, the recommended target pH(CaCl) for 0-10 cm is 5.8.**

BACKGROUND

Riverine Plains has identified that the extent and impact of Fusarium crown rot remains largely unrecognised by cereal growers in the region. This is despite an increase in Fusarium crown rot locally, as confirmed by surveillance and test results conducted by the NSW Department of Primary Industries.

The lack of recognition is likely due to the masking of disease symptoms by wet conditions in recent seasons. This has reduced the expression of the whiteheads and reduced yields typical of the disease, which occurs when cereal crops are filling under moisture stress. It is also likely that recent wet conditions have favoured disease build up and survival.

In 2021, the Riverine Plains project *Improving soils to optimise water use on farm* studied the impact of cereal stubble management and subsurface acidity on yield at a field site in Murchison. Four stubble treatments used in this project were sampled for Fusarium crown rot in January 2023 using Predicta B testing, with results indicating a potential correlation between stubble treatment and subsurface acidity, Fusarium crown rot infection and yield loss.

The Grains Research and Development Corporation (GRDC) and Riverine Plains are further investigating this potential link through a National Grower Network project, *Understanding the link between cereal stubble, subsurface acidity and crown rot*. Trials for this project commenced in October 2023 and will be completed in December 2026.

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

LITERATURE REVIEW

A literature review was undertaken to understand if there is a correlation between Fusarium crown rot and soil pH.

INCREMENTED PH TESTING

A total of 14 farmer paddocks and 8 treatments at the Murchison stubble demonstration site were sampled for soil pH from 0-20 cm, in 5 cm increments.

PREDICTA B TESTING

Fourteen farmer paddocks were tested using Predicta B during February 2024. A demonstration site at Murchison also provided samples for Predicta B testing, to show how stubble management strategies can impact Fusarium crown rot levels

RESULTS AND DISCUSSION

LITERATURE REVIEW OUTCOMES

The literature review highlighted that acidic and saline conditions can reduce the ability of beneficial soil microorganisms to thrive and that such environments can cause crops, including cereals, to become more susceptible to diseases such as Fusarium crown rot.

The review clearly established that there was a lack of research into the link between subsoil acidity and Fusarium crown rot under Australian conditions. However overseas research indicates that low pH is correlated to higher levels of whiteheads caused by Fusarium crown rot.

INCREMENTED PH TESTING – FARMER PADDOCKS

Soil testing conducted across 14 paddocks in the region showed that at a depth of 0-5 cm, only a single paddock had a pH lower than 5 (Figure 1). Additionally, no paddocks showed aluminium toxicity at this depth, with aluminium levels remaining below the 5% toxicity threshold (data not shown). However, most pulse crops are sensitive to pH below 5.2, and several of the sampled paddocks showed a pH of 5.1 at this depth. This indicates they may not be suitable in supporting legumes as break crops to reduce diseases such as Fusarium crown rot.

An acidic layer, corresponding to the area with the highest aluminium toxicity, was often found at a depth of 5-10 cm (Figure 2). At the 5-10 cm depth, most paddocks samples had a pH below 5 and aluminium levels above 5 percent, with pH ranging from 4.5 to 5.6 across different paddocks. Seven paddocks had a pH below 5 at the 10-15 cm depth (Figure 3), while two paddocks had a pH below 5 at the 15-20 cm depth (Figure 4). The pH range at these depths varied from 4.6 to 5.5 and 4.6 to 5.7, respectively.

The Riverine Plains region is known for its acid soils, and the lack of significant acidity in the surface soil samples suggests that farmers are applying lime, but not at high enough rates to ameliorate acidity in the subsurface. The target pH(CaCl) to ameliorate subsurface acidity in the 0-10 cm depth is 5.8.

