

Density and nitrogen timing effects on productivity of early sown wheat in Western Australia

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Key messages

Four field trials in 2018 assessed the influence of plant density, nitrogen timing and grazing on yield and quality of three long maturing wheat varieties sown early April in Western Australia.

- Based on yield, Forrest and Longsword wheat varieties are more suitable for the early sowing opportunities in April than growing a mid winter (ie EGA Wedgetail) earlier.
- If there are establishment issues sowing in early April, there is generally no penalty if establishment is down to 50 plants/m². Some varietal specific responses were observed although these responses were also driven by nitrogen timing.
- For early April sown crops, delaying nitrogen application until stem elongation improved yields at Esperance, Katanning and Yuna.
- Grazing did reduce yields by up to 0.9t/ha depending on environment and variety choice, but could be achieved with minimal yield loss for some varieties and environments.

Aims

To test the following hypotheses:

1. Low plant density will not reduce yield of early April sown wheat
2. Delayed nitrogen application will not affect grain yield
3. Agronomy can offset yield reductions from grazing wheat sown in early April

Background

Early April sowing in Western Australia can provide opportunities for grazing and grain production. However to put this research in context, sowing crops early needs to be matched with rainfall and temperature so that maximum growth can be attained. Winter wheats have a vernalisation requirement that will delay stem elongation and head development until conditions are favourable. Grazing during tillering can delay stem elongation and flowering time and grazing after stem elongation can reduce head numbers and grain yield. These experiments evaluate how low plant density, timing of nitrogen application and grazing can affect the yield of winter and long maturing spring wheats in Western Australia.

Method

The effects of plant density, nitrogen timing, and grazing on the yield and grain quality of three long maturing wheat varieties was assessed in four experiments sown between the 10th and 13th April 2018. The experiments were located at Yuna, Muresk, Katanning and Gibson in Western Australia. The varieties tested were EGA Wedgetail^A, Forrest^A and Longsword^A (Table 1).

Table 1: Characteristics of wheat varieties included in the 2018 trials.

Variety	Classification	Maturity	Maturity traits		
			Vernalisation	Photoperiod	BVP
Forrest ^A	ASW	Long spring	Nil	Very high	High
Longsword ^A	Feed	Fast winter	High	Nil	High
EGA Wedgetail ^A	APW	Mid winter	High	Nil	Very high

There was stored moisture from summer rains (Table 2) however due to dry conditions at seeding and to ensure that germination occurred shortly after seeding, 20mm of water was applied prior to or immediately following seeding via a mobile irrigator at all locations except Gibson. At both Yuna and Muresk the irrigation was applied the day prior to seeding in a one-pass operation. 6mm applied prior to and after seeding supplying a total of 12mm.

Table 2: Rainfall (mm) for the four trial sites recorded at closest DPIRD weather stations in 2018.

SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	RAIN (JAN-MAR)	RAIN (APR-OCT)
Yuna	73	21	5	11	44	38	88	55	6	13	99	275*
Muresk	89	11	1	7	47	53	98	91	9	31	102	355*
Katanning	37	10	17	16	16	48	55	45	10	28	64	238*
Gibson	5	117	26	3	23	47	47	139	48	26	148	333

*: April rain does not include irrigation at seeding but irrigation included in the GSR

The experiments consisted of small plots (10-12m long x 1.54m wide) sown in three or six banks, with three replicates per treatment. All trials were sown into canola stubble and all experiments received approximately 11N, 12K, 11P and 7S (treated with Uniform® except Yuna for which 25K was top-dressed in place of banded K) banded below the seed which was treated with Emerge®. Plant density treatments targeted an establishment of either 50 or 150 plants/m². At the low density, 41 - 60 plants/m² was achieved. At the higher density, 150 plants/m² was achieved at Katanning and Gibson but only 100plants/m² was achieved at Muresk and Yuna. Nitrogen treatments (200kg/ha urea, 46% N) were top-dressed at seeding or at Z31 for each variety. The grazed treatments were a mechanical treatment with a rotating string 'whipper snipper' to 10cm plant height before Z30 at Muresk, Katanning and Gibson and at Z31 at Yuna (Table 3).

