Long coleoptile wheat on the Eyre Peninsula

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Location
Cootra - Todd Matthews
Rainfall
Av. Annual: 340 mm
Av. GSR: 241 mm
2021 Total: 413 mm (71 mm Nov, 5 mm Dec)
2021 GSR: 268 mm
Yield
Potential: 4.9 t/ha yield prophet
Actual: 4.6 t/ha (highest yielding treatment)
Paddock history
2020: Wheat
2019: Pasture
2018: Barley
Soil type
Sand over sandy clay loam
Soil test 0-10cm
Texture: Sand, pH $CaCl_2$: 6.67, Org C: 0.43%, Nitrate: 6.2 mg/kg, Colwell P: 13 mg/kg
Trial design
randomised complete block, split plot
Yield limiting factors
Some yellow leaf spot

Key messages

- **Longer coleoptile wheat varieties provide opportunities and flexibility to successfully establish crops in situations where previously not possible.**
- **The coleoptile provides protection to the emerging shoot. Longer coleoptiles allow wheat to successfully emerge from deeper sowing.**
- **2021 trials conducted on sandy soils at Cootra found that both a Mace and a version of Mace with a long coleoptile gene emerged equally well from a sowing depth of 10 cm.**
- **The long coleoptile genetics did not show any yield penalty when sown at 10 cm.**
- **Four newly released commercial varieties with longer coleoptiles all were all able to establish well from a depth of 10 cm.**

Why do the trial?

Improving the reliability of early plant establishment plays an important role in increasing water use efficiency and yield potential in dryland cropping environments. Establishing plants earlier in the season extends the growing period of a crop, and when combined with optimal phenology, provides more time for a plant to develop resources that ultimately contribute to grain fill and yield.

Seeding deeper, into soil moisture present below the 'normal seeding bed' may help to establish plants earlier without relying on an autumn break for germination. Currently, wheat growers are restricted to a seeding depth of 3-5 cm because modern wheat varieties have a shortened coleoptile associated with dwarfing genes that were introduced in the 1960's to increase yields. The length of a coleoptile restricts seeding depth because it is a hollow shoot that protects the first leaves as they grow towards the soil surface during germination. Breeders have now identified an alternate dwarfing gene 'Rht18' that allows a coleoptile up to 12 cm long, whilst maintaining the reduced height associated with modern high yielding wheat varieties.

The trials reported here assessed the performance of long coleoptile wheats in an Eyre Peninsula farming system.

How was it done?

Two trials were established on a sand over sandy loam soil in the Cootra area (central EP). Trial 1 compared three wheat varieties with standard length coleoptiles, to a CSIRO developed, long coleoptile derivative of Mace. All varieties were sown at three depths; 5, 8 and 10 cm. In this article, only Mace and LC (long coleoptile) Mace will be reported.

Trial 2 compared four newly released varieties Calibre, LR Bale, LR Dual, and Valiant CL Plus, all marketed to have long coleoptile traits, at three depths of seeding.

The trial was sown on 7 May 2021 with seeding rates targeting 160 plants/m^2. At seeding, the trial was fertilised with 16 kg/ha of phosphorus, and 14 kg/ha nitrogen. A further 106 kg/ha of nitrogen was applied post-emergent. A foliar application of 120 gm/ha Zinc, 150 gm/ha Manganese and 45 gm/ha Copper was applied at late tillering. Weed control was achieved through the application of 118 g/ha of Sakura®, and 1.6 L/ha of Avadex Xtra® applied prior to seeding and 25 g/ha of Paradigm®, 300 mL/ha of LVE MCPA, 500 mL/100L of Uptake®, applied post-emergent. 300 mL/ha of Prosaro®, 600 mL/ha of Aviator® and 70 mL/ha of Alpha Scud®, was applied to control disease and insects. Both trials were harvested on 1 December 2021.

Measurements were taken for: emergence, coleoptile length, sub-crown internode length, seeding depth, tillers, above and below ground biomass (at Zadoks growth stages: GS 12 and 21), growth stages, head density, harvest index, grain yield, grain protein, screenings and test weight. Only a selection of these measurements are reported here. Results were analysed using Genstat® version 19.

What happened?

The site had good levels of moisture below the traditional 'seedbed' and a dry topsoil when the site was sown prior to the break in the season. At sowing there was sufficient moisture from 8 cm for establishment. Small rainfall events in the week post seeding assisted in wetting soil at shallower depths.

Mace type trial (Trial 1)

Emergence

Eleven days after seeding LC Mace had established 44% more plants than the standard Mace variety when sown at 8 cm and 50% more plants when sown at 10 cm. However, by the time the trial had fully emerged, there were no differences in plant number between the two varieties. Overall, the deeper sown treatments had poorer final emergence, regardless of coleoptile genetics. Plant numbers decreased by 10% at 8 cm and by 20% at 10 cm, but all treatments had populations in excess of 110 plants/m^2 by 23 June.

Biomass

At the two-leaf stage, plants in the treatments sown deeper had greater biomass than those sown at 5 cm. By early tillering (GS 21), plants in treatments sown at 8 cm had greater biomass than at 4 cm and 10 cm.