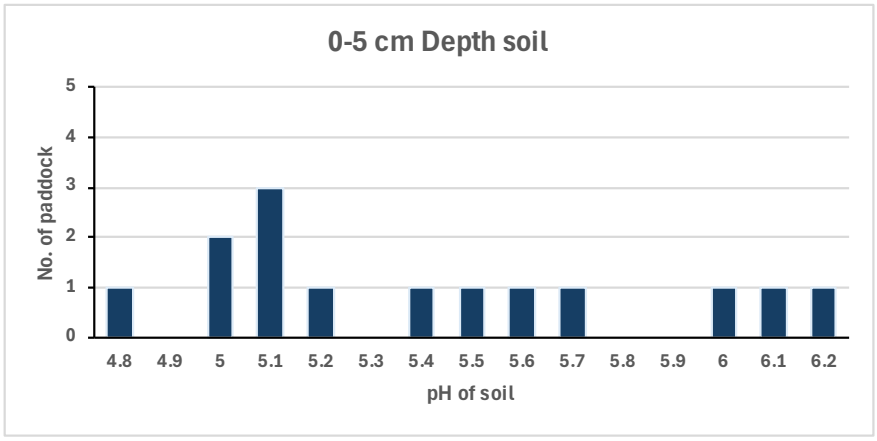

Figure 1 The pH range of paddocks sampled at 0-5 cm depth in the Riverine Plains, 2023

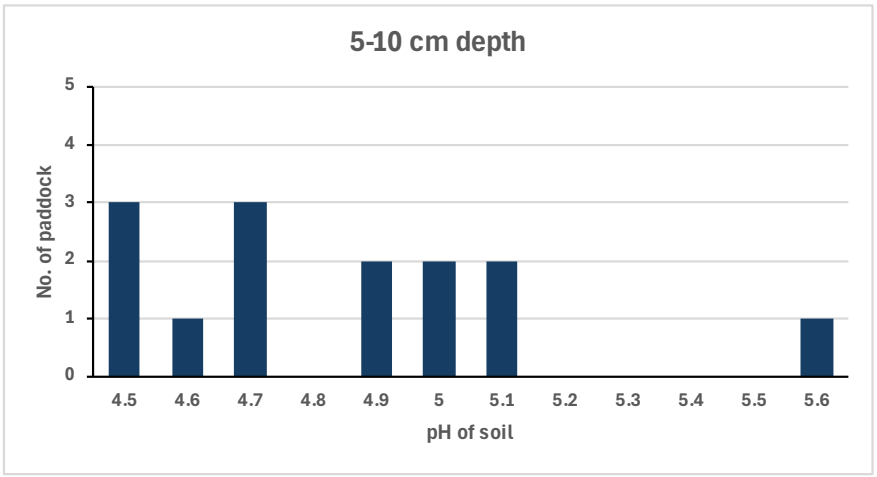

Figure 2 The pH range of paddocks sampled at 5-10 cm depth in the Riverine Plains, 2023

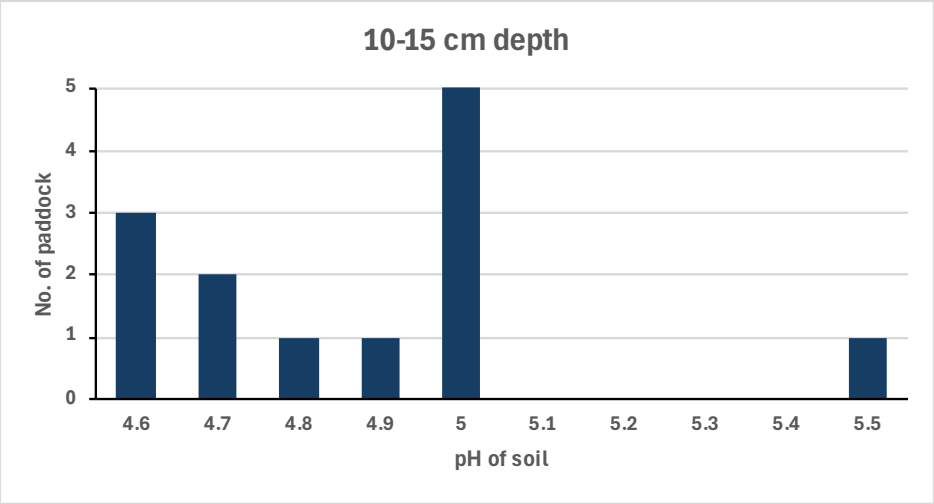

Figure 3 The pH range of paddocks sampled at 10-15 cm depth in the Riverine Plains, 2023

