Effect of sowing date on grain yield, water-use efficiency and grain quality of wheat – Canowindra 2015

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Key findings

- The variety Beckom sown on 5 May yielded highest (5.67 t/ha).
- Grain yield reductions up to 4 t/ha occurred when varieties were not sown at the correct time (due to flowering throughout August–September frost events).
- Greatest yield losses occurred when quick maturing varieties were sown early rather than longer season varieties sown late.
- Winter wheats and very long spring wheats performed better in 2015 than 2014, presumably due to less early aphid pressure (BYDV) in 2015.
- Grain yield was maximised when winter wheats were sown early (mid-April) or mid to mid–fast varieties were sown in the first week of May. If spring conditions had been favourable, the winter wheats may have outperformed the mid to mid–fast varieties when sown in late May.
- Screenings increased as sowing was delayed.

Introduction

Recent research and crop modelling (Hunt et al. 2013) identified potential grain yield advantages from sowing slower maturing wheat varieties with either strong vernalisation (winter wheats) or strong photoperiod requirement in early- to mid-April when seasonal conditions allow.

This experiment evaluated the performance of recently released wheat varieties in response to various times of sowing. The wheat varieties evaluated ranged from long season winter wheats to very fast spring wheats.

Site details

Location	"The Pines" Canowindra NSW
Soil type	Red chromosol
Previous crop	Canola
Stubble management	Stubble incorporated with Kelly chain prior to sowing
Harvest date	24 November 2015
Fertiliser	20 kg P/ha banded at sowing 80 kg N/ha applied at 2–3 leaf stage
Soil pH_{Ca}	6.4
Colwell P (mg/kg)	29
Mineral N at sowing (1.2 m depth)	176 kg N/ha
Fungicide	Flutriafol-treated fertiliser (400 mL/ha) Prosaro® applied at flag leaf emergence (GS39)
Starting soil moisture[a]	157 mm (plant available water)
In-crop rainfall (April–October)	316 mm (only 6 mm in September)
Frost events (late August–October) 20 events	21/8, 30/8, 31/8, 1/9, 2/9, 6/9, 8/9, 9/9, 16/9, 17/9, 18/9, 19/9, 23/9, 24/9, 25/9, 26/9, 27/9, 28/9, 29/9, 2/10

[a] Gravimetric moisture measured via five soil cores

Treatments

Thirty-six wheat varieties were sown at three sowing dates: 17 April, 5 May and 25 May 2015 (Table 1).

Table 1. Wheat varieties, maturity type and recommended sowing window for central-eastern NSW.

Maturity type	Suggested sowing window	Varieties
Winter wheat	Late Feb to late April	Naparoo$^{\Phi}$, EGA_Wedgetail$^{\Phi}$, LPB11-0140
Very slow	Early to mid-late April	Eaglehawk$^{\Phi}$, Sunlamb$^{\Phi}$
Slow	Mid-April to early May	Bolac$^{\Phi}$, Lancer$^{\Phi}$, Suntime$^{\Phi}$, Kiora$^{\Phi}$
Mid	Late April to mid-May	EGA_Gregory$^{\Phi}$, Flanker$^{\Phi}$, Gauntlet$^{\Phi}$, Sunvale$^{\Phi}$, Viking$^{\Phi}$, Mitch$^{\Phi}$, Trojan$^{\Phi}$, HRZ08-0062
Mid–fast	Early May to mid-May	Elmore CL PLUS$^{\Phi}$, Sunguard$^{\Phi}$, Suntop$^{\Phi}$, HRZ03-0056, Beckom$^{\Phi}$, Janz, Harper$^{\Phi}$, LPB09-0358, Cosmick$^{\Phi}$
Fast	Mid-May onwards	Corack$^{\Phi}$, Emu Rock$^{\Phi}$, Livingston$^{\Phi}$, Mace$^{\Phi}$, Merlin$^{\Phi}$, Spitfire$^{\Phi}$, Sunmate, Dart$^{\Phi}$, Condo$^{\Phi}$, LPB10-0018

Table 2. Grain yield and rank of 36 wheat varieties sown at three sowing dates at Canowindra, 2015.

