GOA Trial Site Report

Manipulating sowing rates across wheat varieties with a delayed seasonal break, Fifield.

Trial code:	GOMA00518 - 3
Season/year:	Autumn 2018
Location:	'Glenaroo', Fifield
Trial partners:	Gordon Larkins

Keywords

GOMA005, wheat, late sowing, sowing rate, variety, maturity, dry seasons, drought

Key findings

- Targeting higher plant populations rarely increased yields but did increased screenings for some varieties.
- Higher plant populations increase seed costs which reduces profitability.
- Across all varieties increasing the target plant population from 60-140 plants/m^2 resulted in ~$30 – 90/ha less income.
- Yields of most varieties tended to decline with increasing plant populations, apart from Flanker⫚ and Dart⫚, which had a flat yield response to plant population.
- Protein increased as the plant population increased.

Background

In some seasons wheat sowing can be delayed due to a late seasonal break. In this scenario growers often change to quicker maturing varieties and increase their seeding rates to account for reduced tillering time. However, the seed of alternate, quicker wheat varieties is often hard to source. This can limit the area that can be switched to these quicker varieties and/or the amount that seeding rates can be increased. This limitation can mean that farmers will plant the next most suitable variety that is available.

It is well established that sowing any variety earlier than recommended can result in significant yield penalties primarily due to frost, while planting later than recommended can expose the crop to heat stress at the end of the season.

In 2018, many growers faced a late planting scenario and raised concerns that sowing longer season wheat varieties would expose crops to late season heat stress, while raising questions about the impact on yields of increasing the seeding rate.

Aim

Test the response in a range of wheat varieties with differing maturities to increases in seeding rate for yield and grain quality.

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Methods

- Six wheat varieties with differing maturities at 4 different sowing rates were evaluated.
- Sowing rates used started at the lower end of what farmers might sow, particularly in the more western areas of the central west and up to very high rates.
- Rates were corrected using an establishment factor to reflect the change in sowing efficiency" (i.e. the percent of seed sown that emerges) with higher target plant populations [2](**Table 2**).

Table 1. Treatment list

	Maturity		Targeted plant population (plants/m2)
Kittyhawk	Long season (winter habit)		60
Suntop	Main season		100
Lancer	Mid-late maturity		140
Flanker	Mid-late maturity		180
Spitfire	Early-mid maturity		
Dart	Quick		

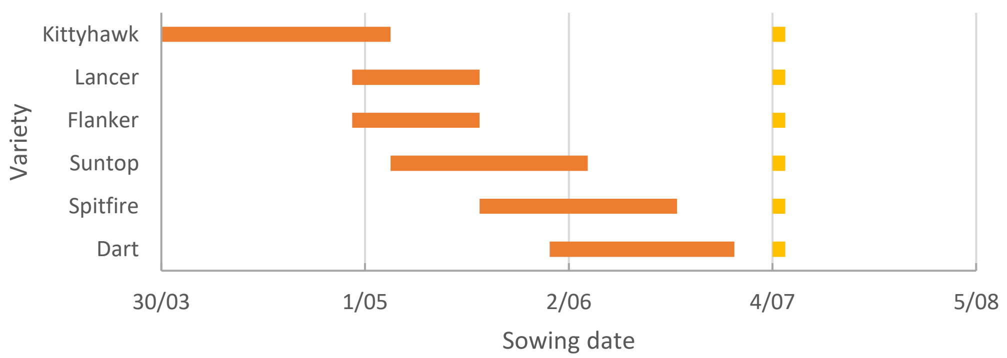


Figure 1. Recommended sowing windows for the various varieties (orange bars) versus sowing date (yellow bars) Fifield 2018.

Table 2. Seed quality and parameters used to determine actual sowing rates.