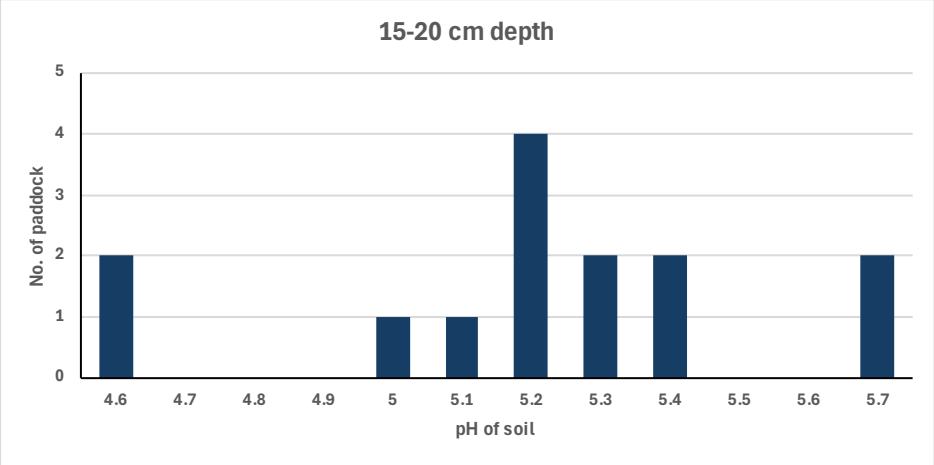

Figure 4 The pH range of paddocks sampled at 15-20 cm depth in the Riverine Plains, 2023

INCREMENTED PH TESTING MURCHISON STUBBLE DEMONSTRATION SITE

An acid layer at a depth of between 10 and 15cm was identified at the Murchison stubble demonstration site in 2021. To raise soil pH, 6.7 t/ha lime was applied across the paddock in March 2022.

Follow-up soil testing at the site in 2024 showed that the lime improved both soil pH and aluminium levels across various treatments at the soil surface (Table 1). However, only the deep incorporation treatments (Treatments 3 and 4) increased pH and reduced aluminium at the 10-15cm depth, compared to other treatments. This is because the deep incorporation facilitated the downward movement of lime into the soil profile, ameliorating acidity to a greater depth over the two year period.

Table 1 Soil pH and aluminium levels at the Murchison stubble demonstration site, 2024

	Soil pH				
TREATMENT APPLIED POST-HARVEST 2021	**0-5 CM DEPTH**	**5-10 CM DEPTH**	**10-15 CM DEPTH**	**15-20 CM DEPTH**	**ELEVATED ALUMINIUM (>5%)**
1 - Harvest cut high and bale	6.2	4.8	4.5	4.7	10-15cm
2 - Harvest cut low	6	4.8	4.5	4.7	10-15cm
3 - Harvest cut high, deep incorporation of stubble	6.2	5.7	4.8	4.9	
4 - Harvest cut low, deep incorporation of stubble	6.3	5.4	5.2	4.8	
5 - Harvest cut high, flail mulch stubble	6.3	5	4.6	4.8	10-15cm
6 - Harvest cut high, shallow incorporation of stubble	6.4	5.3	4.6	4.8	10-15cm
7 - Harvest cut low, shallow incorporation of stubble	6	4.7	4.5	5.1	10-15cm
8 -Burn	6.3	4.9	4.6	4.9	10-15cm

These stubble management treatments were oversown with faba beans inoculated with rhizobia in 2023. Follow-up rhizobial testing was undertaken at the site in 2024 to assess survival rates under the various stubble management treatments. Survival of rhizobia and other microbes, which can suppress pathogens like Fusarium crown rot, are linked to a better pH environment and the results showed nitrogen-fixing rhizobia were at medium to high levels across all treatments in February 2024 (Table 2). This result was likely improved by the application of lime the previous season, which increased pH and created a more favourable environment for the nitrogen-fixing rhizobia to survive. While the link between Fusarium crown rot and soil acidity has not been proven in Australia, overseas research indicates a correlation between low pH and an increasing incidence of whiteheads associated with Fusarium crown rot.

