Targeting maximum yields of irrigated wheat in southern NSW

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Key findings

- Correct varietal selection and optimal agronomic management can result in irrigated wheat yields of over 10 t/ha.
- LongReach Cobra$^{\phi}$, LongReach Trojan$^{\phi}$ and Beckom$^{\phi}$ were the highest yielding varieties.
- Delaying nitrogen fertiliser application by applying the greatest amount at booting was shown to improve grain protein concentration and reduce lodging compared with applying more nitrogen at sowing.
- A plant population of 120 plants/m^2 was shown to yield more than higher plant populations whilst also minimising lodging.

Introduction

High-yielding irrigated wheat production depends on appropriate varietal selection for a given environment and tactical agronomic management. Experimental results from the 'Southern irrigated cereal and canola varieties achieving target yields' project in 2014 and 2015 demonstrated that the appropriate combination of variety and agronomic management can result in grain yields of over 10 t/ha in the Murrumbidgee and Murray valleys. Nitrogen management and plant population were also shown to affect yield, grain quality and lodging in these earlier experiments.

The third year of experiments for this project was conducted in the winter growing season of 2016 and results are reported in this paper.

Site details

Site 1	Location	Coleambally
	Experimental design	Randomised complete block design Variety (12) × plant population (4) × 3 reps
	Sowing date	4 May 2016
	Irrigation schedule	No irrigation applied
	Rainfall	Autumn: 97 mm Winter: 191 mm Spring: 167 mm Total: 457 mm (4.6 ML/ha)
	Base fertiliser	MAP 200 kg/ha
	Herbicides	MCPA 1.25 L/ha Lontrel™ 70 mL/ha
	Fungicides	Orius® 150 mL/ha
	Harvest date	2 December 2016
Site 2	Location	Finley
	Experimental design	Randomised complete block design Variety (12) × nitrogen management (4) × 3 reps
	Sowing date	3 May 2016

Irrigation schedule	One spring irrigation (29 October 2016) Total 0.8 ML/ha
Rainfall	Autumn: 80 mm Winter: 189 mm Spring: 178 mm Total: 447 mm (4.5 ML/ha)
Base fertiliser	MAP 150 kg/ha
Herbicides	Boxer Gold 2.0 L/ha Axial 300 mL/ha + Adigor® 500 mL/100 L water LVE MCPA 1.8 L/ha
Fungicide	Prosaro® 200 mL/ha (two applications)
Harvest date	12 December 2016

Treatments

Irrigated wheat experiments were conducted in southern NSW at Coleambally in the Murrumbidgee Valley and Finley in the Murray Valley. The experiment at Coleambally evaluated the effect of variety and plant population on yield and grain quality (tables 1 and 2), whilst the Finley experiment evaluated the effect of variety and nitrogen (N) timing on yield and grain quality (tables 1 and 3).

Harvest was conducted using a Kingaroy small plot harvester. Subsamples of the harvested grain were used to measure grain quality including screenings, grain protein and test weight. Grain yield and protein content were calculated at 12% grain moisture. Lodging assessments were conducted using a score of 0–9 with 0 indicating no lodging and 9 indicating the plants were flat on the ground. Individual experiments were analysed with Genstat 18th edition (VSN International 2015) using a spatial model.

Table 1. Varieties evaluated in the irrigated wheat experiments at Coleambally and Finley in 2016.

Varieties	
Coleambally	**Finley**
Suntop$^{\Phi}$	Suntop$^{\Phi}$
Corack$^{\Phi}$	Corack$^{\Phi}$
LongReach Cobra$^{\Phi}$	LongReach Cobra$^{\Phi}$
Kiora$^{\Phi}$	Kiora$^{\Phi}$
Wallup$^{\Phi}$	Wallup$^{\Phi}$
Chara$^{\Phi}$	Chara$^{\Phi}$
280913 (durum line)	280913 (durum line)
LongReach Lancer$^{\Phi}$	LongReach Lancer$^{\Phi}$
EGA Bellaroi$^{\Phi}$	EGA Bellaroi$^{\Phi}$
LongReach Trojan$^{\Phi}$	LongReach Trojan$^{\Phi}$
Mace$^{\Phi}$	Beckom$^{\Phi}$
EGA Gregory$^{\Phi}$	DS Darwin$^{\Phi}$

Table 2. Plant populations evaluated in the irrigated wheat experiment at Coleambally in 2016.

Target plant population
Very low: 80 plants/m^2
Low: 120 plants/m^2
Medium: 160 plants/m^2
High: 200 plants/m^2

Table 3. Nitrogen timing treatments evaluated in the irrigated wheat experiment at Finley in 2016.