	Dart	Flanker	Kittyhawk	Lancer	Spitfire	Suntop
1000 seed weight (g)	32	32	41	34	44	46

[2] Newman, P., 2014 'Aim for the narrowest possible row spacing' AHRI, http://www.giwa.org.au/pdfs/2014/Presented_Papers/Newman%20Peter_Aim%20for%20the%20narrowest%20possible%20row%20spacing_short%20version%20DR.pdf

Germination %		95	97	99	94	99	95
Target population	**Establishment factor (%)**	**Sowing rates (kg/ha)**					
60	82	24	24	30	26	32	35
100	74	45	43	56	49	59	64
140	68	69	66	85	74	89	97
180	60	100	96	123	108	130	142

This trial used a replicated (4 reps) small plot factorial design and was analysed using ASREML.

The Least Significant Difference (LSD) method was used to determine if there were differences between treatments. A statistically significant difference is one in which we can be confident that the differences observed are real and not a result of chance. Unless otherwise stated the statistical difference is tested using 95% level of confidence.

Table 3. Trial site details

Trial date	Autumn - 2018		
Crop and variety	Wheat, various	**Seeding rate**	Various
Sowing date	6.7.2018	**Harvest date**	10.12.2018
Seeding equipment	Knife point, press wheel. Direct drilled	**Row Spacing**	27.5 cm
Crop nutrition (kg/ha)	100 MAP, 50 urea	**Soil type**	Red kandosol
Previous crop	2017 canola	**Stubble level (pre-sow)**	20% ground cover
Soil nutrition at sowing	Colwell P ~ 16 ppm, Sulphur ~ 14 ppm	**Nitrogen**	0-10cm ~ 40 kg/ha, 10-60cm ~ 72 kg/ha

Table 4. Monthly rainfall[4] (mm) and long-term average (LTA)

Month	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	**TOTAL**
2018	14	22	7	4	4	42	0	8	13	61	74	84	333
LTA	48	46	44	35	37	36	32	32	30	42	41	45	468

Results

The full set of results are tables in Appendix 1: Results and statistical data

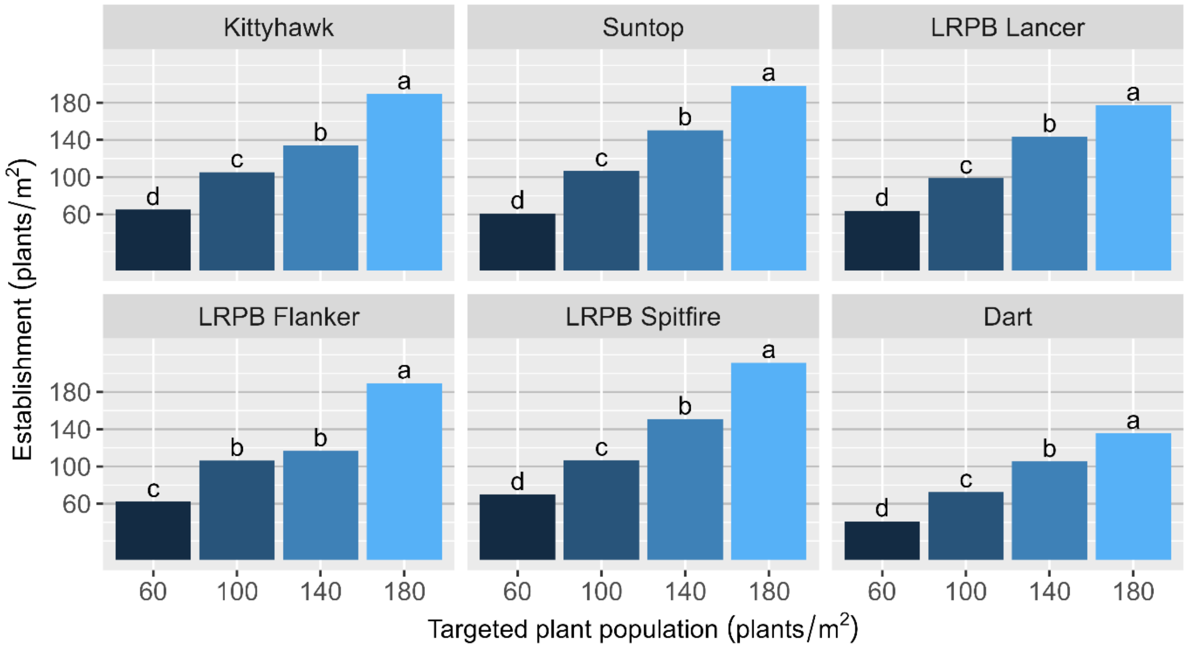
Rainfall

2018 was a very dry year, rainfall was also well below average, prior to sowing approximately 170 mm fell in the fallow (~half of this prior to Christmas). In-crop rainfall was ~160 mm, well down on the average of 467 mm.

