Increased wheat plant population: the interaction with variety, Fusarium crown rot and nitrogen

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Take home message

- Fusarium crown rot (FCR) pressure had a greater impact on wheat yield and quality than plant population or nitrogen (N) status under low to moderate yield conditions.
- The interaction of FCR pressure, N status and plant population varied depending upon variety.
- Beckom◊ and LRPB Flanker◊ outyielded LRPB Raider◊ and LRPB Lancer◊, but suffered greater yield loss from FCR. Despite this, under higher FCR pressure both Beckom◊ and LRPB Flanker◊ out yielded LRPB Lancer◊ and LRPB Raider◊.
- Higher plant populations either increased yield or had no impact at the three sites.
- Under higher FCR pressure in moderate yield environments of 3–4.5 t/ha, increasing plant populations appeared to reduce the impact of FCR.

Background

Growers are urged to use other weed control tactics besides herbicides to continue to farm sustainably in the future. One option is to increase crop competition against weeds. This reduces the ability of the weed to compete for limited resources like moisture and nutrients in the short term, but also benefits in the medium to longer term through reduced weed seed set.

Increasing crop competition can be achieved through crop choice, row spacing or plant populations. The first 2 options are restricted by several factors, such as crop suitability, growing environments and profitability, as well as the need to invest in new machinery and/or modification to change plant row spacings. However, changing plant populations is a relatively easy option achieved by simply adjusting sowing rates.

Many growers and advisors are concerned that increasing plant populations could lead to an increased risk of yield and grain quality instability, ultimately reducing crop profitability. This view is more common in the lower rainfall growing areas where relatively low plant populations are the norm. If growers were confident that increasing plant population did not carry the risk of reduced yield or poor grain quality, it would be an easy and relatively low-cost option in the battle against weeds and herbicide resistance.

In response, Grain Orana Alliance (GOA), with the support of the Grains Research and Development Corporation (GRDC), has for the past 4 years conducted a series of trials investigating the impact of wheat population on yield and quality in the low rainfall environments of the GOA region (central west NSW). It is clear from this data set of 10 trials (over 5 years; 2018, 2020-2023, and 15 varieties) that increasing plant population resulted in higher yield (**Figure**) with fewer screenings in the majority of cases. There were cases where yield was reduced and/or screenings increased, however the impact was less frequent and severe compared to the yield benefits of higher plant populations.

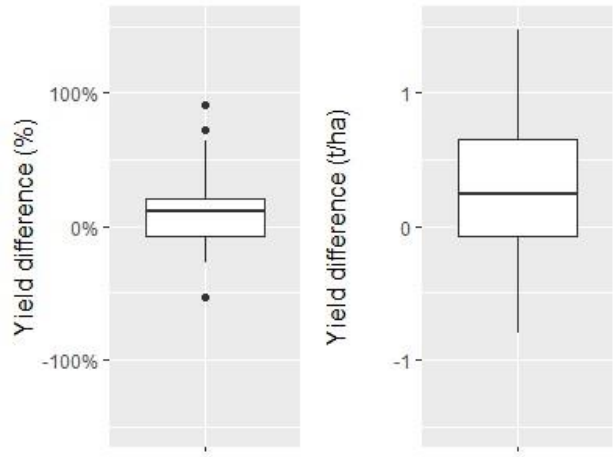


Figure 1. Yield difference % (left) and t/ha (right) moving from the lowest to the highest wheat population averaged across 5 trial years, 10 sites and 15 varieties.

It has been hypothesised that fusarium crown rot (FCR), may be contributing to a common commercial perception of higher plant populations having reduced yield and increased screenings. Previous trials were largely conducted in low FCR risk situations, such as following canola or pulse break crops, which may explain the differing outcomes. But for growers it is not always possible to sow into low disease risk paddocks.

FCR impacts the crown and lower stem bases of infected wheat plants reducing its ability to transport water which is most influential on yield and quality in hot and/or dry springs during seed set and grain filling. Growers and advisors in the region question whether increased plant population could further exacerbate stress during this period and hence further exacerbate the impact of FCR. In addition, will increasing nitrogen (N) rates exacerbate the yield impact of FCR through excessive moisture use before grain fill, leading to increased stress during grain filling.

In 2023 three collaborative trials, between NSW DPI, Brill Ag and GOA with the support of GRDC, were established across central west and southern NSW to investigate if there is an interaction between plant variety, populations, FCR and N nutrition.

