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Long coleoptile durum wheat experiment – Riverina 2023

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Key findings

- With adequate soil moisture, sowing durum wheat earlier in the season (22 May) at either 4 cm (0.48 t/ha benefit) or 12 cm deep (1.64 t/ha benefit) produced the highest yield compared with a later sowing (21 June).
- With earlier sowing, when there is not enough soil moisture at 4 cm, and the option to sow deeper at 12 cm into moisture is taken, equivalent yield can be achieved even though establishment was reduced.
- Deeper sowing at 12 cm must be done earlier in the season as delaying by 4 weeks resulted in reduced yield compared with shallower sowing at 4 cm.
- DBA Aurora⍉ was the best performing durum variety with the highest grain yield at both sowing depths and sowing dates. The long coleoptile durum lines did not demonstrate any advantage over the commercial durum varieties in this experiment.
- The effects of fusarium crown rot (FCR) on yield were reduced with earlier sowing with 8% (0.30 t/ha) yield loss when sown on 22 May and 16% (0.45 t/ha) yield loss when sowing was delayed until 21 June. Earlier sowing, even if it requires an increase in sowing depth to 12 cm appears to be a useful strategy to minimise yield loss from FCR in higher risk paddocks.

Keywords Durum, variety, grain yield, sowing depth, sowing date

Introduction

In seasons when the autumn break is delayed, growers might consider the option to sow cereals deeper than the normal 4–5 cm in search of adequate soil moisture to allow seed germination and emergence. When sowing depth is increased to 12 cm, there is the potential for wheat varieties with genetically longer coleoptiles to improve crop establishment and productivity. This experiment assessed yield and fusarium crown rot (FCR) outcomes associated with planting at 2 different depths for both early and later sowing within the sowing window.

We asked the questions: should growers adopt longer coleoptile durum varieties to improve establishment when sowing deeper, and what is the risk vs reward of these strategies for growers?

Site details

Location	Leeton Field Station (LFS)
Soil type	Self-mulching medium clay
Previous crop	Fallow (2022), wheat (2021)

Soil starting nitrogen (N)	95 kg N/ha (60 cm deep)
Fertiliser	• Pre-sowing: 100 kg/ha of mono-ammonium phosphate (MAP) (10 kg N/ha) • Top-dressing: 110 kg/ha of urea (50 kg N/ha)
Row spacing	350 mm
In-season rainfall	• Autumn: 9 mm • Winter: 102 mm • Spring: 25 mm
Fungicides	Veritas (200 g/L tebuconazole and 120 g/L azoxystrobin) at 600 mL/ha (× 3)
Herbicides	• Trilogy (480 g/L trifluralin) at 1.7 L/ha • Boxer Gold (800 g/L prosulfocarb and 120 g/L S-metolachlor) at 2.5 L/ha • Axial (100 g/L pinoxaden and 25 g/L cloquintocet-mexyl) at 600 mL/ha

Treatments

The experiment comprised 3 replicates of 6 varieties × 2 FCR treatments (minus and plus FCR) × 2 sowing depths × 2 sowing dates, with a total of 144 plots (Table 1). All plots were 1.4 m wide (4 rows at 35 cm apart) and 12 m long. The experiment was sown using a cone seeder for both seed placement and base fertiliser application. Nitrogen was topdressed as urea when the crop was at the GS31 growth stage and broadcast by hand.

Table 1 Treatments (sowing date, target sowing depth, FCR status and genotype) evaluated in the 2023 LFS long coleoptile durum wheat (LCDW) experiment.

Treatment	Comment
Sowing date (SD)	
SD1: 22 May	Early in the sowing window for the Riverina
SD2: 16 June	Late in the sowing window for the Riverina
Target depth	
4 cm	Actual depth ranged from 3.7 cm to 4 cm
12 cm	Actual depth ranged from 10 cm to 12 cm
FCR status	
Minus FCR	FCR inoculum NOT added to seed before sowing
Plus FCR	FCR inoculum added to seed before sowing
Genotype	
DBA Aurora[PBR]	Commercial durum variety
Scepter[PBR]	Commercial bread variety
DBA Vittaroi[PBR]	Commercial durum variety
V190245-6	Long coleoptile durum line
V189631-3	Long coleoptile durum line
V189586-4	Long coleoptile durum line

Measurements

Plant counts were conducted 3 times/week to determine emergence date and plant density. The date for emergence was determined when at least 50% of the final plant density had emerged. Final plant density was assessed 5 weeks after sowing. Early biomass accumulation was assessed using hand cuts at the GS31 growth stage. Early biomass samples were collected evenly across all 4 plant lines. Biomass samples were dried, weighed and expressed as g/m².

All plots were sown 12 m long and reduced to 10 m before harvest. The 10 m plots were harvested using a Kingaroy plot header with all 4 rows harvested to determine grain yield. Subsamples from the machine harvest were collected and used to determine grain quality with yield calculated at 12% grain moisture.

Results

Emergence, establishment and early growth

Average soil temperatures were relatively stable across sowing depths with a 0.1 °C increase between 4 cm and 12 cm depths in both SD1 and SD2 (Table 2).

