Strategies for managing fusarium crown rot: new data from central NSW 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 up to 25% to 118% and barley variety choice of up to 102% to 165% in 2023
- Victrato® (registration pending) application provided a 25% to 49% yield benefit in the presence of added FCR at only two of the three sites in 2023 but did not fully reduce yield loss from this disease
- The application of Victrato to more intolerant wheat varieties was equivalent 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 than currently registered products (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.

Three 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
Coonamble	30 May 2023	8 Nov 2023	Faba bean	Wheat	Wheat
Nyngan	2 Jun 2023	23 Nov 2023	Lupin	Wheat	Canola
Wellington	1 Jun 2023	15 Nov 2023	Pasture	Pasture	Pasture

Table 2. Rainfall data (mm) – farm records Coonamble and Wellington, nearest BOM at Nyngan

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Coonamble	9.0	14.0	18.0	20.0	12.0	18.0	15.0	3.0	7.0	32.0	141.0	0.0
Nyngan	40.8	2.4	52.0	23.4	1.0	45.8	33.6	2.6	0.0	8.0	69.6	0.0
Wellington	26.0	20.0	27.0	36.0	0.0	34.0	35.0	0.0	0.0	28.0	88.0	20.5

Treatments

Cereal varieties evaluated at each site had some variation but mainly consisted of bread wheats. Two durum varieties were also examined at Coonamble (Table 3). Four barley varieties were sown as part of the experiment at both Nyngan and Wellington (Table 4 and 5). 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 to FCR was additionally treated with Victrato at two different rates, either 200 mL/100 kg seed or 400 mL/100 kg seed at each site. The variety was LRPB Reliant♭ at Coonamble and LRPB Flanker♭ at Nyngan and Wellington.

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.

All 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?

Coonamble 2023

In the no added FCR treatment, yield ranged from 2.80 t/ha in the durum variety DBA Aurora♭ up to 3.31 t/ha in the bread wheat variety LRPB Mustang♭ (Table 3).

Dry conditions during the flowering and grain-fill period (August to October) with a total of only 42.0 mm of rainfall (Table 2) were 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 12% in bread wheat variety LRPB Lancer♭ (0.35 t/ha) up to 46% in durum variety Caparoi♭ (1.35 t/ha; Table 3). In the presence of added FCR there was a 25% (0.53 t/ha) yield difference between the best (LRPB Lancer♭) and worst (LRPB Reliant♭) bread wheat variety.

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

Crop	Variety	Yield (t/ha)		Yield loss (%)
		No added FCR	Added FCR	
Durum	DBA Aurora♭	2.80 d	1.91 i	32
	Caparoi♭	2.91 cd	1.56 j	46
Bread wheat	LRPB Lancer♭	2.95 cd	2.60 e	12
	LRPB Reliant♭ + Victrato® 400 mL	2.94 cd	2.60 e	12
	Sunmaster♭	3.23 ab	2.54 ef	21
	LRPB Reliant♭ + Victrato® 200 mL	2.99 cd	2.49 ef	17
	LRPB Mustang♭	3.31 a	2.46 ef	26
	LRPB Stealth♭	3.07 bc	2.35 fg	24
	LRPB Raider♭	2.89 cd	2.24 gh	22
	LRPB Hellfire♭	2.91 d	2.20 gh	24
	Suntop♭	2.85 d	2.14 i	25
	LRPB Reliant♭	2.83 d	2.08 j	27
	Site mean	**2.97**	**2.26**	
	CV (%)	**4.5**		
	***P* value**	**<0.001**		

In the no added FCR treatment, the application of Victrato to LRPB Reliant(b) seed did not significantly increase yield over the control (Table 3). This indicates minimal background FCR infection at this site with a faba bean break crop being grown in the previous season (Table 1).

In the added FCR treatment, Victrato reduced the extent of yield loss from 27% down to 17% at the 200 mL application rate and 12% at the higher 400 mL rate (Table 3). Victrato provided a significant yield benefit of 0.41 t/ha (+20%) at the 200 mL rate and 0.52 t/ha (25%) 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 at this site (Table 3).

Nyngan 2023

In the no added FCR treatment, yield ranged from 0.79 t/ha in LRPB Raider(b) up to 1.42 t/ha in the barley variety Spartacus CL(b) at this low yielding site in 2023 (Table 4).

Dry conditions during the flowering and grain-fill period (August to October) with a total of only 10.6 mm of rainfall (Table 2) were conducive to expression and yield loss from FCR infection. Except for LRPB Hellfire(b), all varieties suffered significant yield loss under high levels of FCR infection (added FCR), ranging from 18% in Scepter(b) (0.21 t/ha) up to 53% in the barley variety RGT Planet(b) (0.43 t/ha; Table 4). In the presence of added FCR there was a 53% (0.31 t/ha) yield difference between the best (Scepter(b)) and worst (LRPB Lancer(b)) bread wheat and 165% (0.64 t/ha) between the best (Spartacus CL(b)) and worst (RGT Planet(b)) barley variety.