The trials

Three small-plot trials were established. At the Coonamble and Nyngan sites, trials were randomised, complete block factorial designs and at Ganmain trials were a split-plot (with nitrogen as main block) factorial design, all examining the 4 variables outlined in Table 1.

Table 1. Treatments implemented in 2023 trials at Ganmain, Coonamble and Nyngan, NSW.

Wheat variety	**Target plant population (pl/m^2)**	**N strategy**	**FCR inoculum**
Beckom(b)	Moderate (targeting 70 plants/m^2)	-N (40 kg/ha added at Ganmain, 25 kg/ha at Nyngan and Coonamble)	-FCR (background level)
LRPB Flanker(b)			
LRPB Lancer(b)	High (targeting 150 plants/m^2)	+ N (130 kg/ha added at Ganmain, 100 kg/ha at Nyngan and Coonamble)	+FCR (plots inoculated)
LRPB Raider(b)			

Plant population

Seed was accessed from the GRDC experimental seed supply program to ensure trueness to type and was not treated with any seed dressings. Seeding rates were calculated based on individual variety germination rates, seed size (1000 seed weight) and assumed establishment percentages. Individual sowing rates are shown in Table 2.

Table 2. Seeding rates used for varieties tested at two contrasting plant populations in 2023 at Ganmain, Coonamble and Nyngan, NSW.

Variety	Seeding rate (kg/ha)	
	Moderate	High
Beckom(b)	29	61
LRPB Flanker(b)	37	79
LRPB Lancer(b)	35	76
LRPB Raider(b)	37	80

FCR

The +FCR plots were inoculated at sowing with non-viable wheat seed colonised by *F. pseudograminearum* (mixture of 5 isolates) at the rate of 1.4 g/m row (100 grams/plot) to establish a medium to high disease pressure (Forknall *et al.,* 2019). The -FCR plots received no artificial inoculation. PreDicta® B tests were conducted confirming Coonamble, Nyngan and Ganmain sites had FCR inoculum levels below detection (BDL) and all had canola as the previous crop. The Coonamble site was burnt to enable sowing, Nyngan was Kelly disced, and Ganmain was treated with a stubble cruncher.

Nitrogen

All N was applied as urea and incorporated by sowing, except Ganmain which had 40 kg N/ha broadcast over all treatments on 4 August.

Table 3. Site details for the 3 trials in 2023. FCR status, BDL = below detection limit, GSR = growing season rainfall

Trial location	FCR status	Sowing date	Starting N (0–60 cm)	GSR (May–Sept)
Coonamble	BDL	19 May 2023	80 kg/ha	53 mm
Nyngan	BDL	18 May 2023	98 kg/ha	54 mm
Ganmain	BDL	24 May 2023	55 kg/ha	140 mm

Results summary

The results presented were analysed using ASReml and any references to differences are statistically significant to 95% confidence. Results presented with the same letter are not significantly different (*P*=0.05). A factorial analysis of the trials resulted in the following findings.

Nyngan

- High plant population had no impact on yield, but increased screenings from 3.3% to 4.0% compared to moderate plant population.

- The +N treatment reduced yield by ~0.16 t/ha (12%) and increased screenings from 3.5% to 3.8% compared to the -N treatment.
- The +FCR reduced yield by ~0.38 t/ha (26%) and increased screenings from 2.1% to 5.2% compared to the -FCR treatment.

Coonamble

- High plant population increased yield by ~0.35 t/ha (~9%), and reduced screenings from 2.3% to 2.0% compared to moderate plant population.
- The +N treatment increased yield by ~0.29 t/ha (8%) and had no impact on screenings compared to the -N treatment.
- The +FCR reduced yield by ~0.61 t/ha (-16%) and increased screening from 1.9% to 2.4% compared to the -FCR treatment.

Ganmain

- High plant population increased yield by ~0.39 t/ha (12%) and increased screenings from 1.8% to 1.9% compared to moderate plant population.
- The +N treatment increased yield by 0.29 t/ha (9%) increased screenings from 1.6% to 2.1% compared to the -N treatment.
- The +FCR reduced yields by ~0.39 t/ha (-10%) and increased screenings from 1.1% to 2.6% compared to the -FCR treatment.