Nitrogen treatment	Base (kg N/ha)	First node (kg N/ha)	Booting (kg N/ha)	Total (kg N/ha)
Early N	145	100	0	245
Late N 1	45	150	50	245
Late N 2	45	100	100	245
Late N 3	45	50	150	245

Results

Grain yield

There were significant ($P = 0.05$) differences between varieties for grain yield in the Coleambally and Finley experiments. The highest yielding variety at Coleambally was LongReach Cobra$^{\phi}$ (11.48 t/ha), which also yielded over 10 t/ha at Finley (Table 4). LongReach Trojan$^{\phi}$ was the second highest yielding variety in both experiments yielding 10.99 t/ha and 10.38 t/ha at Coleambally and Finley respectively (Table 4). Beckom$^{\phi}$ was the highest yielding variety at Finley (10.41 t/ha).

The advanced durum breeding line 280913 yielded lowest in both experiments with 7.67 t/ha at Coleambally and 3.53 t/ha at Finley. Lower yields were generally recorded at the Finley site. This could have been due to soil type, the effects of cold temperature events during anthesis, and possible increased crown rot infection due to wheat in the cropping rotation history.

Table 4. Grain yield (t/ha) and protein (%) of 14 wheat varieties evaluated in the irrigated wheat experiments at Coleambally and Finley in 2016.

Variety	Grain yield (t/ha)		Grain protein (%)	
	Coleambally	Finley	Coleambally	Finley
Durum				
280913	7.67	3.53	13.5	13.9
EGA Bellaroi	9.57	8.44	13.3	12.7
Bread				
Beckom	-	10.41	-	10.7
Chara	9.82	10.05	11.9	11.2
LongReach Cobra	11.48	10.10	12.0	11.9
Corack	9.66	8.06	12.3	12.7
DS Darwin	-	8.92	-	11.8
EGA Gregory	8.51	-	11.9	-
Kiora	9.17	10.01	11.9	11.0
LongReach Lancer	10.09	9.70	12.1	11.2
LongReach Trojan	10.99	10.38	11.4	10.8
Mace	9.56	-	12.5	-
Suntop	10.04	9.49	11.6	11.2
Wallup	9.42	7.97	13.0	13.3
Average	9.67	8.92	11.3	11.0
l.s.d. ($P = 0.05$)	0.24	0.46	0.2	0.3

High plant populations of 160 and 200 plants/m^2 had a lower grain yield compared with lower plant populations of 80 and 120 plants/m^2 (Table 5). There was also a significant ($P = 0.05$) interaction between variety and plant population in 2016.

LongReach Cobra$^{\phi}$, Corack$^{\phi}$, EGA Bellaroi$^{\phi}$, Mace$^{\phi}$ and EGA Gregory$^{\phi}$ all had significantly higher yields at the very low or low populations compared with the high population. LongReach Lancer$^{\phi}$ was the only variety that had a significantly lower yield from the very low population compared with the high population.

Differing responses to plant population and variety might have been due to differences in crop architecture and plant structure.

Table 5. Plant population treatments evaluated in the irrigated wheat experiment at Coleambally in 2016.

Plant population	Grain yield (t/ha)	Grain protein (%)	Screenings (%)	Lodging (Score 0–9)
Very low	9.71	12.24	4.03	1.71
Low	9.74	12.27	3.61	1.94
Medium	9.61	12.36	3.62	2.50
High	9.59	12.3	3.34	2.62
l.s.d. ($P = 0.05$)	0.14	n.a.	n.a.	0.39

Grain quality

Variety had a significant ($P = 0.05$) effect on grain protein content, screenings and test weight in both experiments. The advanced durum breeding line 280913 had high grain protein concentration in both experiments, 13.5% at Coleambally and 13.9% at Finley (Table 4). Other varieties that accumulated high protein concentrations were Wallup$^{\phi}$ and EGA Bellaroi$^{\phi}$. Beckom$^{\phi}$ had the lowest grain protein content at Finley with 10.7% (Table 4), however, it had the highest grain yield.

Grain protein concentration was higher when the bulk of the N application was delayed. The average grain protein content was 12.2% when the majority of N was applied at booting compared with 11.6% when the majority was applied at sowing. Grain protein concentration did not differ when plant population varied between 80 plants/m^2 and 200 plants/m^2.

Screenings ranged from 1.7% to 8.4% (average of 5.1%) in the Finley experiment compared with a range of 1.4% to 5.6% (average of 3.6%) in the Coleambally experiment (Table 6). There was a significant ($P = 0.05$) effect of variety in both experiments. Wallup$^{\phi}$ had the lowest screenings in both experiments with 1.7% at Finley and 1.4% at Coleambally (Table 6). Other varieties with low screenings included the advanced durum breeding line 280913, Mace$^{\phi}$ and LongReach Trojan$^{\phi}$. LongReach Lancer$^{\phi}$ had the highest screenings at Finley (8.4%) and Coleambally (4.9%). Chara$^{\phi}$ and Suntop$^{\phi}$ also had relatively high screenings (Table 6).