Increasing sowing depth from 4 cm to 12 cm delayed emergence by 2.4 days for SD1. A longer delay of 4.3 days occurred for SD2 when the sowing depth was increased from 4 cm to 12 cm.

A large variation in early biomass accumulation by GS31 was observed between sowing date and sowing depth. Delaying sowing or increasing the sowing depth significantly decreased biomass accumulation. Biomass underpins yield; generally, the more biomass the better the yield. The average early biomass accumulation for SD1 at 4 cm was 100.8 g/m². The average early biomass accumulation for SD2 at 12 cm depth was 5.8 g/m², which is only 5.7% of SD1 at 4 cm (Table 2).

Table 2 Average measured soil temperature at 2 sowing depths and 2 sowing dates and the effect on days to emergence and early growth for the 2023 LCDW experiment at LFS.

Sowing depth	Soil temperature (°C)		Emergence (days)		Early biomass (g/m²)	
	SD1	SD2	SD1	SD2	SD1	SD2
4 cm	12.4	9.2	13.0 a	21.1 c	100.8 a	61.8 b
12 cm	12.3	9.3	15.4 b	25.4 d	45.7 c	5.8 d

Values followed by the same letter are not significantly different at the 95% confidence level.

Scepter⁽ᵈ⁾ sown at 4 cm deep had the highest density with 106.9 plants/m² and was statistically similar to the longer coleoptile variety V189586-4 at 4 cm, which had an average density of 99.1 plants/m² (Table 3). Scepter⁽ᵈ⁾ sown at 12 cm had the lowest average density with 26.5 plants/m² and was statistically similar to DBA Aurora⁽ᵈ⁾ at 12 cm with 34.1 plants/m².

Table 3 Effect of 2 sowing depths (averaged across both sowing dates) on density (plants/m²) on one bread wheat and 5 durum wheat varieties for the 2023 LCDW experiment at LFS.

Variety	Sowing depth	
	4 cm	12 cm
DBA Aurora	88.7 bcd	34.1 fg
Scepter	106.9 a	26.5 g
Vittaroi	97.4 abc	38.2 ef
V190245-6	88.4 cd	39.6 ef
V189631-3	86.1 d	41.0 ef
V189586-4	99.1 ab	46.2 e
Average	94.1	46.2

Values followed by the same letter are not significantly different at the 95% confidence level.

SD2 at 4 cm achieved the highest average density with 97.6 plants/m^2 yet was statistically similar to SD1 at 4 cm with an average density of 91.6 plants/m^2 (Table 4). SD2 at 12 cm had the lowest density with 20.4 plants/m^2 and was significantly lower than all other combinations of sowing date and sowing depth.

Table 4 Effect of 2 sowing dates on density (plants/m^2) at 2 sowing depths for the 2023 LCDW experiment at LFS.

Sowing depth	Sowing date	
	SD1	SD2
4 cm	91.6 ^{a}	97.6 ^{a}
12 cm	54.9 ^{b}	20.4 ^{c}

Values followed by the same letter are not significantly different at the 95% confidence level.

Grain yield

Grain yield averaged 3.10 t/ha across all variety, sowing date, depth and fusarium treatments. DBA Aurora$^{\phi}$ was the highest yielding variety when averaged across all treatments at 3.68 t/ha and was statistically similar to Scepter$^{\phi}$ that had an average yield of 3.50 t/ha (Table 5). The 3 long coleoptile varieties (V189631-6, V189631-3 and V189586-4) all had a significantly lower average yield than DBA Aurora$^{\phi}$ or Scepter$^{\phi}$.

Table 5 Average grain yield (t/ha) for the one bread wheat and 5 durum wheat varieties in the 2023 LCDW experiment at LFS.

Variety	Grain yield
DBA Aurora	3.68 ^{a}
Scepter	3.50 ^{a}
Vittaroi	3.16 ^{b}
V190245-6	3.15 ^{b}
V189631-3	2.56 ^{c}
V189586-4	2.55 ^{c}
Average	3.10

Values followed by the same letter are not significantly different at the 95% confidence level.

SD1 sown at 4 cm achieved the highest average grain yield of 3.69 t/ha and was statistically similar to SD1 at 12 cm with an average yield of 3.57 t/ha (Table 6). SD2 sown at 12 cm had the lowest average grain yield with 1.93 t/ha and was significantly lower yielding than all other combinations of sowing date and sowing depth.

Table 6 Effect of 2 sowing dates on yield (t/ha) at 2 sowing depths for the 2023 LCDW experiment at LFS.

Sowing depth	Sowing date	
	SD1	SD2
4 cm	3.69 ^{a}	3.21 ^{b}
12 cm	3.57 ^{a}	1.93 ^{c}

Values followed by the same letter are not significantly different at the 95% confidence level.

DBA Aurora$^{\phi}$ at SD1 achieved the highest average grain yield with 4.23 t/ha and was statistically similar to Scepter$^{\phi}$ at SD1 with an average yield of 4.06 t/ha (Table 7). V189586-4 in SD2 and V189631-3 in SD2 had the lowest average grain yield with 2.02 t/ha and 2.12 t/ha respectively.

