GOA Trial Site Report

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

Trial code:	GOMA00518 - 5
Season/year:	Autumn 2018
Location:	Forbes
Trial partners:	Matt Duff and Matthew Shepherd

Keywords

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

Key findings

- Vegetative index (VI) increased with the increasing plant populations.
- Only one variety, Dart[A], had increased yields with increased plant population.
- Plant population had very little effect on protein levels.
- Switching to a shorter season variety, such as Spitfire[A] or Dart[A], had no yield advantage over the longer season varieties, and in most cases this decision cost yield.
- Profit was not improved by increasing the targeted plant population or changing variety.

Background

In some seasons 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

To test the response, both yield and quality, of a range of wheat maturities to increased seeding rates.

Methods

- Six wheat varieties with differing maturities (**Figure 1**; **Table 1**) at 4 target plant populations, 4 reps.
- Sowing rates reflect rates at the lower end of farmer's standard practice, particularly in the more western areas of the central west. Very high sowing rates to be used at the other end of the scale.

- 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**).

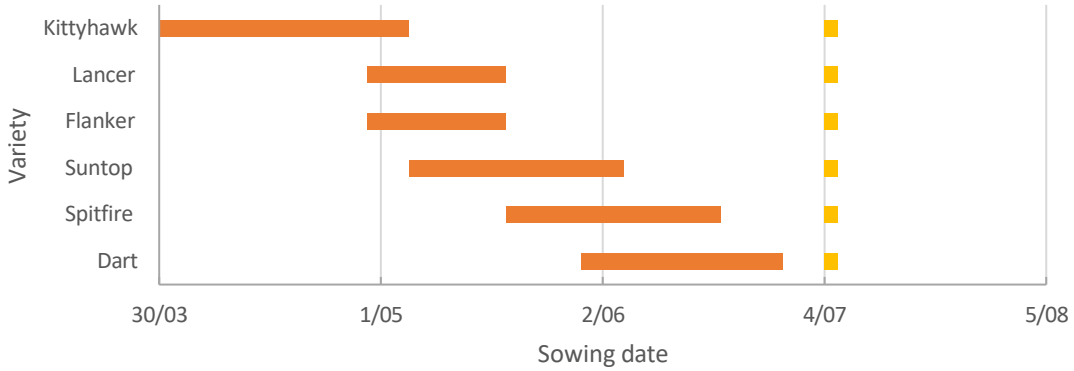

Figure 1. Recommended sowing windows (orange bars) for the various varieties and sowing dates (yellow bars).

Table 1. Treatment list.

Varieties	
Kittyhawk	Long season (winter habit)
Suntop	Main season
Lancer	Mid- late
Flanker	Mid- late
Spitfire	Late
Dart	Quick

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
Germination %		95	97	99	94	99	95
Target population	**Establishment (%) factor**	Calculated 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) small plot factorial design and was analysed using ASREML. The Least Significant Difference (LSD) method was used to determine differences between the 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

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Establishment date	Autumn - 2018		
Crop and variety	Wheat (various)	**Seeding rate**	Various
Sowing date	6/07/2018	**Harvest Date**	4/12/2018
Sowing equipment	Knife point, press wheel	**Soil type**	Grey clay vertosol
Crop nutrition (kg/ha)	100 MAP; 50 urea		
Previous crop (and yield)	2017 Wheat	**Pre-sowing stubble management**	Direct drilled, 20% ground cover
Soil residual nutrition (at sowing)	Colwell P ~ 46 ppm,	**Nitrogen**	0-10cm ~ 57 kg/ha, 10-60cm ~ 122 kg/ha

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Results

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

Establishment

Crop establishment was close to the target plant population (**Figure 2**). Within each variety, the differences between the actual and target establishment rates were significant (except for Dart[A] at the 2 lowest rates). Within an establishment rate there were some varietal differences, i.e. Spitfire[A] at a target of 180 plants/m^2 had a significantly higher population than Dart[A] at the same target population.