[4] Gridded data for the trial site from: Access Gridded Data | LongPaddock | Queensland Government

Establishment

Crop establishment was close to the target plant population (



- **Figure 2**). Within each variety, the differences between the actual establishment rates were significant. Within an establishment rate there were some varietal differences, i.e. Spitfire$^{\Phi}$ at a target of 180 plants/m^2 had a significantly higher population than Dart$^{\Phi}$ at the same target population.

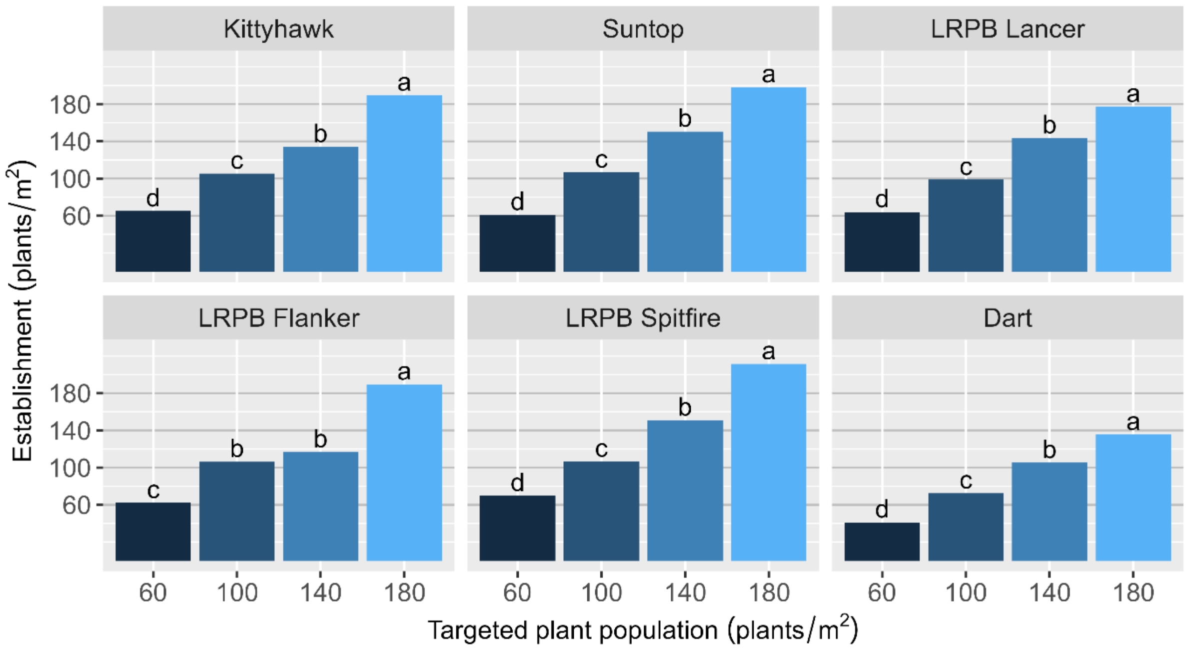


Figure 2. Crop establishment target (lines) and achieved plant populations (bars). Treatments within (but not between) a variety with the same letter are not significantly different.

- The use of an establishment factor (**Table 2**) at this site tended to over-estimate the seed requirements at the higher target plant populations, for example, Spitfire$^{\Phi}$ target of 180 achieved 211 plants/m^2. Where the target population for Spitfire$^{\Phi}$ was 60, the actual was 69 plants/m^2.