Variety	Grade (South)	Maturity group	Grain yield (t/ha) and rank					
			17 April		5 May		25 May	
EGA_Wedgetail	APH	Winter wheat	5.52	2	4.82	19	3.31	35
LPB11-0140		Winter wheat	5.54	1	4.66	26	3.85	24
Naparoo	FEED	Winter wheat	5.19	4	4.41	30	3.53	32
EGA_Eaglehawk	APH	Very slow	5.41	3	4.65	27	3.49	33
Sunlamb	ASW	Very slow	5.06	5	4.70	24	2.85	36
Bolac	APH	Slow	4.78	6	4.55	28	4.02	18
HRZ08-0062		Slow	3.72	11	5.24	5	3.34	34
Kiora	AH	Slow	4.51	7	5.00	11	3.74	28
Lancer	APH	Slow	4.14	10	5.12	7	3.61	29
Suntime		Slow	4.36	8	4.72	22	3.61	30
Cosmick		Mid	1.93	23	4.68	25	4.21	15
EGA_Gregory	AH	Mid	3.05	13	5.09	8	4.26	13
Gauntlet	AH	Mid	1.41	29	5.05	9	3.89	23
Flanker	APH	Mid	2.19	21	5.29	4	4.45	7
Mitch	APW	Mid	2.81	16	4.77	21	3.79	26
Sunvale	APH	Mid	4.22	9	4.91	16	3.54	31
Trojan	APW	Mid	3.06	12	5.61	2	4.39	8
Viking	APH	Mid	2.40	19	5.22	6	4.30	11
Elmore CL PLUS	AH	Mid–fast	2.14	22	4.95	13	4.45	6
Harper		Mid–fast	2.87	14	4.95	14	4.24	14
HRZ03-0056		Mid–fast	1.33	30	5.31	3	4.32	10
Janz	APH	Mid–fast	2.22	20	4.77	20	3.94	20
LPB09-0358		Mid–fast	2.67	18	5.03	10	4.27	12
Sunguard	AH	Mid–fast	2.79	17	4.86	18	3.95	19
Suntop	APH	Mid–fast	2.83	15	4.98	12	4.36	9
Beckom	AH	Mid–fast	1.52	27	5.67	1	4.54	4
Condo	AH	Fast	1.55	26	4.94	15	3.56	3
Corack	APW	Fast	0.75	35	4.71	23	4.81	1
Dart	AH	Fast	1.68	24	3.76	35	3.80	25
Emu Rock	AH	Fast	1.64	25	3.88	34	3.94	21
Livingston	AH	Fast	0.58	36	4.05	32	4.20	16
LPB10-0018		Fast	0.90	31	4.35	31	4.51	5
Mace	AH	Fast	0.81	33	4.45	29	4.68	2
Merlin	AH	Fast	0.77	34	3.58	36	3.93	22
Spitfire	APH	Fast	0.87	32	3.89	33	3.77	27
Sunmate	AH	Fast	1.42	28	4.86	17	4.14	17
		Min	0.58		3.58		2.85	
		Mean	2.74		4.76		4.02	
		Max	5.54		5.67		4.81	
l.s.d.(P=0.05)	Sowing date = 0.14; variety = 0.25; sowing date × variety = 0.44							

Results

The 2015 season had ideal soil moisture levels in autumn to germinate and establish all wheat varieties across all three sowing dates. The winter had above average rainfall during July and August providing good conditions for crop growth but spring was dry and hot with only 6 mm of rainfall during the critical period leading up to anthesis/grain fill (September). This resulted in grain yield reductions across the entire trial site. Late rainfall events occurred in mid-October which would have benefited the longer season varieties sown in late May.

Table 3. Grain quality results including protein (%), test weight (kg/hL) and screenings (%) of 36 wheat varieties sown at three sowing dates at Canowindra, 2015.