Table 3 Date of grazing and post emergence nitrogen application (200kg/ha Urea)

Location	Date of grazing			Date of post em. N (200kg/ha urea)		
	Forrest	Longsword	EGA Wedgetail	Forrest	Longsword	EGA Wedgetail
Yuna	5-Jun	20-Jun	10-Jul	5-Jun	20-Jun	10-Jul
Muresk	7-Jun	15-Jun	29-Jun	13-Jun	19-Jun	14-Aug
Katanning	1-Jun	29-Jun	5-Jul	8-Jun	5-Jul	10-Jul
Gibson	31-May	29-Jun	11-Jul	7-Jun	11-Jul	20-Jul

Results

Variety and grazing influenced wheat grain yield at each of the four locations in Western Australia (Table 4). There was a variety by nitrogen interactions at three of the four locations.

Table 4 Significance of variety, plant density at seeding, nitrogen timing and grazing on grain yield at four locations in 2018.**

FACTOR	YUNA	MURESK	KATANNING	GIBSON
Variety	<0.001	<0.001	<0.001	<0.001
Density	n.s.	n.s.	0.05	n.s.
Nitrogen	n.s.	n.s.	<0.001	0.01
Grazing	<0.001	<0.001	0.005	<0.001
Variety.Density	0.01	n.s.	n.s.	n.s.
Variety.Nitrogen	<0.001	0.05	<0.001	n.s.
Variety.Grazing	n.s.	0.05	n.s.	0.01
Density.Grazing	n.s.	0.05	n.s.	n.s.
Variety.Density.Nitrogen	0.05	n.s.	n.s.	n.s.

** treatment interactions with not significant difference at any site have been removed from the table.

Variety choice

At Yuna, the mid maturing winter wheat, EGA Wedgetail, had a significantly lower yield than Longsword (winter wheat) and Forrest (a long spring wheat) (Table 5). Variety choice along with sowing time are important factors to reduce frost risk in Katanning which had the lowest rainfall (238mm) of all sites. Longsword, was the lowest yielding wheat variety (0.56t/ha) at Katanning due to frost in September. At Muresk and Gibson, Longsword was the highest yielding variety, followed by EGA Wedgetail and then Forrest at Muresk; and Forrest then EGA Wedgetail at Gibson. Based on yield, Forrest and Longsword will be more suitable for the early sowing opportunities while EGA Wedgetail will produce lower yields but has flowering later than Longsword when considering frost as a risk to production.

Table 5 Main effect of variety (un-grazed) on grain yields* (t/ha) at four locations in 2018

Location	YIELD (t/ha)			LSD
	Forrest	Longsword	EGA Wedgetail	
Yuna	3.06	3.17	2.35	0.12
Muresk	3.48	4.38	3.90	0.17
Katanning	2.02	0.56	2.10	0.14
Gibson	4.81	5.05	4.32	0.21

*: Grain yield average of density and nitrogen treatment

Will low plant densities affect production of early sown wheat

Plant density did not influence the yield of wheat sown in early April at Muresk or Esperance (Figure 1). At Katanning, yields were low due to frost and low rainfall, and there was a small but significant decline in yield at the higher plant density. At Yuna there was a variety by density by nitrogen interaction on yield. Forrest's yields were lowest at the low density and when nitrogen was applied at seeding (averaged for grazing) (Figure 1 and 2). In contrast, EGA Wedgetail's yields were the highest at the same density and nitrogen combination.