This data supports the use of an establishment factor, increasing the target plant population sowing rate from 60 to 180 kg/ha resulted in reduced actual establishment from 84% to 62% (Table **Table 4**).

Table 4. Establishment factor versus the actual establishment for targeted plant populations, averaged across varieties.

Targeted plant populations (plants/m^2)	Establishment factor	Actual establishment %
60	82	84
100	74	75
140	68	67
180	60	62

Vegetation index (VI)

The VI, measured using a Green Seeker, increased with the increasing plant population (

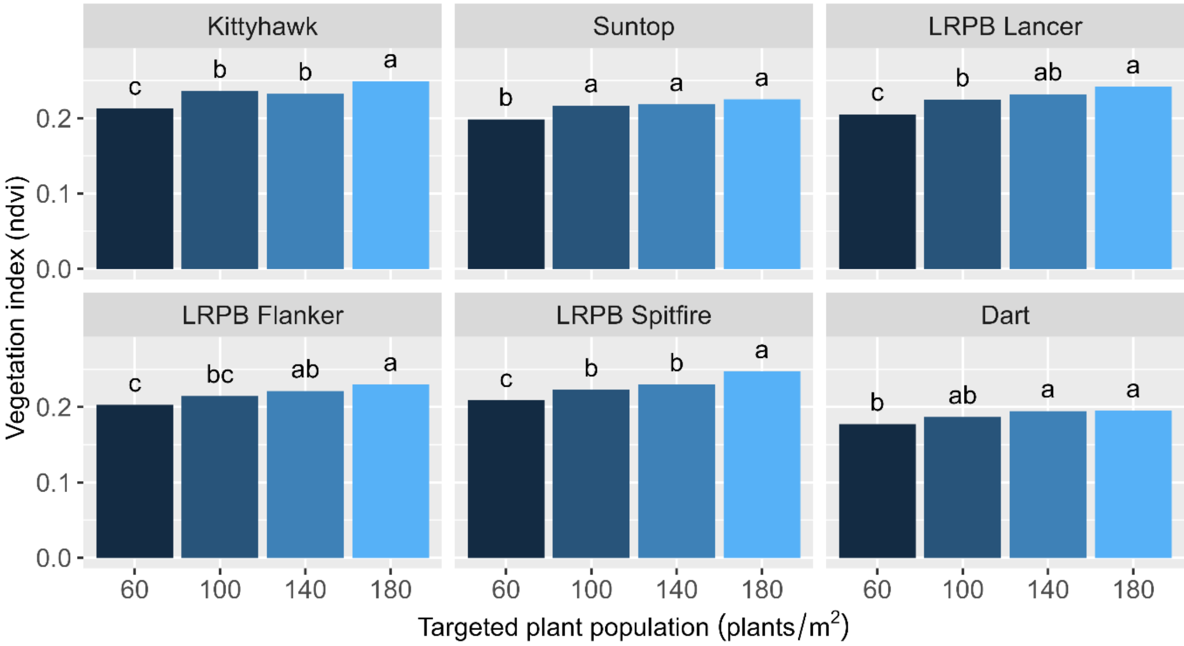


Figure 3). Differences in VI between varieties tended to reflect the growth habit of the varieties.

