Strategies for managing fusarium crown rot: new data from northern NSW and southern Qld in 2023

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Take home message

- In the presence of high levels of Fusarium crown rot (FCR) infection wheat variety choice provided a yield benefit of 64% to 99% in 2023
- Victrato® (not yet registered) application provided a 19% to 37% yield benefit in the presence of added FCR but did not fully reduce yield loss from this disease
- The application of Victrato® to more intolerant wheat varieties was still inferior to the yield achieved by sowing a variety more tolerant to FCR without the application of Victrato®
- Victrato® should be used in combination with improved varietal tolerance and other integrated disease management strategies to minimise yield loss from FCR.

Introduction

Fusarium crown rot (CR), caused predominantly by the fungus *Fusarium pseudograminearum* (*Fp*), remains a major constraint to winter cereal production in the northern grain region. Cereal varieties differ in their resistance and tolerance to FCR, which can have a significant effect on their relative yield in the presence of this disease. Three fungicide seed treatments have been registered for the suppression of FCR in recent years with a further product Victrato® from Syngenta® likely to be available to Australian growers in 2024. Victrato® will be registered for the control of FCR with independent data showing this product to have stronger activity against FCR (Simpfendorfer 2022). Growers and advisors are therefore interested in obtaining local data as to where this new product may fit within current integrated disease management (IDM) strategies.

Two replicated field experiments were conducted in 2023 to examine the impact of FCR on yield and quality of cereal varieties along with the role of Victrato® in limiting loss in one intolerant bread wheat variety.

Field experiments in 2023

Table 1. Site details

Location	Sowing	Harvest	Crop 2022	Crop 2021	Crop 2020
Walgett, nth NSW	19 May 2023	17 Nov 2023	Wheat	Wheat	Wheat
Westmar, sth Qld	29 May 2023	18 Oct 2023	Fallow	Sorghum	Wheat

Table 2. Rainfall data (mm) – Nearest BOM Station

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Walgett	29.8	6.0	4.0	22.0	53.2	25.0	31.4	3.4	3.2	9.0	96.4	0.0
Westmar	18.0	3.0	46.0	5.5	72.0	11.2	18.0	0.0	2.0	3.0	239.0	37.0

Treatments

Cereal varieties evaluated at each site had some variation but mainly consisted of bread wheats. Two durum varieties were also examined at Walgett (Table 3). Barley varieties were sown as part of the experiment at Westmar but were unfortunately selectively grazed out by feral sheep throughout the season. Consequently, the Westmar field experiment only consisted of bread wheat varieties

(Table 3). The sowing rate of each variety was adjusted to target 100 plants/m^2 based on seed size (1000 grain weight) and percentage germination and treated with Vibrance® (180 mL/100 kg seed) to protect against establishment diseases.

A single bread wheat variety known to be more intolerant of FCR was additionally treated with Victrato® at two rates, either 200 mL/100 kg seed or 400 mL/100 kg seed at each site. The variety was LRPB Reliant(b) at Walgett and Coolah(b) at Westmar (Table 3 and 4).

Each variety then had added or no added FCR at sowing using sterilised wheat grain colonised by at least five different isolates of *Fp* at a rate of 2.0 g/m of row. This process provides uniform and high (>70%) FCR infection in inoculated plots to allow comparison with lower background FCR infection levels in the no added FCR treatment.

Both field experiments had a complete randomised block design with three replicates of each treatment combination. Establishment, yield, grain quality and Fusarium crown rot incidence and severity at harvest were measured.

What did we find?

Walgett, northern NSW 2023

In the no added FCR treatment, yield ranged from 0.99 t/ha in the durum variety Caparoi(b) up to 1.91 t/ha in the bread wheat variety LRPB Mustang(b) (Table 3).

Dry conditions during the flowering and grain-fill period (August to October) with a total of only 15.6 mm of rainfall (Table 2) was conducive to expression and yield loss from FCR infection. All varieties suffered significant yield loss under high levels of FCR infection (added FCR), ranging from 15% in bread wheat variety Sunmaster(b) (0.29 t/ha) up to 59% in durum variety Caparoi(b) (0.59 t/ha; Table 3). In the presence of added FCR there was a 64% (0.62 t/ha) yield difference between the best (Sunmaster(b)) and worst (Suntop(b)) bread wheat variety.