Variety	TOS 1 – 17 April			TOS 2 – 5 May			TOS 3 – 25 May		
	Protein (%)	Test weight (kg/hL)	Screenings (%)	Protein (%)	Test weight (kg/hL)	Screenings (%)	Protein (%)	Test weight (kg/hL)	Screenings (%)
Bolac	13.1	74.6	8.2	13.0	74.6	12.0	13.7	77.8	10.7
Condo	15.3	77.8	7.2	12.6	77.2	8.1	12.9	76.9	7.4
Corack	16.0	77.6	2.0	13.4	77.8	3.2	12.2	76.0	5.9
Cosmick	13.2	74.8	5.4	12.4	73.7	9.1	13.2	73.2	14.0
Dart	16.0	79.4	4.8	13.9	77.9	4.3	13.3	77.1	8.6
EGA_Eaglehawk	11.7	76.5	9.7	13.3	77.9	6.8	13.9	79.8	5.6
EGA_Gregory	13.1	77.9	3.7	12.5	76.8	7.3	12.9	77.4	9.0
EGA_Wedgetail	12.6	71.2	4.8	13.5	72.5	7.2	13.8	74.5	4.1
Elmore CL PLUS	14.7	79.6	3.5	12.7	77.0	6.1	13.6	77.1	12.5
Emu Rock	16.1	77.3	3.5	14.1	77.3	5.2	13.1	75.4	5.8
Gauntlet	14.7	78.5	4.1	12.9	77.9	9.0	12.7	80.7	4.1
Harper	13.9	77.1	4.6	13.6	76.5	8.1	13.2	76.0	8.5
HRZ03-0056	14.9	76.3	4.0	12.5	75.5	4.7	12.6	76.9	6.1
HRZ08-0062	13.3	77.3	4.3	12.6	74.6	6.2	13.5	78.6	6.9
Janz	14.0	78.9	2.6	13.0	75.5	7.1	13.3	78.3	8.1
Kiora	13.1	78.3	4.7	13.1	75.0	11.1	13.4	78.3	11.2
Lancer	13.5	76.2	3.3	13.0	77.1	4.7	14.3	79.2	5.3
Livingston	16.4	76.1	4.5	13.7	77.0	6.5	13.6	75.4	10.7
LPB09-0358	14.7	77.3	4.2	12.8	75.8	4.5	12.8	75.7	7.5
LPB10-0018	15.4	77.6	3.6	12.9	77.5	5.6	12.6	77.0	10.4
LPB10-2555	14.1	78.2	3.7	12.2	76.8	7.9	12.7	77.8	10.8
LPB11-0140	11.9	77.4	7.7	12.9	76.9	6.0	13.1	78.4	7.2
Mace	15.8	76.6	2.6	12.8	77.2	4.1	11.9	76.3	7.2
Merlin	17.0	77.2	2.4	14.7	79.7	3.6	13.9	78.4	7.2
Mitch	13.0	75.7	4.1	11.9	73.7	6.6	12.7	75.8	9.4
Naparoo	12.2	74.2	12.0	12.7	75.5	11.1	13.3	77.2	8.7
Spitfire	17.2	77.6	4.0	14.8	80.2	3.9	13.6	79.0	5.3
Sun512C	12.6	75.4	9.7	13.4	77.7	10.6	15.1	78.5	7.1
Sunguard	13.7	76.8	5.9	12.4	76.2	6.7	13.1	76.5	8.1
Sunmate	14.6	76.8	4.2	12.1	74.7	6.6	13.1	76.5	6.2
Suntime	13.2	75.8	7.4	12.6	76.4	9.5	13.2	79.5	7.2
Suntop	13.9	76.6	5.4	12.3	75.7	7.1	12.2	78.2	10.4
Sunvale	13.2	79.3	3.5	13.6	76.9	7.3	14.0	78.4	8.5
Trojan	13.5	78.1	3.7	12.3	76.9	4.7	13.0	78.8	7.3
V06008-14	14.3	77.9	3.7	11.9	74.8	6.4	12.7	75.3	12.8
Viking	14.1	79.0	3.7	12.5	76.3	9.4	12.8	79.8	11.5
Min	11.7	71.2	2.0	11.9	72.5	3.2	11.9	73.2	4.1
Mean	14.2	77.0	4.9	13.0	76.4	6.9	13.2	77.4	8.3
Max	17.2	79.6	12.0	14.8	80.2	12.0	15.1	80.7	14.0
l.s.d. (P=0.05)									
TOS	0.4	0.7	1.4						
Variety	0.4	1.1	2.0						
Variety × TOS	0.7	2.0	3.5						