Beckom◊ yielded the highest or equal highest across all sites. LRPB Flanker◊ was the lowest yielding at Ganmain and Coonamble, LRPB Lancer◊ and LRPB Raider◊ were equally the lowest at Nyngan. Differences between the lowest to the highest yielding varieties at Nyngan was 0.46 t/ha (+30%), Coonamble was 0.49 t/ha (+14%), and at Ganmain 0.97 t/ha (24%).

In summary across all sites, increasing plant population improved yield by 0–12%. Whereas +FCR had the largest negative effects of between 10–-27% yield reduction. Whilst there is a clear message in this alone, investigation of the influence of population on various combinations of variety, N and FCR pressure, revealed some interesting interactions.

Detailed results

The following results are based on an ANOVA and compare "paired" treatments, the pairs being +FCR and -FCR, or moderate versus high plant population whilst other parameters such as variety and N nutrition remains the same.

In the Tables 4 to 9 shading denotes a significant difference between the treatments within the comparison. The lettering is across all treatments but only within either yield or screenings.

Nyngan

The effect of +FCR was significant (Table 4), negatively impacting three of the varieties (except LRPB Lancer◊) in at least three N and population scenarios. LRPB Flanker◊ was the most affected by +FCR, with up to 0.94 t/ha yield loss in similar plant population and N nutrition scenarios. Beckom◊ and LRPB Raider◊ were less affected with up to 0.56 t/ha yield loss. LRPB Lancer◊ was least affected by +FCR, with yield reduced by a maximum of 0.21 t/ha, in the +N, high population treatment (Table 4).

Adding FCR increased screenings in all variety, population and N combinations, with screenings ranging from 1.4% up to 6.1%, with LRPB Flanker◊ and Beckom◊ being the most affected.

Table 4. Impact of FCR pressure on yield and screenings of various combinations of wheat variety (Var), N nutrition and plant population (Pop), Nyngan 2023.

Var	N	Pop	Yield (t/ha)				Δ Yield (t/ha)	Screenings (%)				Δ SCN (%)
			-FCR		+FCR			-FCR		+FCR		
Beckom	+N	High	1.36	efgh	1.53	def	NS	2.3	jklmno	6.0	cd	3.8
		Moderate	1.77	abcd	1.25	ghij	-0.52	2.1	klmno	5.9	cde	3.7
	-N	High	1.81	ab	1.27	ghij	-0.54	2.5	ijklmn	7.2	ab	4.7
		Moderate	2.00	a	1.44	efg	-0.56	1.6	no	4.7	fg	3.1
Flanker	+N	High	1.55	def	0.90	mno	-0.65	3.0	ijk	6.6	bc	3.6
		Moderate	1.31	fghi	0.89	mno	-0.42	2.0	klmno	8.1	a	6.1
	-N	High	1.76	bcd	0.82	o	-0.94	2.6	ijklm	6.7	bc	4.0
		Moderate	1.79	abc	0.93	lmno	-0.86	2.0	lmno	5.0	ef	3.0
Lancer	+N	High	1.08	ijklmn	0.87	no	NS	2.2	klmno	3.9	gh	1.7
		Moderate	1.04	jklmno	1.02	klmno	NS	1.6	no	3.2	hij	1.6
	-N	High	1.29	ghi	1.11	ijklm	NS	1.8	mno	3.4	hi	1.6
		Moderate	1.24	ghijk	1.05	jklmno	NS	1.4	o	2.8	ijkl	1.4
Raider	+N	High	1.20	ghijk	0.95	lmno	-0.25	2.3	jklmno	5.3	def	3.0
		Moderate	1.21	ghijk	0.89	mno	-0.32	1.9	lmno	4.5	fg	2.6
	-N	High	1.56	cde	1.06	jklmn	-0.5	2.5	ijklmn	5.0	ef	2.5
		Moderate	1.26	ghij	1.14	hijkl	NS	1.8	mno	4.8	fg	3.1

When comparing the effects of plant population (Table 5), there were 3 paired comparisons where yield increased with population by 0.24–0.30 t/ha or 18–24% – Beckom♁ with +N and +FCR, LRPB Flanker♁ with +N and -FCR and LRPB Raider♁ with -N and -FCR.

Only in Beckom♁ with +N and -FCR was there a yield decrease (0.41 t/ha or 23%) with the high plant population. All other comparisons of high and low population resulted in no yield impact (Table 5).

Table 5. Impact of plant population on yield and screenings of various combinations of wheat variety (Var), N nutrition N and FCR, Nyngan 2023.