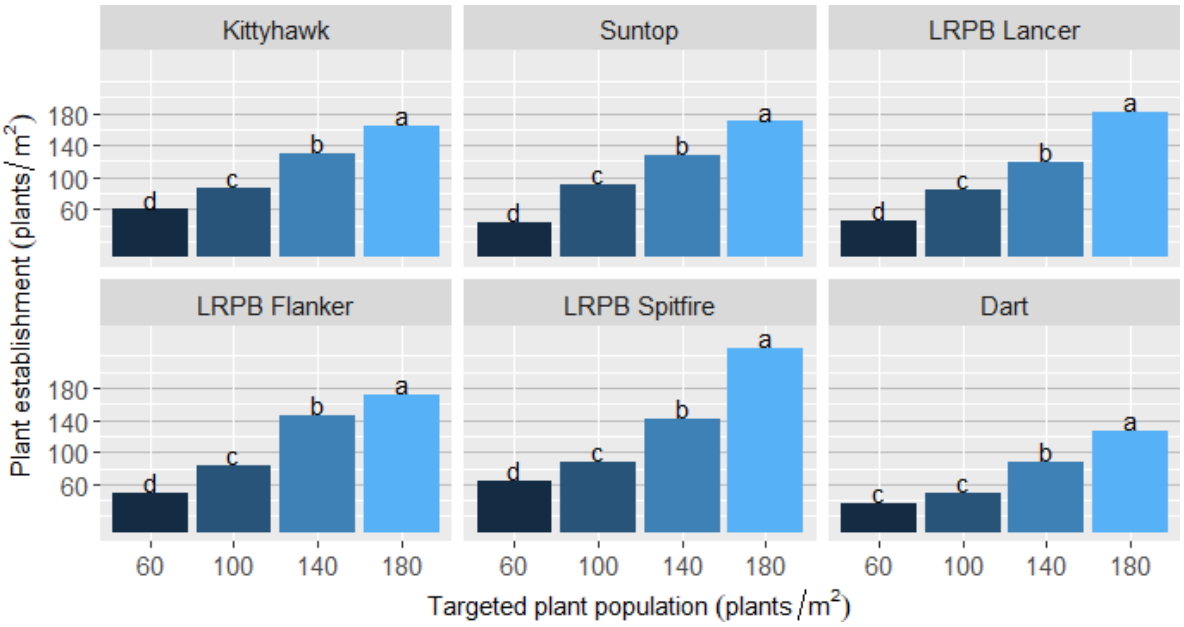

Figure 2. Crop establishment target and actual establishment. Treatments within (but not between) a variety with the same letter are not significantly different.

The use of an establishment factor (**Table 2**) at this site tended to underestimate the seed requirements for most varieties except for Spitfire, for example, Spitfire[A] target of 180 achieved 230 plants/m^2. Where the target population for Spitfire [A] was 60, the actual was 64 plants/m^2.

Increasing the target plant population resulted in a reduction in the actual establishment. When averaged across all varieties the differences in actual establishment were 22% lower for the highest targeted population when compared to the lowest (**Table 4**).

Table 4. Comparison between the establishment factor and the actual establishment for the targeted plant populations (averaged across varieties).

Targeted plant populations (plants/m2)	Establishment factor %	Actual establishment %
60	82	68%
100	74	61%
140	68	62%
180	60	59%

Vegetation index

The VI, measured using a Green Seeker, tended to increase with the increasing plant populations.

