Effect of seeding density and nitrogen rate on yield and quality of milling oat varieties – Wagga Wagga 2016 and Marrar 2017

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Key findings

- Yield responses to seeding density and nitrogen rate varied between the 2016 and 2017 seasons.
- Bannister⁽ᴾ⁾ achieved the highest grain yields and had consistent grain quality in both years compared with other varieties.
- In 2017 the new milling variety Kowari⁽ᴾ⁾ had a yield advantage over benchmark variety Mitika⁽ᴾ⁾, and had a more stable grain quality at higher seeding and nitrogen rates.

Introduction

Field experiments were conducted in 2016 (Wagga Wagga) and 2017 (Marrar) to evaluate the influence of seeding density and nitrogen (N) applied at sowing on plant establishment, phenology, grain yield and quality of four commercial milling oat varieties.

Site details

Season	2016	2017
Location	Wagga Wagga Agricultural Institute	'Pine Grove', Marrar
Soil type	Red chromosol	Red chromosol
Soil pH_{Ca}	5.1 (0–10 cm)	4.5 (0–10 cm); 4.9 (10–30 cm)
Mineral nitrogen at sowing	142 kg N/ha (180 cm depth)	172 kg N/ha (180 cm depth)
Previous crop	Canola – standing stubble	Canola – standing stubble
Fertiliser	100 kg/ha mono-ammonium phosphate (MAP) at sowing Nitrogen applied as per treatment at sowing	80 kg/ha mono-ammonium phosphate (MAP) at sowing
Sowing	Direct-drilled using six-row DBS cone seeder with GPS auto steer	
Row spacing	240 mm	250 mm
Sowing date	Sown 17 May, 2016	Sown 10 May, 2017
Target plant density	as per treatment	
Weed management	Knockdown: glyphosate (450 g/L) 1.2 L/ha Pre-emergent: Diuron 900 g/kg + Bouncer® 350 g/ha Post-emergent: Paradigm™ 25 g/ha, MCPA 570 g/L, Uptake™ 500 mL/ha	
Disease management	Seed treatment: Hombre® Ultra 200 mL/100kg Flutriafol-treated MAP 400 mL/ha Prosaro® 300 mL/ha (at GS30/37 to suppress disease) TILT®Xtra 500 mL/ha (at GS37 to suppress disease)	

	In-crop rainfall (April–October)		
		592 mm (long-term average 355 mm)	194 mm (long-term average 293 mm)
Treatments	**Varieties**	2016 – Bannister[⌽], Mitika[⌽], Durack[⌽] 2017 – Bannister[⌽], Mitika[⌽], Durack[⌽], Kowari[⌽]	
	Seeding density	Plants were sown for a target density of 75, 150 and 300 plants/m^2	
	Nitrogen application	Nitrogen was applied as urea at sowing at 0, 30, and 90 kg N/ha	

Agronomy–cereals

Results

Plant density

Established plant density increased with seeding rates; however, none of the varieties achieved the target density of 300 plants/m^2. There was a lower plant establishment percentage recorded in 2016 than 2017 (Table 1).

Table 1. Established plant densities for all seeding density × variety treatment combinations at Wagga Wagga, 2016 and Marrar, 2017.

Variety	Target seeding density (plants/m^2)	Established plant density 2016 (plants/m^2)	Established plant density 2017 (plants/m^2)
Bannister	75	55	88
	150	100	140
	300	159	226
Durack	75	60	67
	150	100	111
	300	146	192
Mitika	75	63	76
	150	114	140
	300	176	215
Kowari	75		74
	150		130
	300		220
l.s.d ($P = <0.05$)			
genotype		8.0	9.3
seeding density		8.0	9.3

Phenology

Nitrogen treatment had no significant influence on phenology in either 2016 or 2017. There was a significant interaction between seeding density and time to ear emergence (GS55) recorded for Mitika⌽ in both years and Kowari⌽ in 2017, with ear emergence occurring faster with increasing plant density (Figure 1). There were no significant timing differences from sowing to ear emergence (GS55) in Bannister⌽ and Durack⌽ in both years (Figure 1). Overall, Durack⌽ was faster to ear emergence, than Mitika⌽ and Bannister⌽ respectively, whilst the new milling variety Kowari⌽ showed a similar maturity to Mitika⌽.