Table 3. Yield of durum and bread wheat varieties with no added and added fusarium crown rot (FCR) – Walgett, northern NSW 2023

Crop	Variety	Yield (t/ha)				Yield loss (%)
		No added FCR		Added FCR		
Durum	DBA Aurora(b)	1.17	i	0.78	k	33
	Caparoi(b)	0.99	j	0.40	l	59
Bread wheat	Sunmaster(b)	1.89	ab	1.60	de	15
	LRPB Mustang(b)	1.91	a	1.43	fg	25
	LRPB Reliant(b) + Victrato 400 mL	1.60	de	1.42	g	11
	LRPB Lancer(b)	1.78	abc	1.36	g	24
	LRPB Stealth(b)	1.76	bc	1.35	g	24
	LRPB Reliant(b) + Victrato 200 mL	1.61	d	1.33	gh	18
	LRPB Raider(b)	1.56	def	1.20	hi	23
	LRPB Hellfire(b)	1.68	cd	1.18	i	30
	LRPB Reliant(b)	1.46	efg	1.11	ij	24
	Suntop(b)	1.39	g	0.98	j	29
	Site mean	**1.57**		**1.18**		
	CV (%)	**7.2**				
	***P* value**	**0.077**				

In the no added FCR treatment, the application of Victrato® to LRPB Reliant(b) seed resulted in equivalent yield at both rates, but only the 200 mL rate was significantly higher yielding than the control (+0.15 t/ha or +10%; Table 3). This indicates there was likely background FCR infection at this site which would not be surprising given that this experiment was the fourth consecutive wheat crop in this paddock (Table 1).

In the added FCR treatment, Victrato® reduced the extent of yield loss from 24% down to 18% at the 200 mL application rate and 11% at the higher 400 mL rate (Table 3). Victrato® provided a significant yield benefit of 0.22 t/ha (+19%) at the 200 mL rate and 0.30 t/ha (21%) at the 400 mL rate compared with the control LRPB Reliant(b) treatment but the difference between the two Victrato® rates was not statistically significant (Table 3). However, the yield benefit of applying Victrato® under high disease pressure (added FCR) in the more intolerant variety LRPB Reliant(b) was equivalent to the yield achieved by sowing other more tolerant varieties in the absence of Victrato® and still significantly lower than Sunmaster(b) without Victrato® at this site (Table 3).

Westmar, southern Qld 2023

In the no added FCR treatment, yield ranged from 2.62 t/ha in Sunchaser(b) up to 3.02 t/ha in the bread wheat variety LRPB Mustang(b) (Table 4).

Dry conditions during the flowering and grain-fill period (August to October) with a total of only 5.0 mm of rainfall (Table 2) was conducive to expression and yield loss from FCR infection. All varieties suffered significant yield loss under high levels of FCR infection (added FCR), ranging from 18% in LRPB Hellfire(b) (0.50 t/ha) up to 63% in LRPB Reliant(b) (1.88 t/ha; Table 4). In the presence of added FCR there was a 99% (1.11 t/ha) yield difference between the best (LRPB Hellfire(b)) and worst (LRPB Reliant(b)) variety.

Table 4. Yield of bread wheat varieties with no added and added fusarium crown rot (FCR) – Westmar, southern Qld 2023

Variety	Yield (t/ha)				Yield loss (%)
	No added FCR		Added FCR		
LRPB Hellfire(b)	2.72	de	2.23	f	18
LRPB Stealth(b)	2.90	abcd	2.14	fg	26
LRPB Mustang(b)	3.02	a	2.03	fgh	33
Sunchaser(b)	2.62	e	1.98	ghi	24
LRPB Lancer(b)	2.81	bcde	1.90	hi	32
Coolah(b) + Victrato 400 mL	2.93	abc	1.81	ij	38
Coolah(b) + Victrato 200 mL	2.98	ab	1.68	jk	44
LRPB Raider(b)	2.74	cde	1.66	jk	39
Sunmaster(b)	2.84	abcd	1.49	kl	48
Coolah(b)	2.82	abcde	1.33	lm	53
LRPB Flanker(b)	2.92	abcd	1.27	mn	57
LRPB Reliant(b)	3.00	ab	1.12	n	63
Site mean	**2.14**		**1.29**		
CV (%)	**8.5**				
***P* value**	**<0.001**				

In the no added FCR treatment, the application of Victrato® to Coolah(b) seed did not significantly increase yield over the control (Table 4). This indicates minimal background FCR infection at this site due to the last FCR host crop being in 2020 (Table 1).