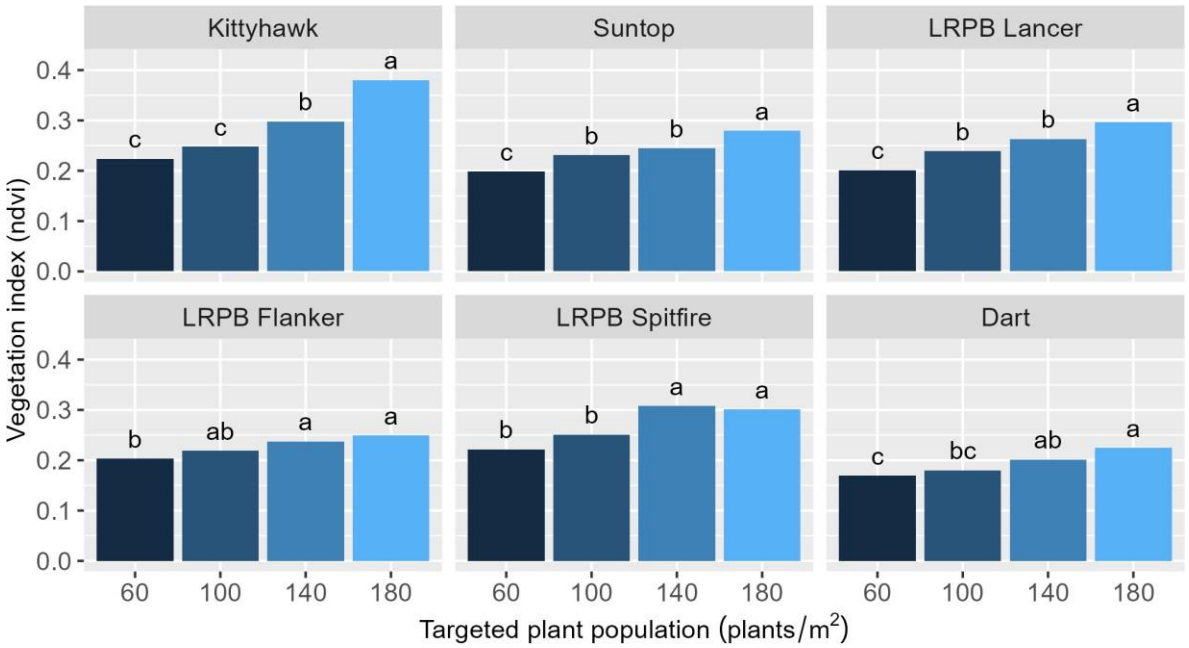

Figure 3. Vegetation index by variety and plant population (plants/m^2) 59 days after sowing. Treatments within (but not between) a variety with the same letter are not significantly different.

Yields

The average yield in this trial was ~0.52 t/ha, with a range of 0.34-0.71 t/ha. Only one variety, Dart[A], had increased yields with increased plant population, and only at the 140 plants/m^2 target population rate

Kittyhawk[A] had a higher yield at the highest plant population than at the 100 plants/m^2 target, otherwise population had little effect on the yields of the remaining varieties. There were yield differences between varieties, with Dart[A] having significantly lower yields.

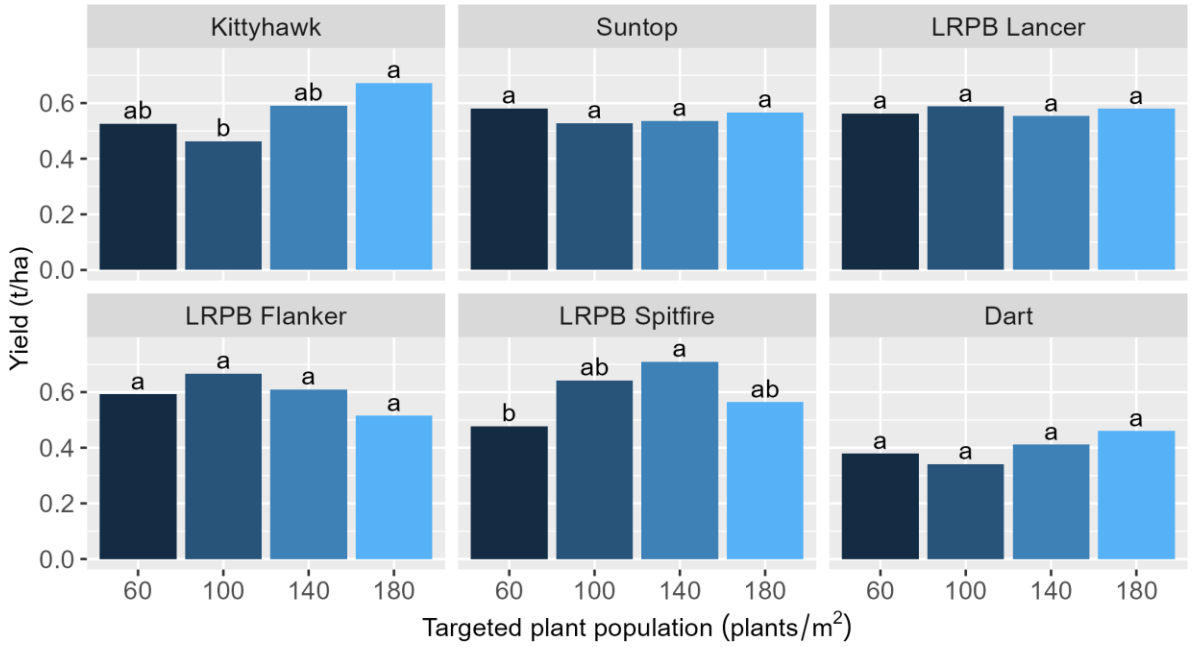

Figure 4. Crop yield x variety and sowing rates. Treatments within (but not between) a variety with the same letter are not significantly different.

Protein

Protein levels from this site were very high, ranging from 13-17%. There was no consistent relationship between plant population and protein (Annex).

There were protein differences between varieties, with Spitfire[A] having higher protein levels than the other varieties (except for Dart[A] at 60 plants/m target population) most other varieties.