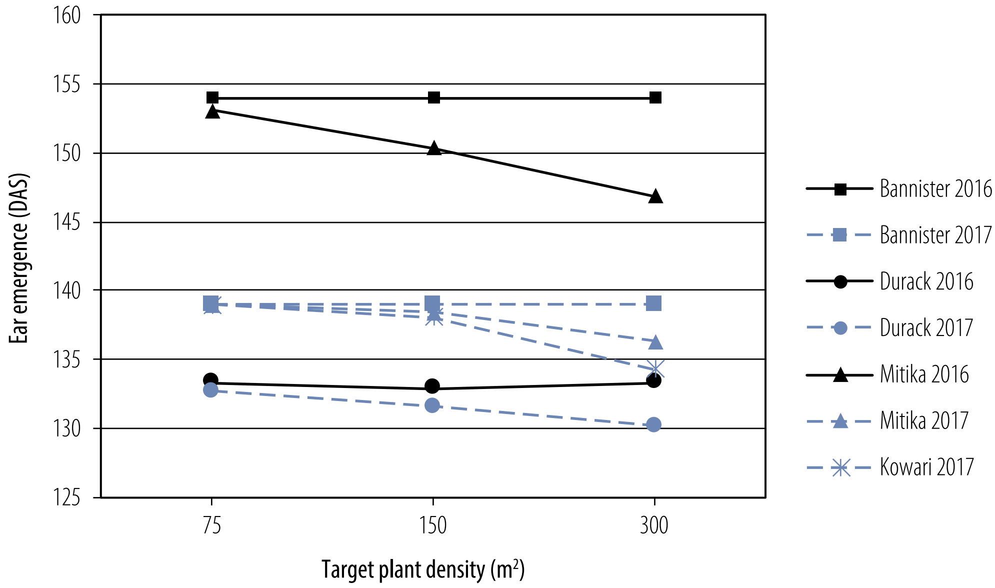

Figure 1. Relationship between timing of ear emergence date reported as days after sowing (DAS) and target plant density for four oat varieties at Wagga Wagga, 2016 and Marrar, 2017.

Grain yield

In 2016, there was no significant interaction between treatments on grain yield responses, with all varieties responding positively to higher seeding density and N rates. Conversely, in 2017, grain yields declined when the N rate and seeding density were increased. These responses are likely to have been driven by contrasting seasonal conditions: 2016 recorded above average rainfall (592 mm vs the long-term average [LTA] of 355 mm), and below average rainfall was recorded in 2017 (194 mm vs LTA 293 mm). Bannister$^{\Phi}$ attained the highest grain yields in both years compared with other varieties, achieving 8.93 t/ha in 2016 and 6.46 t/ha in 2017 (Table 2).

Quality

All treatment combinations achieved screenings <8.0%, however, there was variability in recorded test weight, which influenced milling classification (Table 3). Bannister$^{\Phi}$ had high test weights coupled with low screenings, achieving milling grade across all treatment combinations in both years. Durack$^{\Phi}$ did not achieve milling grade in 2016, however, all treatment combinations, but not the target seeding density of 300 plants/m^2, did achieve milling grade in 2017. There was a contrasting effect of seeding density × nitrogen on Mitika$^{\Phi}$ grain quality across 2016 and 2017. In 2016, high seeding density and N treatments had a positive effect on grain quality, whilst in 2017; grain quality was greatest at a low seeding density (Table 3). The new milling variety, Kowari$^{\Phi}$, was only evaluated in 2017, and achieved milling grade across most N treatments at target seeding densities of 75 and 150 plants/m^2.

Table 2. Grain yield (t/ha) of all treatments: variety, N applied (0, 30 and 90 kg N/ha) and target seeding density (75, 150 and 300 plants/m^2) at Wagga Wagga, 2016 and Marrar, 2017.