In the added FCR treatment, Victrato® reduced the extent of yield loss from 53% down to 44% at the 200 mL application rate and 38% at the higher 400 mL rate (Table 4). Victrato® provided a significant yield benefit of 0.35 t/ha (+27%) at the 200 mL rate and 0.49 t/ha (37%) at the 400 mL rate compared with the control Coolah(b) treatment but the difference between the two Victrato® rates was not statistically significant (Table 4). However, the yield benefit of applying Victrato® under high disease pressure (added FCR) in the more intolerant variety Coolah(b) was equivalent to the yield achieved by sowing other more tolerant varieties in the absence of Victrato® and still significantly lower than LRPB Hellfire(b), LRPB Stealth(b) or LRPB Mustang(b) without Victrato® at this site (Table 4).

Grain quality and pathology

This data was not available at the time of writing this report.

Conclusions 2023

Individual wheat varieties differed in their performance in the presence of FCR infection with variety choice providing a yield benefit of up to 64% at Walgett and 99% at Westmar in 2023. Victrato® application to more FCR intolerant wheat varieties provided a 19% to 37% yield benefit in the presence of added FCR but did not fully reduce yield loss from this disease. The difference between the two Victrato® application rates was not significant but there was a trend towards improved yield with the higher rate. However, the application of Victrato® to more intolerant wheat varieties was still inferior to yield achieved by sowing a variety more tolerant to FCR without the application of Victrato®. Hence, Victrato® should be used in combination with improved varietal tolerance and other IDM strategies to minimise yield loss from FCR within northern cropping systems.

Integrated management of FCR

To manage the risk of yield loss in cereals, firstly identify the risk of Fusarium crown rot in each paddock. High-risk paddocks generally include durum, bread wheat or barley crops being sown into a paddock with a history of stubble retention and tight cereal rotations (including oats). Other considerations include:

- use effective weed management to reduce grass weed hosts in-crop and in fallow situations which serve as alternate hosts for the FCR fungus
- remember the larger the grass weed when controlled the longer that residue serves as a potential inoculum source
- given the recent Fusarium head blight epidemic in 2022, ensure that you are sowing seed free of Fusarium infection as infected seed introduces FCR infection into paddocks.

All other management options are implemented prior to sowing so knowing the risk level within paddocks is important. This can be quantified through either PreDicta® B testing (SARDI) or stubble testing (NSWDPI).

If medium to high FCR risk, then:

- Sow a non-host break crop (e.g., lentil, field pea, faba bean, chickpea, canola). A two-year break may be required if FCR inoculum levels are very high.

If still considering sowing a winter cereal:

- Consider stubble management options in terms of both impacts on FCR inoculum but also fallow soil moisture storage.
    - ***Cultivation*** accelerates stubble decomposition which can decrease FCR risk (as the causal pathogen is stubble-borne) BUT it takes moisture and time. Cultivation also increases the

spread of Fusarium crown rot inoculum across a paddock in the short term and increases exposure of below ground infection points (coleoptile, crown and sub-crown internode) in cereal plants to contact with stubble fragments infected with the FCR fungus. Cultivation close to sowing therefore increases the incidence of plants which get infected with FCR. Cultivation can also significantly reduce soil moisture storage during fallow periods.