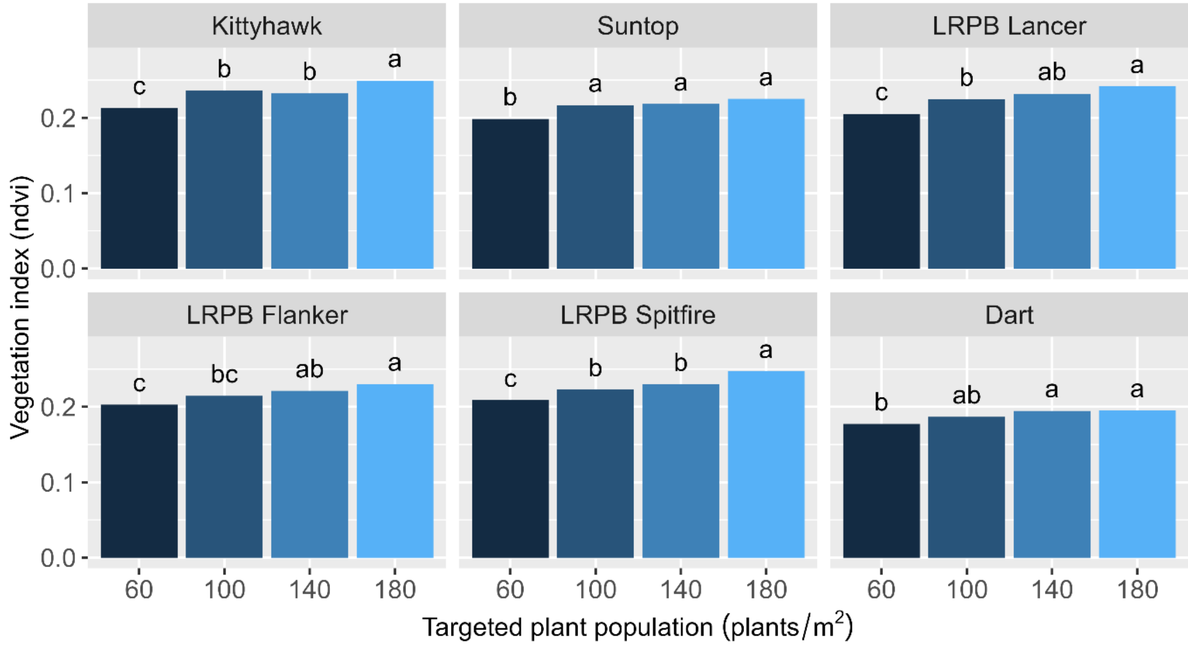
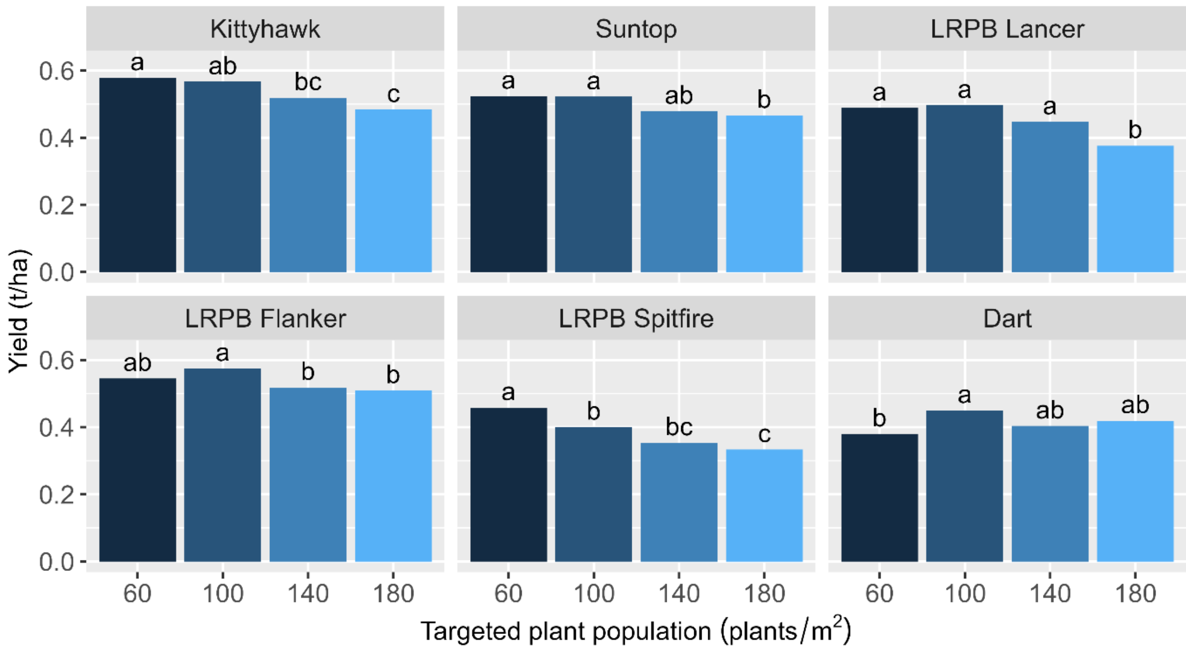


Figure 3. Vegetation index x variety and plant population, assessed 67 days after sowing. Treatments within (but not between) a variety with the same letter are not significantly different.