Variety	Target seeding density (plants/m^2)	2016			2017		
		Nitrogen applied (kg N/ha)			Nitrogen applied (kg N/ha)		
		0	30	90	0	30	90
Bannister	75	5.23	5.21	7.42	6.46	5.85	5.59
	150	5.74	6.99	7.63	6.19	5.89	5.37
	300	7.58	7.34	8.93	5.92	5.53	5.42
Durack	75	4.56	4.30	4.95	4.60	4.72	4.35
	150	4.68	5.12	5.49	4.24	4.25	3.99
	300	4.67	5.77	5.81	3.56	3.69	3.95
Mitika	75	4.62	4.56	6.47	4.28	4.20	4.19
	150	5.73	6.16	6.36	3.38	3.65	3.67
	300	5.85	6.67	7.37	2.72	2.89	2.59
Kowari	75				4.66	4.70	4.80
	150				3.98	4.18	3.63
	300				3.49	3.53	3.44
l.s.d. ($P = 0.05$)							
genotype		0.39			0.15		
seeding density		0.39			0.13		
nitrogen		0.39			0.13		
genotype × seeding density		ns			0.27		
genotype × nitrogen		ns			0.27		

*ns indicates treatments were not significantly different.

Summary

Results varied across the two seasons. In 2016, all varieties had a positive grain yield response to higher seeding density and nitrogen rates, whilst in 2017 there was a negative effect on grain yield. Despite the high seeding rates, varieties were unable to achieve target plant densities of 300 plants/m^2, with 100–150 plants/m^2 more attainable.

Treatments had a minimal influence on varietal phenology, except Mitika$^{\phi}$, in 2016 and 2017, and Kowari$^{\phi}$ in 2017, which were faster to ear emergence at higher plant densities. Bannister$^{\phi}$ had higher grain yields and consistent grain quality across both years compared with other genotypes. New milling variety Kowari$^{\phi}$ showed a yield advantage over benchmark variety Mitika$^{\phi}$ across treatments in 2017, and had more stable grain quality at higher seeding and nitrogen rates.

Despite significant frosts in 2017, there was no observed effect on phenology and grain yield at the Marrar site.

Table 3. Screenings % (SCRN) and test weight (kg/hL) (TWT) for all treatments: variety, N applied (0, 30 and 90 kg N/ha) and target seeding density (75, 150 and 300 plants/m²) at Wagga Wagga, 2016 and Marrar, 2017.

Variety	Target seeding density (plants/m²)	2016						2017					
		Nitrogen applied (kg N/ha)						Nitrogen applied (kg N/ha)					
		0		30		90		0		30		90	
		SCRN	TWT	SCRN	TWT	SCRN	TWT	SCRN	TWT	SCRN	TWT	SCRN	TWT
Bannister	75	7.3	55.3	5.4	52.4	4.9	53.3	2.3	61.0	3.1	60.5	4.2	58.1
	150	5.1	63.1	4.8	58.8	4.6	54.9	3.0	60.9	3.7	58.8	4.1	58.7
	300	4.7	62.8	4.1	64.4	4.0	58.3	2.9	59.4	3.7	57.8	4.1	58.8
Durack	75	5.0	50.3	4.9	47.0	4.6	46.2	3.2	55.7	3.6	58.5	4.7	53.6
	150	4.6	48.9	4.0	49.5	3.0	48.5	3.8	53.1	3.0	58.3	4.4	52.4
	300	3.8	49.7	2.9	49.9	2.6	49.1	4.9	49.1	5.5	47.6	4.8	50.3
Mitika	75	2.9	48.5	2.4	51.8	2.2	48.6	2.1	56.3	2.9	54.8	3.2	53.6
	150	2.0	51.3	1.5	51.1	1.5	51.7	4.2	49.3	4.2	50.8	3.4	50.2
	300	1.9	48.6	1.6	53.1	1.2	53.7	7.0	44.7	6.6	44.9	6.6	45.2
Kowari	75							2.1	54.6	1.8	55.6	1.9	57.2
	150							2.7	52.6	2.1	52.3	2.9	50.4
	300							3.6	48.7	3.3	48.6	3.7	48.2
l.s.d. ($P = 0.05$)		SCRN	TWT					SCRN	TWT				
genotype		0.4	1.5					0.4	1.4				
seeding density		0.4	1.5					0.3	1.3				
nitrogen		0.4	1.5					0.3	n.s.				
genotype × seeding density		n.s.	2.7					0.7	2.5				
genotype × nitrogen		n.s.	2.7					0.7	n.s.				
seeding density × nitrogen		n.s.	2.7					0.6	n.s.				
genotype × seeding density × nitrogen		n.s.	n.s.					n.s.	n.s.				

*Shading indicates treatments that achieved milling quality (specifications according to Crokers Grain at time of publication: SCRN<8%. TWT >52 kg/hL); ns indicates treatments were not significantly different.

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