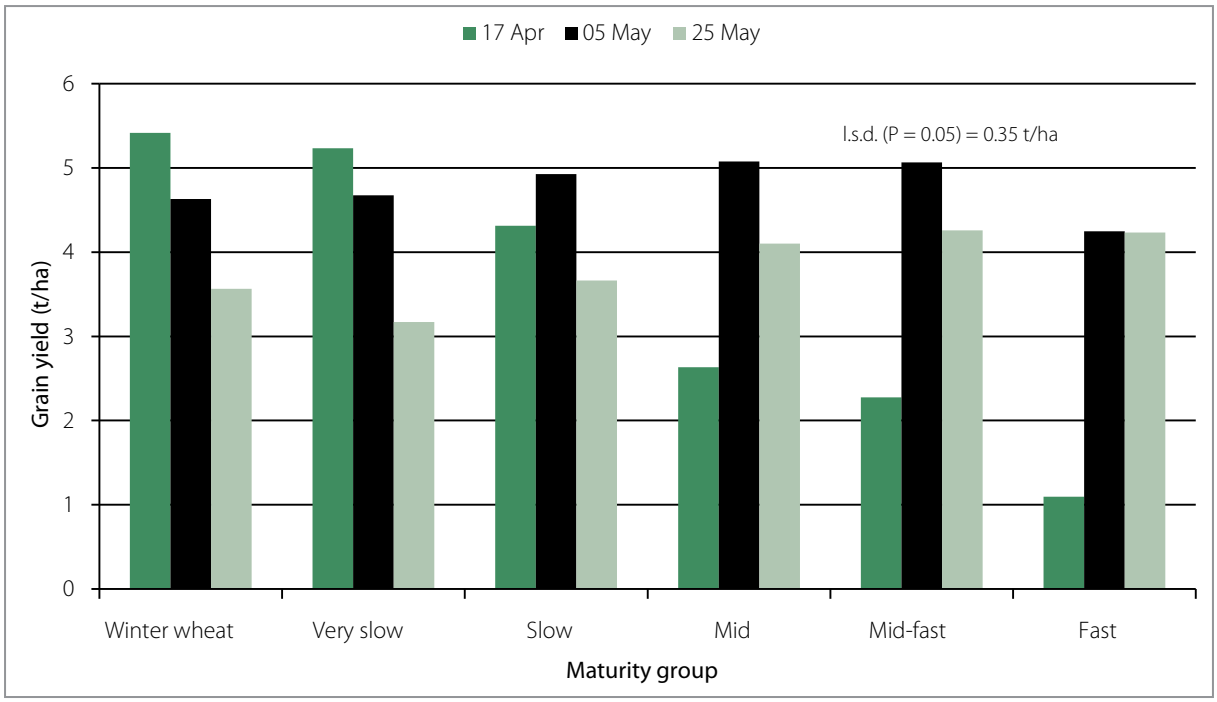

Figure 1. Average grain yield of various maturity groups sown at three sowing dates at Canowindra, 2015.

