Did long coleoptile wheat varieties have a role for developing robust ground cover on sandy soils at Wharminda in 2023?

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Location
Wharminda Ed and Carolyn and Evan and Lauren Hunt and family Roberts - Verran Agricultual Bureau
Rainfall
Av. Annual: 341 mm
Av. GSR: 252 mm
2023 Total: 358 mm
2023 GSR: 191 mm (Decile 3)
Yield
Potential: 1.6 t/ha wheat
Actual: 2.7 t/ha wheat
Paddock history
2022: Vetch
2021: Barley
2020: Wheat
Soil type
Duplex sand over clay
Soil test
pH, nutrition etc.
Plot size
1.8 m x 4 m x 4 reps
Trial design
Randomised complete block
Yield limiting factors
Nil

Key messages

- **Long coleoptile wheat can permit deep sowing to access soil moisture.**
- **When opportunities arise, it might be possible to use a range of currently available, shorter coleoptile, high yielding genetics sown deeper (6-8 cm) into moisture with only minor establishment and yield penalties.**
- **When sowing deep, good quality seed is important for emergence due to increased reliance on seed reserves and it is recommended that seed intended to be used for deep sowing has high germination and vigour, not affected by weather damage prior to harvest.**

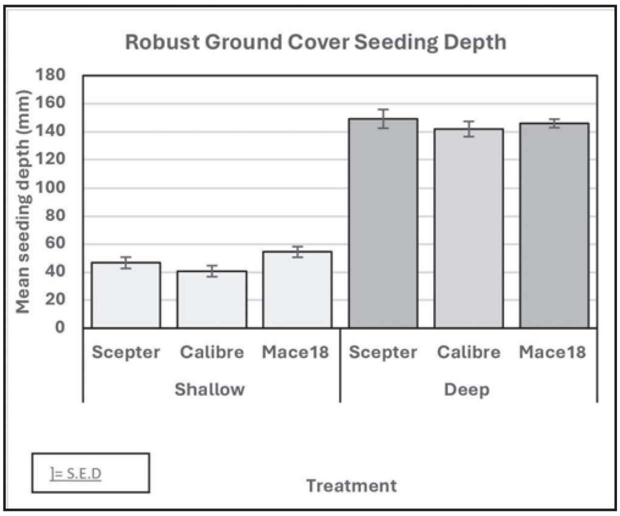
Why do the trial?

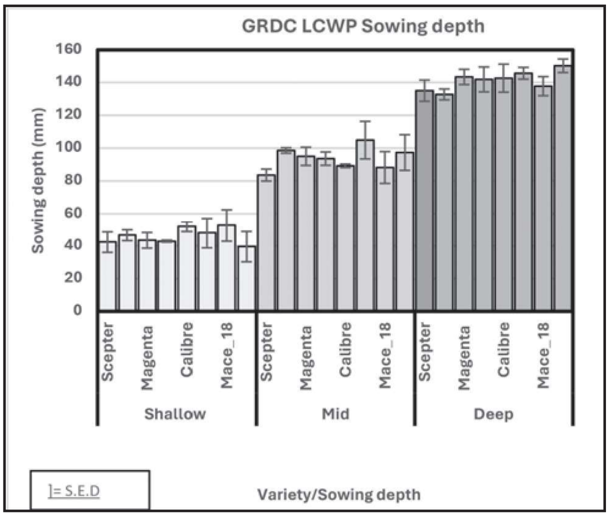
On the water repellent sands at Wharminda, the years where rainfall is limited at the optimum time for seeding are frequent. This results in low soil moisture in the 'normal' seeding depth range (3-6 cm) which can delay sowing and/or cause poor germination, poor early crop vigour and low surface cover for erosion protection. In many years subsurface soil layers contain moisture from earlier summer rainfall with growers wanting to sow crops deeper into this moisture band. However, most of the commonly grown wheat varieties have a shortened coleoptile which can restrict the capacity for plants to emerge and establish in adequate plant numbers from depth (EPFS Summary 2022, p. 48). In 2023, trials investigated the potential for sowing deeper (including with novel long coleoptile varieties) to improve crop establishment on sandy soils at Wharminda under two separate projects: the Australian Government Future Drought Fund (FDF) funded Mallee Sustainable Farming Systems 'Robust Groundcover' project in partnership with AIR EP and the Grains Research and Development Corporation (GRDC) funded CSIRO Long Coleoptile Wheat Project). This report summarises the results from the Future Drought Fund Robust Groundcover trial (FDF RGC) and utilises data collected from the GRDC investment at Wharminda and a contrasting heavier textured soil at Ungarra.