VAR	N	FCR	Yield (t/ha)				Δ Yield (t/ha)	Screenings (%)				Δ SCN (%)
			Moderate population		High population			Moderate population		High population		
Beckom	+N	+FCR	1.25	ghij	1.53	def	0.28	5.9	cde	6.0	cd	NS
		-FCR	1.77	abcd	1.36	efgh	-0.41	2.1	klmno	2.3	jklmno	NS
	-N	+FCR	1.44	efg	1.27	ghij	NS	4.7	fg	7.2	ab	2.5
		-FCR	2.00	a	1.81	ab	NS	1.6	no	2.5	ijklmn	NS
Flanker	+N	+FCR	0.89	mno	0.90	mno	NS	8.1	a	6.6	bc	-1.5
		-FCR	1.31	fghi	1.55	def	0.24	2.0	klmno	3.0	ijk	NS
	-N	+FCR	0.93	lmno	0.82	o	NS	5.0	ef	6.7	bc	1.7
		-FCR	1.79	abc	1.76	bcd	NS	2.0	lmno	2.6	ijklm	NS
Lancer	+N	+FCR	1.02	klmno	0.87	no	NS	3.2	hij	3.9	gh	NS
		-FCR	1.04	jklmno	1.08	ijklmn	NS	1.6	no	2.2	klmno	NS
	-N	+FCR	1.05	jklmno	1.11	ijklm	NS	2.8	ijkl	3.4	hi	NS
		-FCR	1.24	ghijk	1.29	ghi	NS	1.4	o	1.8	mno	NS
Raider	+N	+FCR	0.89	mno	0.95	lmno	NS	4.5	fg	5.3	def	0.8
		-FCR	1.21	ghijk	1.20	ghijk	NS	1.9	lmno	2.3	jklmno	NS
	-N	+FCR	1.14	hijkl	1.06	jklmn	NS	4.8	fg	5.0	ef	NS
		-FCR	1.26	ghij	1.56	cde	0.3	1.8	mno	2.5	ijklmn	NS

There were 3 paired treatments where screenings increased (between 0.8% and 2.5%) at higher plant population, each +FCR (see Table 5, shaded cells): Beckom -N, LRPB Flanker -N, and LRPB Raider +N. LRPB Flanker +N resulted in lower screenings at the high plant population compared with the moderate plant population. All other comparisons of plant population resulted in no effects on screenings.

Coonamble

The addition of +FCR reduced yield by up to 1.20 t/ha (32%) in all paired combinations of variety, population, and N rate, except for one (Table 6). Beckom and LRPB Flanker were affected more than LRPB Lancer and LRPB Raider by +FCR. Screenings in LRPB Flanker increased with +FCR, regardless of N or population. Several other comparisons showed increases in screenings, but none resulted in screenings greater than 5%, the limit for milling wheat (Table 6).

Table 6. Impact of FCR pressure on yield and screenings of various combinations of wheat variety (Var), N nutrition and plant population (Pop), Coonamble 2023

Var	N	Pop	Yield (t/ha)				Δ Yield (t/ha)	Screenings (%)				Δ SCN (%)
			-FCR		+FCR			-FCR		+FCR		
Beckom	+N	High	4.43	a	3.96	cde	-0.47	1.5	j	1.9	fghij	NS
		Moderate	4.41	a	3.45	hijk	-0.96	2.1	efgh	2.2	defg	NS
	-N	High	4.34	ab	3.60	ghi	-0.74	1.4	j	1.6	hij	NS
		Moderate	3.68	efgh	3.12	mn	-0.56	1.4	j	2.0	fghi	0.6
Flanker	+N	High	4.12	bc	3.35	ijklmn	-0.77	1.8	ghij	2.4	cdef	0.6
		Moderate	3.83	defg	2.61	o	-1.22	2.2	defg	2.8	abc	0.6
	-N	High	3.94	cde	3.06	n	-0.88	1.9	fghij	2.6	bcde	0.7
		Moderate	3.41	hijkl	2.69	o	-0.72	2.2	defg	3.3	a	1.2
Lancer	+N	High	3.98	cd	3.53	hij	-0.45	1.5	ij	1.9	fghij	NS
		Moderate	3.55	ghi	3.24	jklmn	-0.31	1.9	fghij	2.2	defg	NS
	-N	High	3.62	fghi	3.12	lmn	-0.5	1.5	ij	2.1	defghi	NS
		Moderate	3.19	klmn	3.07	n	NS	2.1	defgh	2.6	bcd	NS
Raider	+N	High	4.14	abc	3.52	hij	-0.62	2.2	defg	2.4	cdef	NS
		Moderate	4.07	bcd	3.37	ijklm	-0.7	2.1	efgh	2.4	cdef	NS
	-N	High	3.90	cdef	3.46	hijk	-0.44	2.1	defgh	3.1	ab	0.9
		Moderate	3.50	hij	3.18	klmn	-0.32	2.0	fghi	2.6	bcde	0.5

Increasing population from a moderate to high had no impact in six comparisons (Table 7). Yield increased by 8% to 28% or up to 0.74 t/ha in the remaining ten comparisons of plant population.