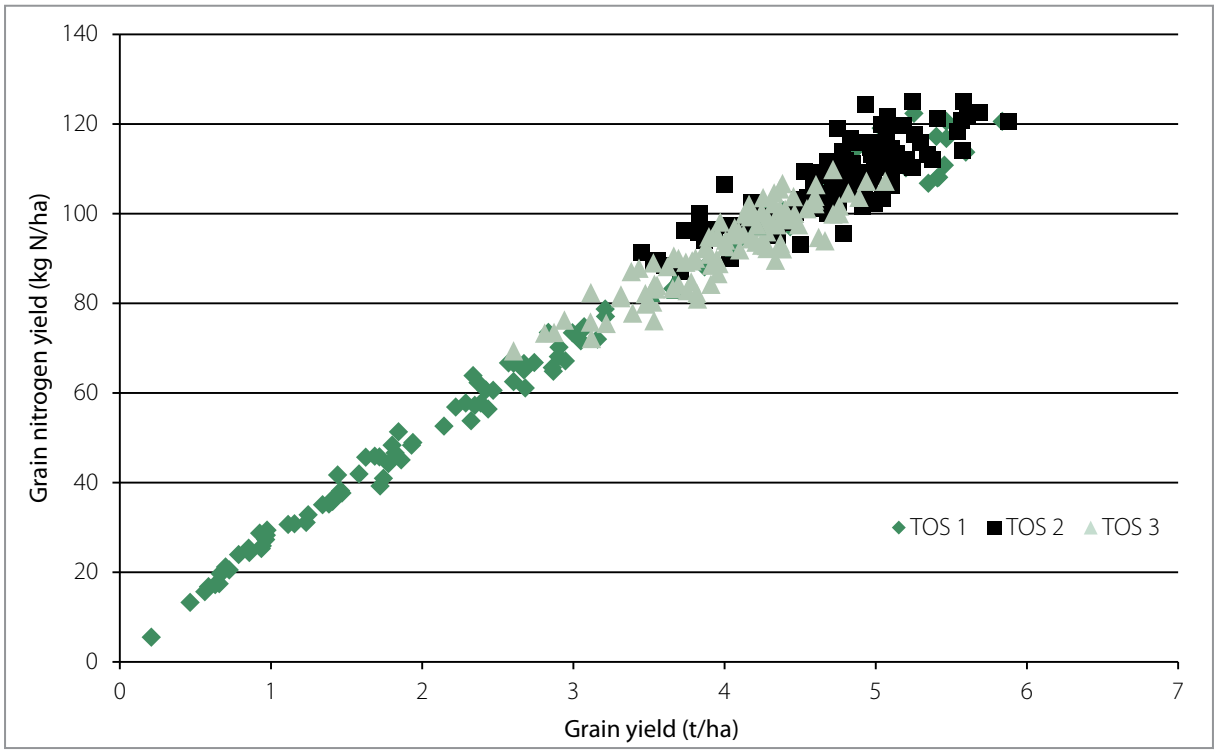

Figure 2. Relationship between grain yield and grain nitrogen yield across three sowing dates at Canowindra, 2015.

Grain yield

Wheat grain yield was significantly affected by time of sowing ($P<0.001$), variety ($P<0.001$) and the interaction between sowing time and variety ($P<0.001$). The interaction between sowing time and phenology type was also significant ($P<0.001$).

When averaged over all 36 varieties, grain yield was significantly higher when sown on 5 May (4.76 t/ha) compared to either 17 April (2.74 t/ha) or 25 May (4.02 t/ha). The highest yielding variety was Beckom (5.67 t/ha) sown on 5 May and the lowest was Livingston sown on 17 April (0.58 t/ha) (Table 2).

Varieties that performed well across all sowing dates (achieved above average yields in each time of sowing) were EGA_Gregory, Suntop and Trojan. These varieties ranged from mid- to mid–fast phenology types.

Winter wheats and the longer season spring varieties such as LPB11-0140, EGA_Wedgetail, EGA_Eaglehawk, Naparoo and Sunlamb performed well when sown early but poorly when sown late.

Conversely, fast to very fast maturing varieties performed poorly with early sowing but well with later sowing e.g. Corack, Mace, Condo, Beckom and LPB10-0140. These quicker maturing varieties, when sown in mid-April suffered major yield penalties due to reproductive frost damage caused by August/September frosts. Corack had a 4 t/ha grain yield reduction when sowing occured 18 days earlier (5 May compared to 17 April). Interestingly, this same trend occurred in 2014 (McMaster et al. 2015).

Grain yield was maximised by sowing a winter wheat early (mid-April) or a mid- to mid–fast maturing variety in the first week of May (Figure 1).

Grain quality (protein, test weight and screenings)

Grain protein was significantly affected by time of sowing ($P<0.002$), variety ($P<0.001$) and the interaction between sowing time and variety ($P<0.001$). Total nitrogen removal (yield × protein × 1.75) was correlated with grain yield (Figure 2).

Grain protein, test weight and screenings are found in Table 3. Due to the dry finish, screenings increased as sowing was delayed.

Summary

These results highlight that specialist varieties exist for specific sowing dates enabling grain yield to be maximised for a given sowing window. However, a specialist variety sown outside its window could result in large yield penalties as observed in this experiment and in the 2014 experiment.

The central-eastern region of NSW is characterised by high yield potential but grain yield reductions of up to 4.0 and 4.9 t/ha occurred in 2014 and 2015 experiments respectively when variety phenology and sowing time were not carefully matched. Highest grain yield losses occurred when quicker maturing varieties were sown early as they flowered during the frost prone period of late August and early September, resulting in severe reproductive frost damage.

Grain yield was maximised by sowing a winter wheat early (mid-April) or a mid to mid–fast variety in the first week of May. If the spring had been more favourable, the winter wheats may have out yielded the mid to mid–fast varieties.

References

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