Yields

The average yield in this trial was ~0.47 t/ha, with a range of 0.33-0.58 t/ha. Yields of most varieties tended to decline with increasing plant populations (



- **Figure 4**), except Flanker$^{\phi}$ and Dart$^{\phi}$, that had a flatter yield response.

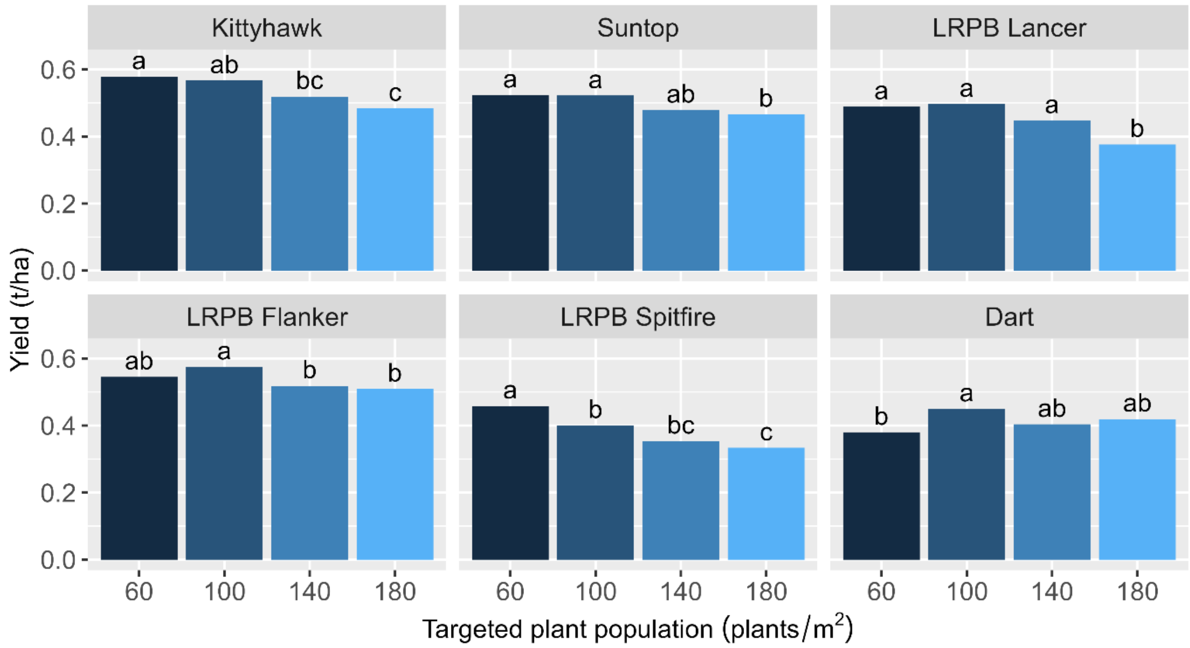


Figure 4. Crop yield x variety and sowing rates. Treatments within (but not between) a variety with the same letter are not significantly different.

Grain quality

- Protein levels tested from sample at this site were very high, ranging from 15.7-19.7%, and increased as the plant population increased. There were some varietal differences with Spitfire⌽ having very high protein levels (Appendix 1).
- Screenings ranged from 6.7-12.8%, with no effect of target plant population. Screenings for the 3 longer season varieties (Kittyhawk⌽, Suntop⌽ and Lancer⌽) tended to increase with increasing plant populations, Flanker and Dart were not affected by plant population while Spitfire screenings reduced as population increased. There were greater screenings differences within the varieties (and population) than there was between the varieties (Appendix 1).