In no comparisons did increasing plant population from moderate to high increase screenings. Three of the 16 comparisons at Coonamble resulted in lower screenings (0.4–0.7%) when plant population was increased (Table 7). In no cases were screenings >5%, the threshold for milling wheat. There was no impact of plant population on screenings in LRPB Raider.

Table 7. Impact of population on yield and screenings of various combinations of wheat variety (Var.), N nutrition and FCR, Coonamble 2023.

VAR.	N	FCR.	Yield (t/ha)				Δ Yield (t/ha)	Screenings (%)				Δ SCN (%)
			Moderate population		High population			Moderate population		High population		
Beckom	+N	+FCR	3.45	hijk	3.96	cde	0.51	2.2	defg	1.9	fghij	NS
		-FCR	4.41	a	4.43	a	NS	2.1	efgh	1.5	j	-0.6
	-N	+FCR	3.12	mn	3.60	ghi	0.48	2.0	fghi	1.6	hij	NS
		-FCR	3.68	efgh	4.34	ab	0.66	1.4	j	1.4	j	NS
Flanker	+N	+FCR	2.61	o	3.35	ijklmn	0.74	2.8	abc	2.4	cdef	NS
		-FCR	3.83	defg	4.12	bc	0.29	2.2	defg	1.8	ghij	NS
	-N	+FCR	2.69	o	3.06	n	0.37	3.3	a	2.6	bcde	-0.7
		-FCR	3.41	hijkl	3.94	cde	0.53	2.2	defg	1.9	fghij	NS
Lancer	+N	+FCR	3.24	jklmn	3.53	hij	NS	2.2	defg	1.9	fghij	NS
		-FCR	3.55	ghi	3.98	cd	0.43	1.9	fghij	1.5	ij	NS
	-N	+FCR	3.07	n	3.12	lmn	NS	2.6	bcd	2.1	defghi	NS
		-FCR	3.19	klmn	3.62	fghi	0.43	2.1	defgh	1.5	ij	-0.6
Raider	+N	+FCR	3.37	ijklm	3.52	hij	NS	2.4	cdef	2.4	cdef	NS
		-FCR	4.07	bcd	4.14	abc	NS	2.1	efgh	2.2	defg	NS
	-N	+FCR	3.18	klmn	3.46	hijk	NS	2.6	bcde	3.1	ab	NS
		-FCR	3.50	hij	3.90	cdef	0.4	2.0	fghi	2.1	defgh	NS

Ganmain

Most paired comparisons of +/-FCR had no impact on yield (Table 8). There was no effect of FCR in LRPB Lancer♁, however LRPB Raider♁ and LRPB Flanker♁ yield was lower at moderate populations when FCR pressure was increased, but there was no impact at higher populations regardless of N. Beckom♁ yield was reduced under +N and high population. Screenings increased with +FCR for all but 2 comparisons: LRPB Lancer♁ -N at both moderate and high plant population.

Table 8. Impact of FCR pressure on yield and screenings of various combinations of wheat variety (Var), N nutrition and plant population (Pop), Ganmain 2023.