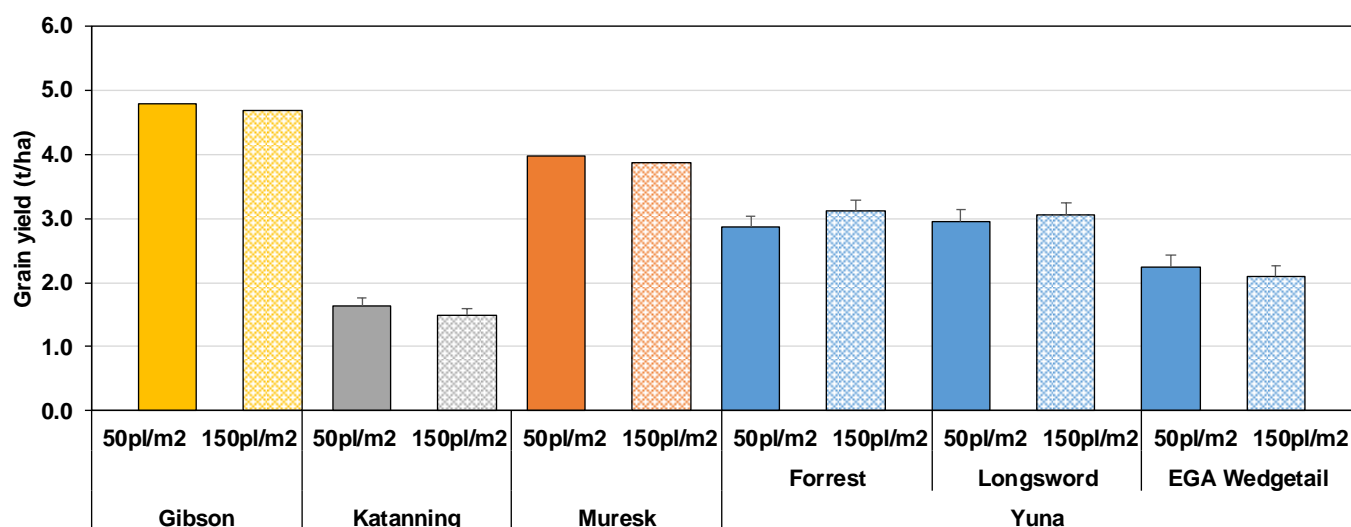


Figure 1 Effect of plant density on grain yield of wheat varieties at three locations in 2018

Will delayed nitrogen application affect production and quality of early sown wheat crops

There were interactions between variety and nitrogen timing on grain yield at three of the four locations. At Yuna, there was a yield improvement with delayed nitrogen on Forrest and Longsword wheats, but not for EGA Wedgetail with nitrogen applied in late July (Figure 2). At Muresk, delayed nitrogen did not affect the yield of Forrest, increased the yield of Longsword and decreased the yield of EGA Wedgetail. A possible potassium or sulphur deficiency observed in-crop could have been a result of high rainfall and a soil pH of 4.6 at 10-20cm leading to leaching or reduced uptake. The in-crop application of sulphate of potash in August may not have been effective at improving uptake of the nitrogen for some varieties, particularly EGA Wedgetail due to the timing of nitrogen application. At Katanning, EGA Wedgetail and Forrest yields increased with the delayed nitrogen application. Longsword was frosted and there was no difference in the yield. At Esperance, yields (averaged for variety, density and grazing) improved with the delayed nitrogen until stem elongation (Figure 2). For early April sown crops, delaying nitrogen application until stem elongation is a strategy that improved yields at Esperance, Katanning and Yuna (except the frosted Longsword at Katanning or EGA Wedgetail at Yuna). Additional benefits in delaying N are probable increases in grain protein, and a better ability to match N inputs with the season's potential.