How was it done?

Two widely grown conventional varieties (one shorter coleoptile control (Scepter) and one which has a comparatively longer coleoptile, Calibre) were compared to a new cultivar containing long coleoptile genetics (LC_Mace). Each cultivar was sown targeting two sowing depths, shallow (at 40-60 mm) and at the maximum working depth of the seeder (at least 120 mm). The Wharminda site was sown on 5 May into good subsurface moisture with seeding rates targeting 120 plants/m^2. The site also received a further 3.5 mm of rainfall immediately after sowing. Plots were fertilised with 80 kg/ha of DAP at seeding and received a further 100 kg/ha of nitrogen during the season.

Measurements were taken for emergence, sub crown internode length, seeding depth, tillers, growth stage, head density, harvest index, grain yield, grain protein, screenings, and test weight. Only a selection of these measurements are reported here. The site was harvested on 7 November 2023. Results were analysed using Genstat®.





Figures 1 and 2. Mean sowing depth (mm) by treatment on Wharminda FDF Robust Ground Cover and GRDC Long Coleoptile Wheat projects sowing depth x variety trials in 2023 (error bars show standard error compared to treatment mean).

What happened?

Seeding depths at Wharminda matched targets with average seeding depths on the shallow sown treatments ranging from 41 to 54 mm and 142 to 149 mm on the deep sown treatments (Figure 1). There was no significant difference in sowing depth between varieties sown at the same depth (P>0.05).

Further useful information was gained from the adjacent GRDC funded CSIRO 'Long Coleoptile Wheat' sowing-depth x variety trial (conducted on the same site at Wharminda and also on a heavier textured soil at Ungarra), which was sown on the same day with an expanded treatment list including a further 5 cultivars and an intermediate (8 to 10 cm) target sowing depth (Figure 2). Average seeding depths on this trial ranged from 42 to 53 mm on shallow, 83 to 105 mm for intermediate, and 133 to 150 mm on deep sown treatments.

There was rapid emergence of plants in the shallow sown treatment, with 52 to 76% of the final plant numbers at establishment emerging by 15 May (10 DAS) (Table 1). However, no plants had emerged on the deep sown plots by this date. On shallow sown Scepter and Calibre plots and deep sown LC Mace, plant numbers were close to those at final establishment (>95%) by 23 May (18 DAS), but plant numbers continued to increase on the shallow sown LC_Mace and deep sown Calibre and Scepter plots until 5 June (30 DAS).

Table 1. Mean plant emergence at 2023 Robust Groundcover site at Wharminda on several sampling dates and compared to final establishment numbers.

	Plants/m²			% of final plant numbers at establishment		Crop establishment when variety sown deep compared to shallow.	
Treatment	**15 May (10 DAS)**	**23 May (18 DAS)**	**5 June (30 DAS)**	**15 May (10 DAS)**	**23 May (18 DAS)**	**5 June (30 DAS)**	**(% of shallow sown treatment)**
Shallow Scepter	58	92	96	61%	98%	100%	*
Shallow Calibre	66	84	84	76%	97%	97%	*
Shallow Mace 18	45	75	85	52%	87%	98%	*
Deep Scepter	0	36	49	0%	72%	97%	53%
Deep Calibre	0	46	57	0%	80%	99%	66%
Deep Mace 18	0	69	71	0%	96%	99%	83%

Sowing depth was the key driver for crop establishment at Wharminda (P=0.003). There was no significant difference between varieties sown at the same depth (P=0.311). In 2023 sowing deep resulted in 17 to 47% fewer plants at establishment than sowing shallow.

Assessments of comparative growth were undertaken using NDVI ('greenness index') and Canopeo (% surface cover) in early and late winter. Growth reflected differences in crop establishment with poorer NDVI values and lower % cover where plant numbers were lower. This poor early vigour on the deep vs shallow sown plots continued throughout season. Cool, wet conditions in early winter slowed growth and estimates of crop biomass from NDVI in July were only in the order of 1 t/ha dry matter in the shallow sown treatments (shallow sown), and 200 to 300 kg/ha on deep sown treatments.