Var.	N	Pop.	Yield (t/ha)				Δ yield (t/ha)	Screenings (%)				Δ SCN (%)
			-FCR		+FCR			-FCR		+FCR		
Beckom	+N	High	4.77	a	4.31	bc	-0.46	1.2	klmn	2.4	fgh	1.2
		Moderate	4.08	bcde	3.69	efghi	NS	1.0	mn	3.0	de	2.0
	-N	High	4.08	bcde	3.69	efghi	NS	0.9	n	1.7	ijk	0.8
		Moderate	3.95	bcdef	3.56	fghijk	NS	0.9	n	1.4	klm	0.5
Flanker	+N	High	3.64	efghij	3.20	jklmn	NS	1.1	mn	2.9	de	1.8
		Moderate	3.17	klmn	2.49	op	-0.68	1.0	mn	3.3	cd	2.3
	-N	High	3.47	ghijkl	3.04	lmn	NS	0.9	n	2.8	def	1.9
		Moderate	2.91	mno	2.41	p	-0.5	1.1	lmn	2.7	efg	1.5
Lancer	+N	High	3.67	efghi	3.34	ijklm	NS	0.9	n	2.0	hi	1.1
		Moderate	3.45	ghijkl	3.21	jklm	NS	0.9	n	1.4	klm	0.5
	-N	High	3.40	hijkl	3.41	hijkl	NS	1.0	n	1.1	lmn	NS
		Moderate	2.92	mno	2.73	nop	NS	1.0	mn	1.1	lmn	NS
Raider	+N	High	4.29	bcd	4.02	bcdef	NS	2.0	hij	5.2	a	3.2
		Moderate	4.43	ab	3.65	efghij	-0.78	1.5	jkl	4.2	b	2.7
	-N	High	4.01	bcdef	3.83	defgh	NS	1.3	klmn	3.5	c	2.2
		Moderate	3.90	cdefg	3.40	hijkl	-0.5	1.4	klm	2.2	gh	0.8

Increasing the plant population at Ganmain did not reduce yield (Table 9). There were 8 cases with no impact, and for the remaining eight, yield increased 0.47–0.71 t/ha (19–29%) with increased plant population. LRPB Flanker℗ responded in all 4 population comparisons, +/- N and +/- FCR. Beckom℗ responded in two comparisons, both +N and +/- FCR, as did LRPB Lancer℗ for the -N treatment. LRPB Raider℗ did not respond to plant population.

Three comparisons resulted in higher screenings with increased population but only one was >5% (Table 9). Screenings were slightly lower in Beckom℗ with +N and +FCR.

Table 9. Impact of plant population (Pop) on yield and screenings of various combinations of wheat variety (Var), N nutrition and FCR, Ganmain 2023.

VAR	N	FCR	Yield: (t/ha)				Δ Yield (t/ha)	Screenings (%)				Δ SCN (%)
			Moderate population		High population			Moderate population		High population		
Beckom	+N	+FCR	3.69	efghi	4.31	bc	0.62	3.0	de	2.4	fgh	-0.6
		-FCR	4.08	bcde	4.77	a	0.69	1.0	mn	1.2	klmn	NS
	-N	+FCR	3.56	fghijk	3.69	efghi	NS	1.4	klm	1.7	ijk	NS
		-FCR	3.95	bcdef	4.08	bcde	NS	0.9	n	0.9	n	NS
Flanker	+N	+FCR	2.49	op	3.20	jklmn	0.71	3.3	cd	2.9	de	NS
		-FCR	3.17	klmn	3.64	efghij	0.47	1.0	mn	1.1	mn	NS
	-N	+FCR	2.41	p	3.04	lmn	0.63	2.7	efg	2.8	def	NS
		-FCR	2.91	mno	3.47	ghijkl	0.56	1.1	lmn	0.9	n	NS
Lancer	+N	+FCR	3.21	jklm	3.34	ijklm	NS	1.4	klm	2.0	hi	0.6
		-FCR	3.45	ghijkl	3.67	efghi	NS	0.9	n	0.9	n	NS
	-N	+FCR	2.73	nop	3.41	hijkl	0.68	1.1	lmn	1.1	lmn	NS
		-FCR	2.92	mno	3.40	hijkl	0.48	1.0	mn	1.0	n	NS
Raider	+N	+FCR	3.65	efghij	4.02	bcdef	NS	4.2	b	5.2	a	1.0
		-FCR	4.43	ab	4.29	bcd	NS	1.5	jkl	2.0	hij	NS
	-N	+FCR	3.40	hijkl	3.83	defgh	NS	2.2	gh	3.5	c	1.3
		-FCR	3.90	cdefg	4.01	bcdef	NS	1.4	klm	1.3	klmn	NS

Discussion

The 3 trial sites in 2023 could be broadly categorised into 2 yield environments: low at Nyngan ~1 t/ha and moderate at both Ganmain and Coonamble, yielding up to ~4.7 t/ha. Despite this, all sites showed significant impacts from the addition of FCR. Nyngan had the largest percentage yield loss across all varieties and N levels from +FCR (26% or ~0.38 t/ha). Ganmain had only ~12% average yield loss across all varieties and N levels from +FCR. Interestingly, the actual tonnage of yield loss from FCR at Ganmain was 0.39 t/ha which was equivalent to the 0.38 t/ha loss associated with FCR infection at Nyngan even though these two sites had vastly different yield potentials in 2023. Individual varieties suffered much bigger losses. At Nyngan, individual varieties had yield reductions of up to 53%, Coonamble up to 32% and Ganmain up 21%, due increased FCR.