Table 4. Yield of barley and bread wheat varieties with no added and added fusarium crown rot (FCR) – Nyngan 2023

Crop	Variety	Yield (t/ha)		Yield loss (%)
		No added FCR	Added FCR	
Barley	Spartacus CL(b)	1.42 a	1.02 efg	28
	Maximus CL(b)	1.22 b	0.99 efgh	19
	Compass(b)	1.22 b	0.96 fghij	21
	RGT Planet(b)	0.81 klmn	0.38 q	53
Bread wheat	Scepter(b)	1.13 bcde	0.92 ghijkl	18
	LRPB Flanker(b) + Victrato® 400 mL	0.94 fghijk	0.87 hijklm	8
	LRPB Mustang(b)	1.20 bc	0.87 hijklm	28
	Sunmaster(b)	1.07 cdef	0.86 hijklmn	20
	LRPB Hellfire(b)	0.97 fghi	0.85 ijklmn	13
	LRPB Flanker(b) + Victrato® 200 mL	0.92 ghijkl	0.82 jklmn	11
	Sunchaser(b)	1.04 defg	0.76 mno	27
	LRPB Flanker(b)	0.95 fghijk	0.73 mnop	23
	LRPB Reliant(b)	1.16 bcd	0.73 nop	38
	LRPB Raider(b)	0.79 lmn	0.63 op	20
	LRPB Stealth(b)	0.86 hijklmn	0.61 p	29
	LRPB Lancer(b)	0.83 ijklmn	0.61 p	27
	Site mean	**1.03**	**0.79**	
	CV (%)	**9.4**		
	***P* value**	**0.007**		

In the no added FCR treatment, the application of Victrato to LRPB Reliant(b) seed did not significantly increase yield over the control (Table 4). This indicates minimal background FCR infection at this site with a lupin break crop being grown in the previous season (Table 1).

In the added FCR treatment, Victrato provided only a slight yield increase in LRPB Flanker(b) which was not significant at this site (Table 4).

Wellington 2023

In the no added FCR treatment, yield ranged from 1.49 t/ha in the barley variety RGT Planet(b) up to 2.51 t/ha in the barley variety Maximus CL(b) at this site in 2023 (Table 5).

Dry conditions during the flowering and grain-fill period (August to October) with a total of only 28.0 mm of rainfall (Table 2) were 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 13% in the barley variety Spartacus CL(b) (0.32 t/ha) up to 55% in LRPB Flanker(b) (1.10 t/ha; Table 5). In the presence of added FCR there was a 118% (1.08 t/ha) yield difference between the best (Scepter(b)) and worst (LRPB Flanker(b)) bread wheat and 102% (1.09 t/ha) between the best (Spartacus CL(b)) and worst (RGT Planet(b)) barley variety (Table 5).

Table 5. Yield of barley and bread wheat varieties with no added and added fusarium crown rot (FCR) – Wellington 2023

Crop	Variety	Yield (t/ha)		Yield loss (%)
		No added FCR	Added FCR	
Barley	Spartacus CL(b)	2.47 a	2.15 bcd	13
	Maximus CL(b)	2.51 a	2.13 cde	15
	Compass(b)	2.47 a	1.92 efg	22
	RGT Planet(b)	1.49 jkl	1.06 mn	28
Bread wheat	Scepter(b)	2.36 ab	2.00 def	16
	Beckom(b)	2.32 abc	1.63 hij	30
	LRPB Stealth(b)	1.93 efg	1.57 ijk	19
	LRPB Hellfire(b)	2.04 de	1.55 ijk	24
	Sunmaster(b)	2.06 de	1.42 jkl	31
	LRPB Lancer(b)	1.80 fgh	1.40 kl	22
	LRPB Flanker(b) + Victrato® 400 mL	2.13 cde	1.37 kl	36
	LRPB Mustang(b)	2.17 bcd	1.27 lm	41
	LRPB Raider(b)	2.05 de	1.06 mn	48
	LRPB Flanker(b) + Victrato® 200 mL	1.97 def	1.04 n	47
	Sunchaser(b)	1.73 ghi	1.02 n	41
	LRPB Flanker(b)	2.02 de	0.92 n	55
	Site mean	**2.10**	**1.47**	
	CV (%)	**7.5**		
	***P* value**	**<0.001**		

In the no added FCR treatment, the application of Victrato to LRPB Flanker(b) seed did not significantly increase yield over the control (Table 5). This indicates minimal background FCR infection at this site with a legume pasture being grown in the previous three seasons (Table 1).

In the added FCR treatment, Victrato reduced the extent of yield loss from 55% down to 36% only at the higher 400 mL rate (Table 5). Victrato provided a significant yield benefit of 0.45 t/ha (+49%) only at the 400 mL rate compared with the control LRPB Flanker(b) treatment (Table 5). However, the yield benefit of applying Victrato under high disease pressure (added FCR) in the more intolerant variety LRPB Flanker(b) was equivalent to the yield achieved by sowing other more tolerant varieties in the absence of Victrato. The yield benefit provided by Victrato at the 400 mL rate on LRPB Flanker(b) was still lower than the yield achieved by sowing either Scepter(b) or Beckom(b) without Victrato at this site in 2023 (Table 5).

Grain quality and pathology

This data was not available at the time or 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 25% at Coonamble, 53% at Nyngan and 118% at Wellington in 2023. This difference was also evident in the two sites with barley entries with 102% yield benefit at Wellington and 165% at Nyngan between the best and worst barley variety in the presence of high FCR infection levels. Victrato application to more FCR intolerant wheat varieties provided mixed results across the three trials in a relatively dry season. Victrato provided a 20% to 25% yield benefit in the presence of added FCR at Coonamble with both application rates, a 49% yield benefit at Wellington only at the 400 mL rate and no significant benefit at either application rate at Nyngan. This is consistent with our previous studies that have highlighted the reduced efficacy of fungicide seed treatments in seasons with limited in-crop rainfall (Simpfendorfer 2022). The application of Victrato to more intolerant wheat varieties was equivalent to the yield achieved by sowing a variety more tolerant to FCR without the application of Victrato at all sites. Hence, Victrato should be used in combination with improved varietal tolerance and other IDM strategies to minimise yield loss from FCR within central NSW cropping systems.

Integrated management of FCR

To manage the risk of yield losses 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 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 PreDicta® B testing (SARDI) or stubble testing (NSW DPI).

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.
    a. ***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.
    b. ***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.

c. ***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.

d. ***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)

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