Screenings

Screenings ranged from 3 to 9%. There were no differences in screening between the highest and lowest target populations of each variety.

Screenings for Kittyhawk[A] and Lancer[A] were >5%, while for Suntop[A] and Dart[A] all screenings were >5%. Dart A had the highest screenins of any variety (**Figure 5**).

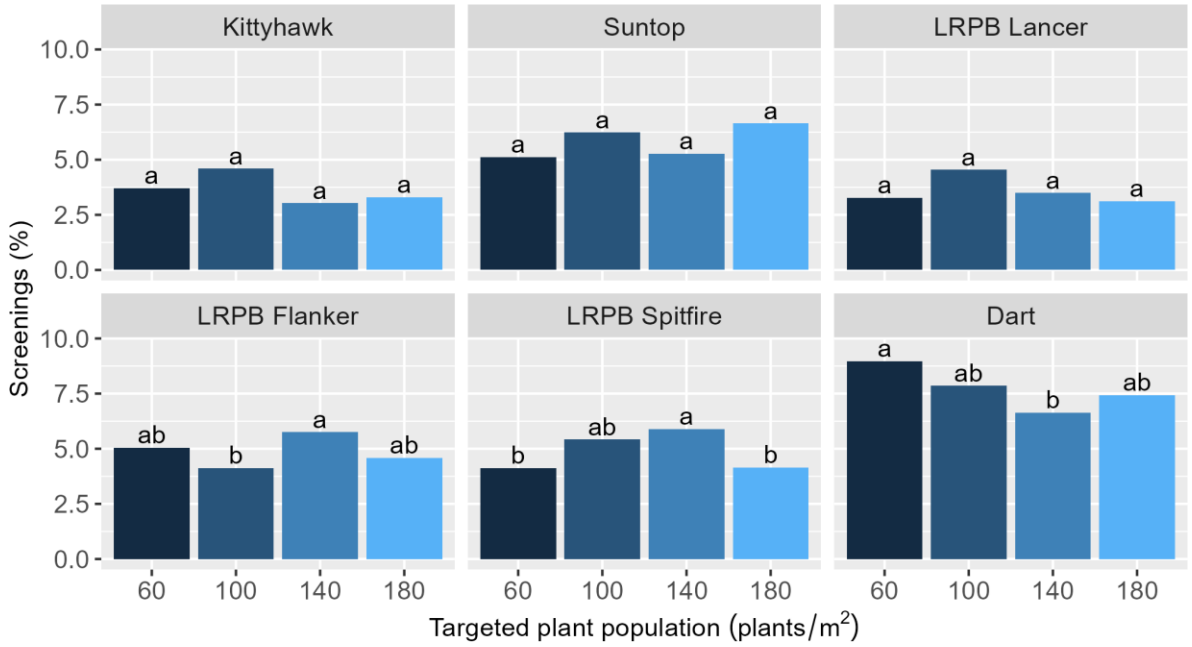

Figure 5. Screenings x variety and sowing rates. Treatments within (but not between) a variety with the same letter are not significantly different.

Discussion

This trial was sown in July, outside the recommended window for all included varieties. It was sown into a short fallow paddock into a dry profile. Rainfall was also well below average. According to the nearest BOM weather station at Burcher prior to sowing approximately 109 mm fell in the fallow (and about half of this prior to Christmas). In-crop rainfall was approximately 140 mm. This is well down on average of 450 mm.

The calculated sowing rates resulted in close to target plant populations, 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. The seeding efficiency was reduced with each increase in targeted plant population, as such these results confirm that the use of a 'factor' that increases sowing rates to achieve increasing target plant populations is necessary.

Sowing rate did not increase in yields for any of the varieties, except for Spitfire[A]. Using VI as a proxy for plant biomass, increasing plant populations increased biomass, however the limitation of a dry finish did not allow the conversion of this to grain. Yields were not supressed due to haying off.

Switching to a shorter season variety, such as Spitfire or Dart, had no yield advantage over the longer season varieties, and in most cases this decision cost yield, i.e. swapping from Suntop[A], Flanker[A], Suntop[A] or Kittyhawk[A] to Dart[A].

The 2018 year was dryer than average. The assumption that yield would be limited in the longer season varieties because of the reduced opportunity time for tillering was not confirmed, likely due to the dry starting conditions and the warmer and dryer than usual spring. The decision to change variety or increase the plant population could perhaps be guided by the prevailing conditions, if the soil profile is relatively dry and the forecast is for below average rainfall then there may be very little benefit in changing varieties or increasing the seeding rate. If the spring had average or above rainfall, the results may have been very different and should be tested.