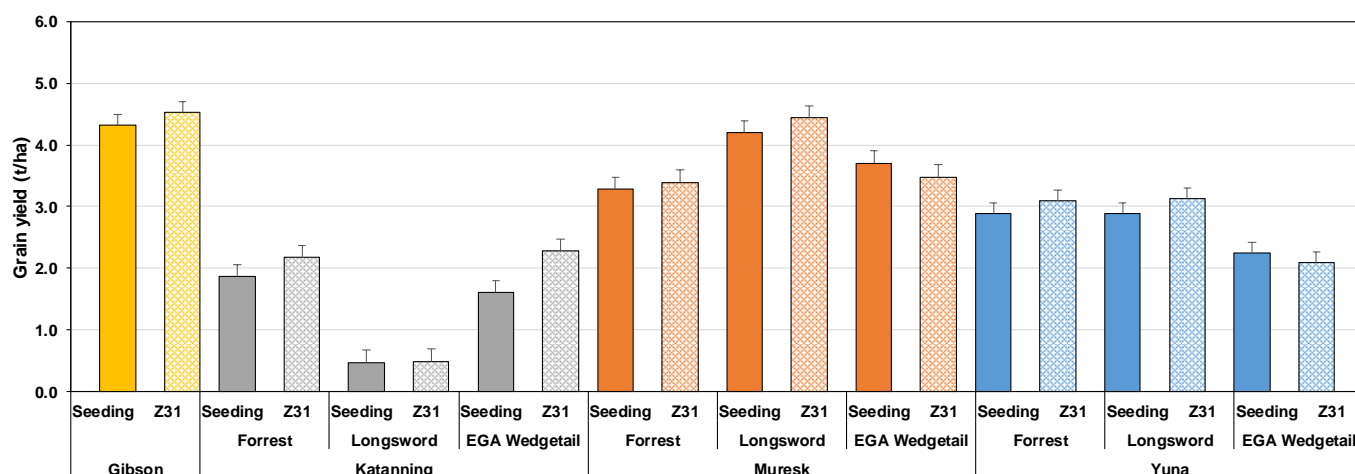


Figure 2 Effect of nitrogen timing on wheat variety yields at four locations

Can agronomy offset yield reductions from grazing wheat sown in early April

April sowing can provide a grazing opportunity in mixed farming systems. EGA Wedgetail produce more dry matter by stem elongation than the other varieties at each locations (Table 6). The treatments were sampled at stem elongation and the trend was for an increase in biomass when nitrogen was applied at seeding for EGA Wedgetail at Yuna and Gibson, and Longsword at Gibson (Table 6). Biomass at stem elongation did not differ for the other varieties.

Table 6 Dry matter (kg/ha) at stem elongation of the wheat varieties prior to grazing at different plant densities and nitrogen application

		DRY MATTER (kg/ha)					
Location		Yuna		Muresk*		Gibson*	
Variety	Urea applied (200kg/ha) Density plants/m ²	50 pl/m ²	150 pl/m ²	50 pl/m ²	150 pl/m ²	50 pl/m ²	150 pl/m ²
Forrest	At Seeding	283	302	222	512	412	399
	Nil urea at sampling	219	311	376	430	357	441
Longsword	Seeding	753	703	782	1114	1946	1734
	Nil urea at sampling	597	767	813	791	929	1217
EGA Wedgetail	Seeding	1977	1859	1019	1399	2485	2007
	Nil urea at sampling	1254	1616	892	1252	1608	1231
LSD (V x density x N)		93	12.8%CV				

* Data not analysed at time of print.

Varieties responded differently to grazing at Muresk and Esperance. At Esperance, Longsword and EGA Wedgetail yields declined significantly (0.73t/ha and 0.89 t/ha respectively) following grazing, but grazing did not affect the yield of Forrest (Figure 3). At Muresk EGA Wedgetail and Forrest yields declined by 0.62t/ha and 0.28t/ha respectively following grazing but grazing did not significantly affect Longsword yields (Figure 3).

There was no variety by grazing interaction on yield at Katanning and Yuna. However, the main effect of grazing at Z31 was a yield reduction of 0.29t/ha to 2.57t/ha at Yuna (average for variety, nitrogen and density). At Katanning the main effect of grazing was a yield reduction of 0.16t/ha to 1.4t/ha when grazing occurred before stem elongation, however the frost occurred at the site which influenced yields of Longsword.

Higher densities did offset yield reductions from grazing at Muresk but not the other locations. A low plant densities (averaged across variety and nitrogen treatment), yields declined by 0.5t/ha from 3.98t/ha in the un-grazed treatment to 3.48t/ha in the grazed treatment. In comparison, at high plant density, yields declined by 0.19t/ha from 3.86t/ha in the un-grazed treatments to 3.67t/ha in the grazed treatments.