Discussion

The trial confirmed that the percent of seed sown that emerges (sowing efficiency) declined with increasing sowing rates (from 84% to 62% when going from 60 to 180 target plant population).

This trial was sown in July, outside the recommended sowing windowsfor all the included varieties. It was sown into a short fallow paddock and soil testing at sowing indicated a very dry profile. [7]

The calculated sowing rates resulted in plant populations close to those targeted, and the resulting populations within each variety were significantly different, thus giving us confidence that any subsequent differences in yield and grain quality could be attributed to population differences (and sowing rate). Some varieties achieved better plant establishment than others, this maybe just as much a reflection of the variability in seed quality (from different sources and years) as varietal differences. In any case these results confirm that the use of a 'factor' that increases sowing rates to achieve increasing target plant populations is necessary.

[7] Rainfall data from the Wilmatha Station (50108), SILO – Australian Climate Data.

- There was no increase in yields by increasing sowing rates for any variety except for Spitfire$^{\phi}$. Using VI as a proxy for plant biomass, it could be assumed that increasing plant populations did increase biomass, however the limitation of the dry season and finish did not allow the conversion of this to grain. On the other hand, this increased biomass did not result in 'haying off' (reduced yields).
- The decision to switch to a shorter season variety such as Spitfire$^{\phi}$ or Dart$^{\phi}$ offered no yield advantage over a longer season variety. In most cases this decision may have cost yield, i.e. swapping from Flanker$^{\phi}$, Suntop$^{\phi}$, Lancer$^{\phi}$ or Kittyhawk$^{\phi}$ to either Spitfire$^{\phi}$ or Dart$^{\phi}$.

The 2018 spring was much warmer and drier than average, if the spring had had average or above average rainfall, the results may have been different. It is plausible that most of the varieties could have taken advantage of the higher biomass generated with higher populations and converted this to grain.

Grain Quality

- Protein was over 15% for all treatments, resulting in no quality downgrades. Protein tended to increase with increasing plant populations, possibly a result of yield dilution.
- Screenings increased with increasing plant populations for the longer season varieties, i.e. Kittyhawk$^{\phi}$, Suntop$^{\phi}$ and Lancer$^{\phi}$, and followed a similar pattern to VI. While the increase in biomass did not impact yield for these varieties it did impact screenings. Spitfire$^{\phi}$ was the outlier, where screenings declined with increasing sowing rates and followed a similar pattern to yield i.e. both screenings and yield declined with increasing sowing rates.

Economics

The yields at this site were very low, and arguably even the best yielding plots would not have produced enough grain to cover growing costs.

Using a simple economic analysis comparing the changes in yield differences and considering grain quality and seed cost showed no economic advantage to increasing sowing rates, and in some cases a significant cost to doing so (**Figure 5**)[8].

Across all varieties increasing the target plant population from 60-140 plants/m2 resulted in ~$30 – 90$/ha less income.

Figure 5. Gross income ($/ha) less seed cost across a range of target plant populations and varieties.

- Yield and grain quality were larger drivers of loss than seed costs. The sowing rate of 60kg/ha had the highest net income (averaged across all varieties). For most varieties the target plant population of 60 plants/m^2 was optimal, changing to a shorter maturing variety would have likely resulted in the grower having higher losses, in the case of swapping out Suntop$^{\phi}$ for either Spitfire$^{\phi}$ or Dart$^{\phi}$ this would have cost between $25 and $42/ha respectively.

[8] Grain prices sourced from "CropConnect", Graincorp, December 2018, Nevertire = Nevertire

Conclusion

In this trial it was confirmed that seeding efficiency is reduced at higher sowing rates. If targeting higher plant populations, it is advised to adjust sowing rates to achieve the desired plant stand.

In late sowing seasons, targeting higher plant populations and/or changing to quicker varieties is unlikely to increase yields if:

1. stored soil moisture is sub-optimal and/or
2. the seasonal outlook is unfavourable.