These growth differences were also reflected at harvest with deep sown plots yielding 20 to 40% less grain (P<0.001) where the same variety was sown shallow. Yields of different varieties sown at the same depth were similar (P>0.05) (Table 2). Screenings were comparatively higher in Calibre compared to LC Mace and Scepter (P=0.002) sown at the same depth (either shallow or deep).

These results are consistent with the GRDC sowing depth x variety trials at both Wharminda and Ungarra in 2023. The plant establishment penalty for LC Mace when sown at depths >12 cm on the sandy soil at Wharminda in 2023 was only 13% compared to more than 43% on other varieties. Whilst this establishment penalty increased on the loamier soil at Ungarra, LC Mace still had the highest plant numbers when sown deep. However, given good soil moisture conditions in the top 10 cm at seeding in 2023, shallow sowing resulted in the highest plant numbers and early vigour at establishment. It is worth noting that on the sandier soil at Wharminda most varieties had little establishment penalty (<20%) when sown at the intermediate depth compared to sowing shallow, whilst (apart from LC Mace) sowing at the intermediate depth on the heavier soil type at Ungarra resulted in plant establishment penalties of 20-39% compared to shallow sowing (Table 3).

As was observed in the Robust Ground Cover trial, the poorer early crop vigour and growth from sowing deep at Wharminda in 2023 resulted in lower grain yields compared to sowing at the shallow or intermediate depths (Table 4).

Farming Systems

Table 2. Mean grain yield and quality from harvesting Robust Ground Cover trial site Wharminda in 2023.

Treatment	Grain yield (t/ha)	Screenings (%)
Deep Calibre	1.83	2.8
Deep LC_Mace	1.68	1.4
Deep Scepter	1.84	1.7
Shallow Calibre	2.56	0.9
Shallow LC_Mace	2.30	0.5
Shallow Scepter	2.24	0.6

Table 3. Relative plant numbers at establishment as a proportion of the shallow sown varietal control at Wharminda and Ungarra in 2023.

		% of field establishment numbers on shallow sown treatment for variety							
Ungarra	**Mid**	70	75	79	61	57	84	73	63
	Deep	40	43	43	42	55	56	55	34
Variety x sowing depth		Scepter	Mace	Magenta	Calibre	Scout	Mace_18	Magenta_13	Scout_18
Wharminda	**Mid**	84	96	84	106	80	84	87	115
	Deep	55	47	60	66	25	87	63	67

Table 4. Comparative grain yields from 2023 Wharminda GRDC LCWP trial when sowing each variety at 8-10 cm and 12+ cm compared to shallow sowing at 4-6 cm.

Wharminda GRDC LCWP Sandy soil 2023 Wheat Yield LC Variety x Sowing Depth (% shallow sowing, 4 cm)								
	Calibre	**Mace**	**LC_Mace**	**Magenta**	**LC_ Magenta**	**Scepter**	**Scout**	**LC_Scout**
8 cm	90%	98%	101%	98%	107%	95%	93%	93%
12 cm	68%	65%	84%	78%	77%	65%	47%	71%

What does this mean?

The Robust Ground Cover trial contrasted strategies of using short and long coleoptile wheat cultivars sown at different depths to improve crop establishment and early surface cover on a sandy soil at Wharminda in 2023. Given good levels of stored subsurface moisture from summer and early autumn rainfall, attempts were made to use tarpaulins to exclude moisture from the surface soil to test the benefit from sowing LC varieties deep into moisture with dry soil at the standard (4-6 cm) sowing depth. However, significant rainfall immediately after seeding resulted in good soil moisture for crop germination in this layer and in 2023 deep sowing (>12 cm) saw reduced early crop vigour, surface cover and grain yield compared to shallow seeding.

This trial and the adjacent GRDC trial suggest that long coleoptile genetics can be used to aid crop emergence if sowing very deep to chase moisture. These results concur with those from Cootra in 2022 (EPFS Summary 2022, p. 92) which demonstrated that in years where surface soils are dry, but there is moisture at depth, cultivars with long coleoptile genetics were able to establish better from deeper sowing.

Results from Wharminda in 2023 also suggested that if there is soil moisture below the traditional seeding depth, current commercial varieties which are grown locally have the capacity to emerge from 6-8 cm with little establishment penalty. Whilst this has improved landholder confidence to sow to 8 cm, plant numbers at establishment were much lower when these varieties were sown deeper than that and growth penalties should be expected if targeting seeding that deep.

Acknowledgements

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