The effects of +FCR on screenings at Nyngan was substantial and impacted all treatment combinations. In many situations, +FCR resulted in screenings above 5%, which generally pushed the samples out of higher priced milling grades. Similarly, +FCR at Ganmain increased screenings in all but two comparisons. Only in one comparison were screenings >5% in response to +FCR.

The N impact varied between sites. There were slight yield reductions and increased screenings at Nyngan, possibly displaying typical haying off, a common concern of growers in these environments. However, the impacts were quite minimal in comparison to the effects of +FCR at this site. At Ganmain +N had no impact on yield and only a small increase in screenings. Again, the effects of this are dwarfed by that of +FCR. At Coonamble there was a large increase in yield and no impact on screenings from the +N application.

All the above results are intertwined with variety. At all sites Beckom◊ was a top performer compared to the other varieties and both it and LRPB Flanker◊ were affected the most by +FCR. Interestingly, even with the impacts of FCR on these two varieties, they often outperformed the other 'more tolerant' LRPB Lancer◊ and LRPB Raider◊, even in the absence of FCR (-FCR).

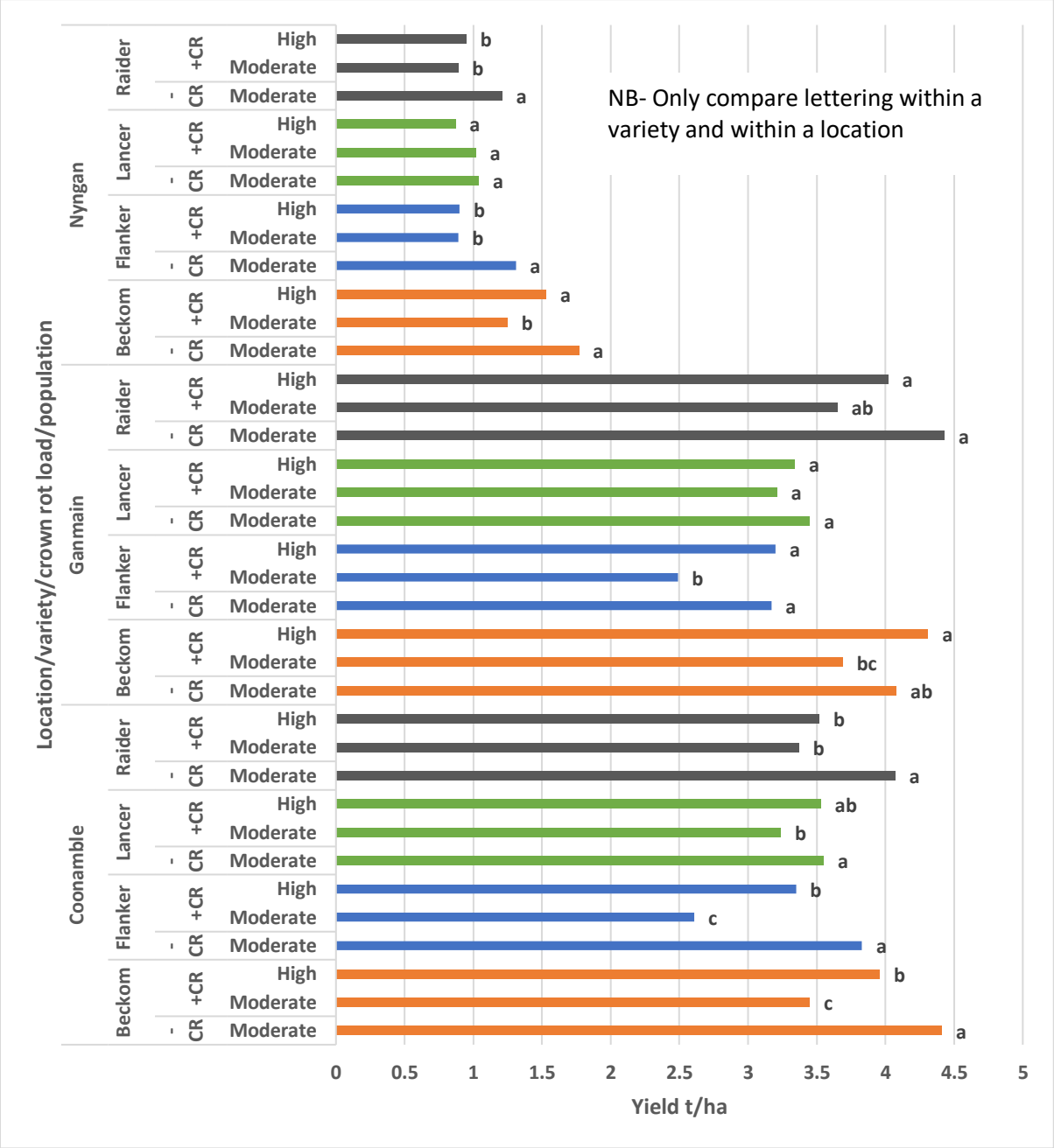
The effects of increasing plant population were often positive for yield and screenings. This benefit was greatest at the higher yielding sites at Coonamble and Ganmain. For both locations there was no negative impacts on yield but increases of up to 29% or 0.75 t/ha with the higher plant population.