- ***Stubble baling*** removes a proportion of the above ground inoculum from a paddock potentially reducing FCR risk. The pathogen will then be concentrated in the shorter stubble butts and below ground in the previous rows. Hence, baling in combination with inter-row sowing is more likely to reduce FCR risk. Reduced ground cover after bailing and removal of cereal straw can reduce fallow efficiency.
- ***Stubble burning*** destroys above ground inoculum but depends on the completeness of the burn. Burning has no effect on the survival of the FCR fungus below ground in crown tissue even with a hotter summer burn. Hence the pathogen will be concentrated below ground in the previous rows with survival between seasons dependent on the extent of summer rainfall. Burning of cereal stubble can considerably reduce fallow soil moisture storage so a 'late-Autumn' burn is preferable to an 'early-Summer' burn. Stubble burning in combination with inter-row sowing is more likely to reduce FCR risk.
- ***Reducing cereal stubble height*** limits the length of stubble which the FCR fungus can vertically grow up during wet fallow periods restricting the overall inoculum load within a paddock. When relative humidity is >92.5% the FCR fungus can colonise vertically up retained standing cereal stubble in a process termed 'saprotrophic growth'. At 100% relative humidity this saprotrophic growth can occur at a maximum rate of 1 cm per day (Petronaitis *et al.* 2020). The FCR fungus can therefore saprotrophically grow to the cut height of the cereal stubble under prolonged or accumulated periods of rainfall. Consequently, harvesting and leaving retained cereal stubble longer (e.g. stripper fronts) leaves a greater length of stubble for subsequent potential saprotrophic growth of the FCR fungus. This is not a major issue in terms of FCR risk if the retained infected cereal stubble is left standing and kept intact. However, if the infected stubble is disturbed and redistributed across a paddock through grazing, mulching, cultivation or the subsequent sowing process then this can increase the incidence of FCR infection. Recent research in NSW has also demonstrated that increased cereal harvest height allowed saprotrophic growth of the FCR fungus above the harvest height of a following chickpea crop. This resulted in FCR infected cereal stubble being spread out the back of the header during the chickpea harvest process increasing FCR risk for the next cereal crop (Petronaitis *et al.* 2022). Consider matching cereal stubble height at or after harvest in paddocks planned for a following shorter status break crop such as chickpea or lentils to prevent redistribution of retained FCR infected cereal stubble during the break crop harvest process.

- Select a cereal type and variety that has more tolerance to FCR ***and*** that is best suited to your region (see above results). Yield loss from FCR is generally durum>bread wheat>barley>oats. Recent research has shown that cereal type and varietal resistance has no impact on saprotrophic growth of the FCR fungus after harvest. Hence, cereal crop and variety choice does not have subsequent benefits for FCR risk with a paddock.
- Consider sowing a variety earlier within its recommended sowing window for your area. This will bring the grain filling period forward slightly and can reduce water and heat stress which exacerbates FCR expression and yield loss. However, this needs to be weighed against the risk of frost damage. Research across locations and seasons in NSW has shown that sowing at the start versus the end of a three-week recommended planting window can roughly halve the yield loss from FCR.

- If previous cereal rows are intact, consider inter-row sowing to increase the distance between the new and old plants, as most inoculum is in the stem bases of the previous cereal crop. Physical contact between an infected piece of stubble and the coleoptile, crown or sub-crown internode of the new cereal plants is required to initiate FCR infection. Research across locations and seasons in NSW (30–35 cm row spacings in stubble retained systems) has shown that inter-row sowing can roughly halve the number of wheat plants that become infected with FCR. Precision row placement can also provide greater benefits for FCR management when used in combination with rotation to non-host crops.
- Ensure nutrition is appropriate for the season. Excessive nitrogen will produce bulky crops that hastens moisture stress and makes the expression of FCR more severe. Whitehead expression can also be made more severe by zinc deficiency.
- Consider a seed fungicide treatment to suppress FCR. Fungicide seed treatments, including Victrato®, are not a stand-alone treatment and must be used as part of an integrated management approach.

References and further resources

PreDicta®B sampling procedure - Sampling_protocol_PreDicta_B_Northern_regions.pdf (pir.sa.gov.au)

Petronaitis T, Forknall C, Simpfendorfer S, Backhouse D (2020) Stubble Olympics: the cereal pathogen 10cm sprint - GRDC GRDC Grains Research Update paper

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