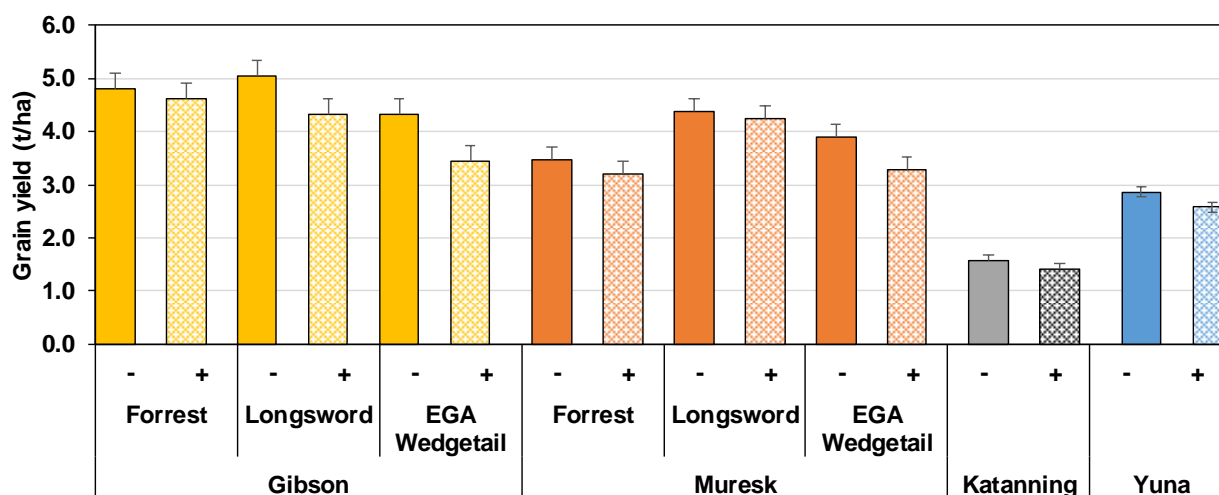


Figure 3 Effect of grazing (-:ungrazed and +: grazed) on grain yield of wheat varieties sown in 2018.

Conclusion

Some growers seed wheat in early April following late March and early April rainfall events. There can be risks of crop failure if moisture and heat stress affects establishment and growth or weeds are not adequately controlled. Research into early April sowing opportunities in Western Australia have focused on variety selection. There is still a need for high yielding wheat varieties for early sowing and sowing wheat at the right time is one of the most important means of maximising grain yield (Shackley et al 2019, Hunt et al 2015). However early sowing with a low cost agronomy package could provide an opportunity to increase production however rotation choices, weed management and erosion risks need to be considered. Studies assessing grazing in Western Australia have focused on the southern districts with May sown crops (Curtis and Whissen 2014).

Four field trials in 2018 assessed the influence of plant density, nitrogen timing and grazing, on the yield and quality of three long maturing wheat varieties sown in the 2nd week of April 2018. The experiments were located at Yuna, Muresk, Katanning and Gibson. This research follows on from similar studies on the east coast (led by Dr James Hunt, La Trobe University). Based on yield, Forrest and Longsword wheat varieties are more suitable for the early sowing opportunities in April than growing a mid winter (ie EGA Wedgetail) earlier. If there are establishment issues sowing in early April, there is generally no penalty if establishment is down to 50 plants/m². Some varietal specific responses were observed although these responses were also driven by nitrogen timing. For early April sown crops, delaying nitrogen application until stem elongation improved yields at Esperance, Katanning and Yuna. Grazing did reduce yields by up to 0.9t/ha depending on environment and variety choice, but could be achieved with minimal yield loss for some varieties and environments. Appropriate variety choice for the environment is more important than the plant density or nitrogen timing strategies tested.

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Key words

Early sowing, agronomy, wheat varieties

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