The highest faba bean yield was observed in Treatment 4, attributed to deep stubble incorporation which facilitated the downward movement of lime. The more favourable soil conditions in this treatment likely enhanced plant growth and soil structure, leading to higher yield.

Table 2 2023 and 2024 detection rates for fusarium and rhizobia, and yield of faba beans at the Murchison stubble demonstration site, 2023

TREATMENT APPLIED POST-HARVEST 2021	**2023 FUSARIUM LEVEL ***	**2024 FUSARIUM LEVEL ^**	**2024 RHIZOBIA LEVEL**	**2023 FABA BEAN YIELD (T/HA)**
1 - Harvest cut high and bale	High	Low	High	3.4
2 - Harvest cut low		Low	Medium	3.8
3 - Harvest cut high, deep incorporation of stubble	High	Low	High	3.8
4 - Harvest cut low, deep incorporation of stubble		Low	High	4.0
5 - Harvest cut high, flail mulch stubble		Low	High	3.8
6 - Harvest cut high, shallow incorporation of stubble		Low	High	3.4
7 - Harvest cut low, shallow incorporation of stubble	High	Low	High	3.4
8 - Burn	High	Low	High	3.4

* Stubble plating risk assessment. ^Predicta B risk assessment.

PREDICTA B RESULTS

FARMER PADDOCKS

To improve our understanding of Fusarium crown rot, 14 sites were selected and sampled across the Riverine Plains region during February 2024. Predicta B testing showed that 78% of these paddocks, which were to be sown to wheat in 2024, had medium to high levels of Fusarium crown rot. Of these, 14% were considered at low risk, while 7% were below the level of detection (Table 3).

This high incidence of Fusarium crown rot can be attributed to consecutive wet seasons, which have built up disease levels in local paddocks. Given Fusarium crown rot requires a dry spring for the classic "whitehead" symptoms to appear (and it has been at least four years since this last occurred), it is likely that many Riverine Plains region growers are unaware of the presence of the disease in their paddocks, or of its potential to build up and cause damage under drier conditions during grain fill.

Table 3 Fusarium crown rot level of farmer paddocks.

FUSARIUM LEVEL RISK CATEGORY	Below detection	Low risk	Medium risk	High risk
% OF PADDOCKS IN CATEGORY	7 %	14%	14%	64%

PREDICTA B RESULTS MURCHISON STUBBLE DEMONSTRATION SITE

During February 2023, four of the treatments at the Murchison demonstration site, including 1 - harvest cut high and bale, 3 - harvest cut high, deep incorporation of stubble, 7 - harvest cut low, shallow incorporation of stubble and 8 – burn, were tested using stubble plating techniques provided by NSW DPI for Fusarium crown rot after two years of being sown to wheat.

The results indicated a high risk of Fusarium crown rot across these treatments, and in an effort to reduce disease levels, the wheat stubble was burnt and the paddock was sown to faba beans in 2023. These practices successfully reduced the crown rot levels to low for all the stubble management treatments.

This season, the project will continue to monitor the 14 sites for Fusarium crown rot.

SUMMARY

Results from this project to date highlight the benefits of understanding Fusarium crown rot risk in the Riverine Plains. Using tests such as Predicta B can help farmers understand the risk of disease and yield loss, allowing for management strategies to be put in place to reduce yield loss in high-risk situations.

Further work is being conducted this year to determine the interaction between soil acidity and stubble management.

ACKNOWLEDGEMENTS

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