At Coonamble, there was either no effect or a decrease on screenings with higher plant populations. For most treatments at Ganmain there was no impact of population on screenings, except in a few cases where a slight increase (<1.3%) was recorded.

Nyngan was less responsive to increasing plant populations, most treatments having no response. The few cases that did respond were mostly positive with yield gains of up to 0.30 t/h or 24% with the higher plant population treatment. Only one comparison out of 16 pairs resulted in a yield decrease of 0.41 t/ha with the high plant population. In only 3 out of 16 comparisons, screenings increased with higher plant population and were >5%.

An interesting interaction of FCR and plant population is illustrated in Figure 2. As already discussed, at moderate plant population the introduction of FCR can reduced yield. If we consider many of the factors investigated in these trials, for the +FCR treatments, increasing plant population often increased yield but not to the same extent as where FCR was lower. This was most evident in the higher yielding sites of Coonamble and Ganmain and in the less tolerant varieties Beckom and LRPB Flanker. This could prove a useful tool for growers to combat the impacts of FCR in moderate risk situations. In the lower yielding Nyngan site, the benefits were less. The reasons for this positive response cannot be explained, however it was observed but not measured that crop maturity was earlier at high population. The high population crops escaped heat and moisture stress that the moderate populations experienced, resulting in improved yields. This may warrant further investigation.

Figure 2. Impact of increased plant population at high and low FCR pressure, and high nitrogen on yield of various varieties at Nyngan, Coonamble and Ganmain, 2023.



Conclusions

Growers are being encouraged to increase crop competition through increasing plant populations to aid in weed control. These trials have shown concerns by advisors and growers of decreased yield and increased screenings, particularly in low yielding environments, may not be well founded.

The first year of these trials reiterates the significant effect that FCR can have on wheat in both low and moderate yielding situations. The negative impacts resulted in both yield reduction and reduced grain quality (increased screenings).

Manipulation of plant population is emerging as a possible tool to reduce the effects of FCR. There was little negative impact of increasing plant population and more positive effects which resulted in increased yield, and in some cases reduced screenings.

Variety choice had a large effect on yield in the presence of FCR. Beckom(ᵇ) and LRPB Flanker(ᵇ) had the greatest yield reductions from FCR compared to LRPB Lancer(ᵇ) and LRPB Raider(ᵇ), however in many cases Beckom(ᵇ) and LRPB Flanker(ᵇ), under higher FCR pressure, still outyielded these more tolerant varieties. The performance of these more intolerant varieties could also be improved under higher FCR pressure by increasing plant population.

This initial research has demonstrated that increasing plant population did not negatively impact crop performance and consistently resulted in improved yield and grain quality. This did not account for the benefits that increased plant populations could offer in terms of weed control. These trials have potentially identified that growers could increase plant populations to limit potential negative impacts of FCR, which was the largest driver of yield reduction in these trials.

Reference

Forknall CR, Simpfendorfer S, Kelly AM (2019) Using yield response curves to measure variation in the tolerance and resistance of wheat cultivars to Fusarium crown rot. *Phytopathology* **109**: 932-941.

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