Table 6. Grain quality and lodging of 14 wheat varieties evaluated in the irrigated wheat experiments at Coleambally and Finley in 2016.

Variety	Screenings (%)		Test weight (kg/hL)		Lodging (score 0–9)	
	Coleambally	Finley	Coleambally	Finley	Coleambally	Finley
Durum						
280913	2.4	3.4	82.1	78.0	1.7	0.7
EGA Bellaroi	3.5	5.0	83.5	83.5	2.4	0.8
Bread						
Beckom	-	5.9	-	85.7		3.7
Chara	4.1	6.8	84.9	85.0	2.2	4.6
Corack	3.2	4.0	85.0	85.0	1.9	2.0
DS Darwin	-	5.8	-	86.2		3.8
EGA Gregory	4.8	-	84.6	-	3.2	
Kiora	5.6	4.7	84.9	86.0	2.0	4.4
LongReach Cobra	3.6	5.2	85.2	86.3	2.1	3.6
LongReach Lancer	4.9	8.4	86.4	86.1	2.3	4.6
LongReach Trojan	3.2	3.7	86.2	86.7	1.5	3.1
Mace	2.8	-	84.5	-	2.3	
Suntop	3.8	6.0	85.6	85.5	2.1	3.6
Wallup	1.4	1.7	85.4	83.4	2.5	3.7
Average	3.6	5.1	84.8	84.6	2.2	3.2
l.s.d. ($P = 0.05$)	1.0	1.1	1.3	0.9	0.7	0.7

Test weights at both Coleambally and Finley were above the minimum Grain Traders Association (GTA) receival standard of 76.0 kg/hL. LongReach Trojan$^{\phi}$ (86.2 and 86.7 kg/hL), LongReach Lancer$^{\phi}$ (86.4 and 86.2 kg/hL) and DS Darwin$^{\phi}$ (86.2 kg/hL) had the highest

test weights in both experiments (Table 6). The advanced durum breeding line 280913 had the lowest test weight with 82.1 kg/hL and 78.1 kg/hL at Coleambally and Finley respectively (Table 6). Plant population at Coleambally and N treatments at Finley had no significant effect on screenings or test weight.

Lodging

Lodging was affected by variety, plant population and N management. Lodging was slightly higher at the Finley experiment with an average lodging score of 3.2 compared with 2.2 at the Coleambally site (Table 6). EGA Gregory[Φ] had a lodging score of 3.2, the highest at Coleambally; Coleambally was a low lodging site. LongReach Lancer[Φ], Chara[Φ] and Kiora[Φ] had high lodging scores, over 4.0, at Finley (Table 6). The advanced durum breeding line 280913 and Corack[Φ] had high tolerance to lodging with low lodging scores in both experiments (Table 6).

Lodging severity increased as the plant population increased ($P = 0.05$). Plant populations of 80 plants/m^2 and 120 plants/m^2 had significantly lower lodging than plant populations of 160 plants/m^2 and 200 plants/m^2.

Timing of N application also significantly affected lodging severity. When the majority of N was applied at sowing, the lodging score was 3.7, which was significantly higher than the lodging score of 2.9 when applying the majority of the N was delayed until the booting stage.

Summary

Variety selection was a key driver of yield in both experiments, reinforcing previous findings. The varieties LongReach Cobra[Φ] and LongReach Trojan[Φ] achieved grain yields above 10 t/ha at both sites.

Grain yield was also influenced by varietal plant population interactions, with LongReach Lancer[Φ] achieving a higher yield at higher plant populations, contrasting with Mace[Φ], Corack[Φ] EGA Gregory[Φ], EGA Bellaroi[Φ], and LongReach Cobra[Φ], all of which yielded higher at lower plant populations. Overall, grain yield increased as plant population decreased from over 200 plants/m^2 to 120 plants/m^2.

Grain protein concentration increased as N application was delayed due to applied N being mobilised into the grain rather than plant biomass. Screenings were higher at Finley than Coleambally, with several varieties having high screenings that could influence varietal selection.

Lodging was affected by variety, plant population and N management. EGA Gregory[Φ] was susceptible to lodging whilst Corack[Φ] was the most resistant variety. Lodging levels were lower as plant population reduced and the majority of N fertiliser was applied later in the growing season.

Variety selection should be based on yield potential, current farming system, crop rotation and pest and disease risk at individual properties. The maximum yield potential of varieties can be achieved through managing N application and plant population. Applying N fertiliser at booting can increase grain protein whilst reducing lodging which, in conjunction with plant populations of approximately 120 plants/m^2, maximised high yields and reduced lodging potential.

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