Grain Quality

Increasing the targeted plant populations didn't have much effect on grain quality (protein and screenings), and while there were some differences between the varieties this is not all that unexpected.

Economics

Using a simple economic analysis comparing yield and grain quality changes and taking in seed costs, showed profit was not improved by increasing the targeted plant population nor changing to a quicker variety. There was a stronger economic argument against increasing the targeted population. Increasing the targeted plant population of Suntop[A] from 60 to 100 plants/m^2 reduced the gross income by $33/ha (~30%). The economic benefits of swapping to a shorter reason variety were also weak, for example swapping from Suntop[A] to Spitfire[A] gave no financial benefit and swapping from Suntop[A] to Dart[A] (at 60 plants/m^2 target population) reduced the gross income by $52/ha (~44%) .

Conclusion

Seeding efficiency is reduced at higher sowing rates. If targeting higher plant populations, it is advisable to compensate (using a factor) to achieve the desired plant stand.

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

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

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

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

Bibliography

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

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Appendix: Results and statistical data

Variety	Target plant population	Plant establishment counts			Vegetation index			Protein			Screenings			Yield		
	(plants/m2)	(plants/m2)			(ndvi)			(%)			(%)			(t/ha)		
			S1	S2		S1	S2		S1	S2		S1	S2		S1	S2
60	Dart	35	i	c	0.17	j	c	15.8	cd	a	9.0	a	a	0.38	ef	a
100	Dart	49	hi	c	0.18	ij	bc	15.5	de	ab	7.8	ab	ab	0.34	f	a
140	Dart	88	f	c	0.20	ghi	ab	15.1	ef	b	6.6	bcd	b	0.41	def	a
180	Dart	127	de	b	0.22	efgh	a	15.1	def	ab	7.4	abc	ab	0.46	cdef	a
60	Flanker	49	hi	d	0.20	ghi	b	14.4	fgh	ab	5.1	defghi	ab	0.59	abcd	a
100	Flanker	84	fg	c	0.22	fgh	ab	13.9	hi	b	4.1	ghij	b	0.67	ab	a
140	Flanker	146	cd	b	0.24	def	a	13.9	hi	b	5.8	def	a	0.61	abc	a
180	Flanker	172	b	a	0.25	cdef	a	14.6	fg	a	4.6	efghij	ab	0.51	abcdef	a
60	Kittyhawk	60	h	d	0.22	efgh	c	14.0	ghi	ab	3.7	hij	a	0.53	abcdef	ab
100	Kittyhawk	88	f	b	0.25	def	c	13.5	i	b	4.6	efghij	a	0.46	cdef	b
140	Kittyhawk	129	de	b	0.30	b	b	14.0	ghi	ab	3.0	j	a	0.59	abcd	ab
180	Kittyhawk	163	bc	a	0.38	a	a	14.7	fg	a	3.3	j	a	0.67	ab	a
60	Lancer	45	hi	d	0.20	ghi	c	15.6	de	a	3.3	j	a	0.56	abcde	a
100	Lancer	85	fg	c	0.24	def	b	15.7	de	a	4.5	efghij	a	0.59	abcd	a
140	Lancer	119	e	b	0.26	cd	b	15.4	de	a	3.5	ij	a	0.55	abcde	a
180	Lancer	182	b	a	0.30	b	a	15.6	de	a	3.1	j	a	0.58	abcd	a
60	Spitfire	64	gh	d	0.22	efgh	b	16.5	ab	ab	4.1	ghij	b	0.48	bcdef	b
100	Spitfire	88	f	c	0.25	cde	b	16.6	ab	ab	5.4	defg	ab	0.64	abc	ab
140	Spitfire	142	cd	b	0.31	b	a	16.4	bc	b	5.9	cde	a	0.71	a	a
180	Spitfire	230	a	a	0.30	b	a	17.2	a	a	4.2	fghij	b	0.56	abcde	ab
60	Suntop	45	hi	d	0.20	hij	c	14.3	gh	a	5.1	defgh	a	0.58	abcd	a
100	Suntop	91	f	c	0.23	efg	b	14.3	gh	a	6.2	bcd	a	0.53	abcdef	a
140	Suntop	127	de	a	0.24	def	b	14.4	fgh	a	5.3	defgh	a	0.54	abcdef	a
180	Suntop	170	b	a	0.28	bc	a	14.2	gh	a	6.7	bcd	a	0.57	abcde	a
	lsd	22			0.03			0.71			1.65			0.20		

- 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.