Increasing the sowing rate can lead to increased screenings for longer season varieties.

It is noted that the 2018 season was very dry with a relatively hot and dry finish, the results are likely to be very different in average or above rainfall seasons.

Acknowledgements

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Bibliography

Matthews, P., & McCaffery, D. (2019). Winter crop variety sowing guide.

Appendix 1: Results and statistical data

Variety	Target plant population	Plant counts			Vegetation index			Protein			Screenings			Yield		
	(plants/m2)	(plants/m2)			(ndvi)			(%)			(%)			(t/ha)		
			S1	S2		S1	S2		S1	S2		S1	S2		S1	S2
Dart	60	41	h	d	0.18	n	b	17.0	ghi	b	9.1	def	a	0.38	jkl	b
Dart	100	73	g	c	0.19	mn	ab	17.3	efgh	ab	8.7	ef	a	0.45	fgh	a
Dart	140	105	f	b	0.19	lm	a	17.5	def	a	8.9	ef	a	0.40	hij	ab
Dart	180	136	cd	a	0.20	lm	a	17.5	defg	ab	8.3	fghi	a	0.42	ghij	ab
Flanker	60	62	g	d	0.20	jkl	c	15.8	m	b	8.1	fghij	a	0.54	abc	ab
Flanker	100	106	f	c	0.21	ghij	bc	16.7	ijk	a	7.5	ghijk	a	0.58	a	a
Flanker	140	128	de	b	0.22	efgh	ab	16.5	jk	a	8.0	fghij	a	0.52	bcd	b
Flanker	180	190	b	a	0.23	cdef	a	17.0	ghij	a	8.6	fg	a	0.51	cde	b
Kittyhawk	60	65	g	d	0.21	ghij	c	15.9	lm	c	8.8	ef	c	0.58	a	a
Kittyhawk	100	105	f	c	0.24	bcd	b	16.7	ijk	b	9.9	cde	bc	0.57	ab	ab
Kittyhawk	140	134	cd	b	0.23	cde	b	16.8	ijk	b	11.1	bc	b	0.52	bcd	bc
Kittyhawk	180	190	b	a	0.25	a	a	17.4	defg	a	12.8	a	a	0.48	def	c
Lancer	60	64	g	d	0.21	ijkl	c	17.0	ghi	c	7.2	ijk	b	0.49	def	a
Lancer	100	99	f	c	0.22	defg	b	17.6	de	b	7.4	hijk	b	0.50	cdef	a
Lancer	140	144	cd	b	0.23	cde	ab	17.8	cd	ab	9.0	ef	a	0.45	fghi	a
Lancer	180	178	b	a	0.24	abc	a	18.1	c	a	8.8	ef	a	0.38	jkl	b
Spitfire	60	70	g	d	0.21	hijk	c	19.1	b	b	12.7	a	a	0.46	efg	a
Spitfire	100	109	ef	c	0.22	defg	b	19.7	a	a	11.6	ab	a	0.40	ijk	b
Spitfire	140	151	c	b	0.23	cdef	b	19.3	ab	ab	10.2	cd	b	0.35	kl	bc
Spitfire	180	211	a	a	0.25	ab	a	19.5	ab	ab	8.5	fgh	c	0.33	l	c
Suntop	60	61	gh	d	0.20	klm	b	15.7	m	c	6.7	k	b	0.52	bcd	a
Suntop	100	107	f	c	0.22	ghi	a	16.4	kl	b	7.1	jk	ab	0.52	bcd	a
Suntop	140	150	c	b	0.22	fghi	a	16.9	hijk	ab	8.2	fghij	a	0.48	def	ab
Suntop	180	198	ab	a	0.23	defg	a	17.1	fghi	a	8.1	fghij	a	0.47	efg	b
	lsd	21			0.013			0.5			1.22			0.05		

- S1 – values with the same letter for each variable are not significantly different
- S2 – values with the same letter for each variable within each variety only are not significantly different