When comparing varieties at each seeding depth: LC Mace had a greater biomass at two leaf stage when sown very deep, and Mace had a greater biomass at early tillering when sown at 4 cm. Generally, Mace had grown more biomass than LC Mace by early tillering, especially in the shallow sown treatments.

Yield

Overall, the highest yields were recorded with seeding at 8 cm and Mace yielded higher than LC Mace. However, the yield gap between the varieties closed with depth, and when sown at 10 cm, the two varieties yielded the same.

Commercial variety trial (Trial 2)

The two LongReach varieties emerged earlier than Calibre or Valiant (table 2). The trial fully emerged by 23 June 2021. There was no yield penalty for planting any of the varieties at 10 cm compared to 5 cm and treatments planted at 8 cm yielded the highest. Valiant and Calibre yielded higher than the two awnless LongReach varieties, regardless of seeding depth.

Table 1: Emergence, early season biomass production and grain yield of Mace and LC Mace at Cootra, 2021.

Seeding depth (cm)	Wheat Variety	Emergence 18 May (plants/m^2)	Emergence 23 June (plants/m^2)	Biomass @ GS 12 (gm/plant)	Biomass @ GS 21 (gm/plant)	Grain Yield (t/ha)
5	Mace	53	148	0.37	4.44	4.24
	LC Mace	53	155	0.28	2.90*	3.66*
8	Mace	47	133	0.58	4.06	4.56
	LC Mace	84*	137	0.60	3.75	4.17*
10	Mace	29	122	0.45	3.51	4.18
	LC Mace	59*	113	0.73*	3.33	4.05
LSD (P=0.05)		*25.4*	*20.7*	*0.22*	*1.13*	*0.36*

** = Mace and LC Mace means are statistically different at the same sowing depth (P=0.05)*

Table 2: Early emergence (18 May) and grain yield of long coleoptile wheat varieties at Cootra in 2021.

Depth	Valiant CL Plus		LR Bale		LR Dual		Calibre		Average of depths	
	Emergence (plants/m^2)	Yield (t/ha)	Emergence (plants/m^2)	Yield (t/ha)	Emergence (plants/m^2)	Yield (t/ha)	Emergence (plants/m^2)	Yield (t/ha)	Emergence (plants/m^2)	Yield (t/ha)
4 cm	110	4.07	111.5	2.91	89.6	3.02	77	3.95	97 *	3.49 a
8 cm	93.7	4.24	124.1	3.09	117	3.36	90.7	4.32	106.4 *,**	3.75 b
10 cm	88.1	4.08	172.6	3.06	135.9	3.26	71.5	4.07	117 **	3.62 a
Average	*149.5**	*4.13 a*	*151.3***	*3.02 b*	*151.3***	*3.22 b*	*146.4**	*4.11 a*		

variety x depth LSD (P=0.05): Emergence = 33.4, Yield = 0.35

What does this mean?

These trials showed that in a late Autumn break, seeding before the break into deeper moisture increased yields. This occurred with all varieties, regardless of the length of their coleoptiles.

Although LC Mace emerged faster than Mace, there was no difference in final establishment. Mace achieved greater biomass and yields than LC Mace, except yields were the same when plants were sown at 10 cm.

Early vigour demonstrated by LC Mace suggests a longer coleoptile can be advantageous; and the equivalent yields to Mace when sown at 10 cm suggests the long coleoptile variety may have a role in deeper seeding systems.

The combination of a sandy soil type and a favourable growing season allowed standard Mace to establish successfully from sowing at 10 cm. In season measurements found Mace's coleoptile to be 7 cm (data not shown), meaning the unprotected emerging leaf was able to successfully push through and emerge through the remaining 3 cm of soil. Similar experiments conducted on different soil types across Australia in 2021 found this was not always possible with reductions of up to 32% in emergence (Rebetszke *et al*, 2022 GRDC Updates).

The high yields achieved by the newly released commercial varieties sown at depth mean that this technology is ready for growers to adopt on sandy soils without non-wetting issues, however more research is needed to evaluate their performance on non-wetting sands and heavier soil types that restrict emergence from depth.

Long coleoptile varieties not only have the potential to enable earlier seeding when deeper soil moisture is present, and the topsoil is dry but may also have other benefits. These include being able to successfully seed over rough terrain after soil amelioration, having confidence to seed deeper to avoid pre-emergent herbicides and being able to establish crops when adverse weather collapses press-wheel furrows (inadvertently deepening the seeding depth).

There are still challenges to developing complete deeper sowing packages. There is a need to understand the impact of varying soil types, moisture availability and depth to moisture on success of the technique, if current seeders require modifications to allow them to successfully seed deeper, the interaction of deep seeding approaches and soil-active herbicides and if further advances/ understanding of long coleoptile genetic material are necessary to work across a number of soil types and environments.

Acknowledgements

Rhaquelle was funded by SAGIT/ AIR EP as part of the Eyre Peninsula internship in applied grains research project, project code EP120. CSIRO for providing the long coleoptile germplasm. AGT, LongReach and InterGrain for proving seed of the newly released varieties. This work was also made possible through the National Landcare Program's Resilient EP project. Todd Matthews and family for providing the trial site. Gary Miller, Mark Saunders, Ashley Flint and Jacob Giles of EPAG Research for their assistance.