Scepter$^{\phi}$ at 4 cm achieved the highest grain yield with 4.31 t/ha and was statistically similar to DBA Aurora$^{\phi}$ at 4 cm with an average yield of 4.20 t/ha (Table 7). V189586-4 at 12 cm had the lowest average grain yield with 2.41 t/ha but was statistically similar to V189631-3 at 12 cm, V189586-4 at 4 cm, V189631-3 at 4 cm and Scepter$^{\phi}$ at 12 cm.

Table 7 Average effect of 2 sowing dates and 2 sowing depths on yield (t/ha) on one bread wheat and 5 durum wheat varieties for the 2023 LCDW experiment at LFS.

Variety	Sowing date		Sowing depth	
	SD1	SD2	4 cm	12 cm
DBA Aurora	4.23 ^{a}	3.14 ^{c}	4.20 ^{a}	3.17 ^{cd}
Scepter	4.06 ^{a}	2.93 ^{c}	4.31 ^{a}	2.69 ^{efg}
Vittaroi	3.69 ^{b}	2.64 ^{d}	3.56 ^{b}	2.77 ^{ef}
V190245-6	3.73 ^{b}	2.57 ^{d}	3.39 ^{bc}	2.91 ^{de}
V189631-3	3.00 ^{c}	2.12 ^{e}	2.59 ^{fg}	2.53 ^{fg}
V189586-4	3.07 ^{c}	2.02 ^{e}	2.68 ^{efg}	2.41 ^{g}
Average	3.63	2.57	3.45	2.75

Values followed by the same letter are not significantly different at the 95% confidence level.

Fusarium

SD1 minus FCR achieved the highest average grain yield with 3.78 t/ha and was significantly higher yielding than SD1 plus FCR with 3.48 t/ha (Table 8). SD2 minus FCR achieved a grain yield of 2.80 t/ha which was significantly higher than SD2 plus FCR with 2.35 t/ha. Earlier sowing even in the presence of FCR infection was still 0.68 t/ha higher yielding than delayed sowing in the absence of FCR.

The sowing depth of 4 cm minus FCR achieved the highest average grain yield with 3.76 t/ha and was significantly higher yielding than the 4 cm sowing depth plus FCR with 3.15 t/ha (Table 8). The presence of FCR did not have a significant effect on yield at 12 cm. Sowing depth of 12 cm minus FCR achieved a grain yield with 2.82 t/ha which was statistically similar to the 12 cm plus FCR treatment with an average yield of 2.67 t/ha.

Table 8 Effect of 2 sowing dates and 2 sowing depths on yield (t/ha) with and without the presence of FCR for the 2023 LCDW experiment at LFS.

FCR	Sowing date		Sowing depth	
	SD1	SD2	4 cm	12 cm
Minus FCR	3.78 ^{a}	2.80 ^{c}	3.76 ^{a}	2.82 ^{c}
Plus FCR	3.48 ^{b}	2.35 ^{d}	3.15 ^{b}	2.67 ^{c}

Values followed by the same letter are not significantly different at the 95% confidence level.

Summary

There was a significant yield penalty associated with delayed sowing. At the shallower sowing depth (4 cm), delayed sowing delivered an average yield penalty of 0.48 t/ha (13%) and an average yield penalty of 1.64 t/ha (46%) at the deeper sowing depth (12 cm). The yield reduction from delayed sowing varied between varieties from 1.09 t/ha (25%) with DBA Aurora$^{\phi}$ to 1.16 t/ha (31%) with V190245-6.

There was no yield difference between sowing depths for the early sowing date (SD1), but a significant yield reduction was seen in the later sowing date (SD2). An average yield reduction across all varieties of 1.28 t/ha (40%) was observed for SD2 when the sowing depth was increased from 4 cm to 12 cm. A significant interaction between varieties and sowing depth was observed. DBA Aurora$^{\phi}$, Scepter$^{\phi}$, DBA Vittaroi$^{\phi}$ and V190245-6 all demonstrated a yield reduction from 4 cm to 12 cm when averaged across both sowing dates, while V189631-3 and V189586-4 demonstrated no yield penalty from 4 cm to 12 cm sowing depths.

Increasing sowing depth significantly reduced plant density for both sowing dates. Sowing depth and sowing date also had a significant effect on early biomass accumulation. Sowing deeper (12 cm) and delaying sowing (SD2) significantly reduced early biomass, which was probably associated with lower grain yield at harvest.

There was a significant yield penalty when FCR was present. At SD1 there was an average yield loss of 0.30 t/ha (8%) with FCR and at SD2 there was an average yield loss of 0.45 t/ha (16%) with FCR.

Earlier sowing, even if it requires an increase in sowing depth to 12 cm appears to be a useful strategy to minimise yield loss from FCR in higher risk paddocks. This highlights the strong interaction between FCR expression and yield loss with moisture and/or temperature stress during grain filling. Earlier sowing to reduce the extent of stress during grain filling provided significant yield benefit both in the presence and absence of FCR infection in this experiment.

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