Optimising the fit for long coleoptile bread and durum wheats in current and future climates

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Team Long Coleoptile Wheat

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- Project support: GRDC

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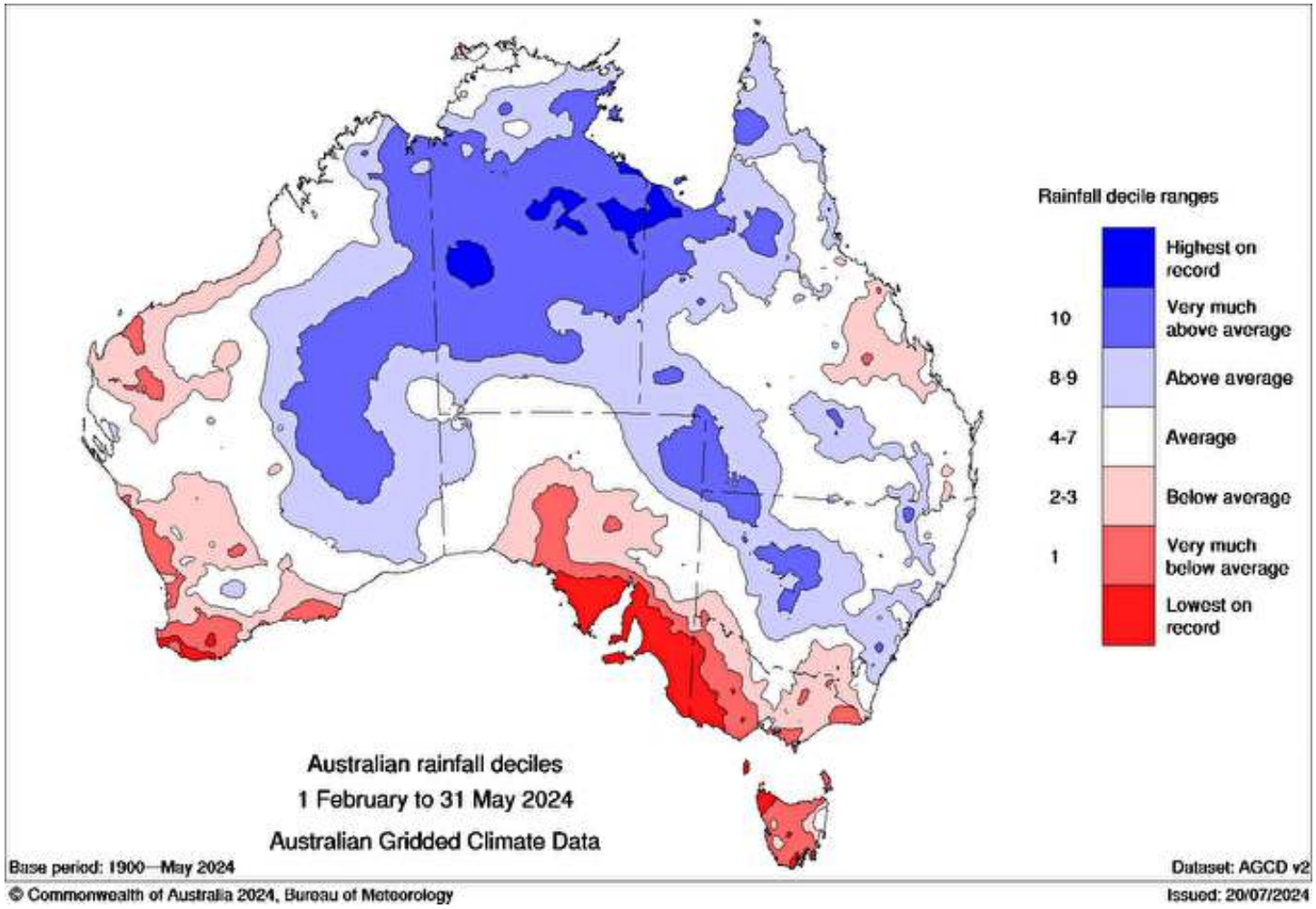
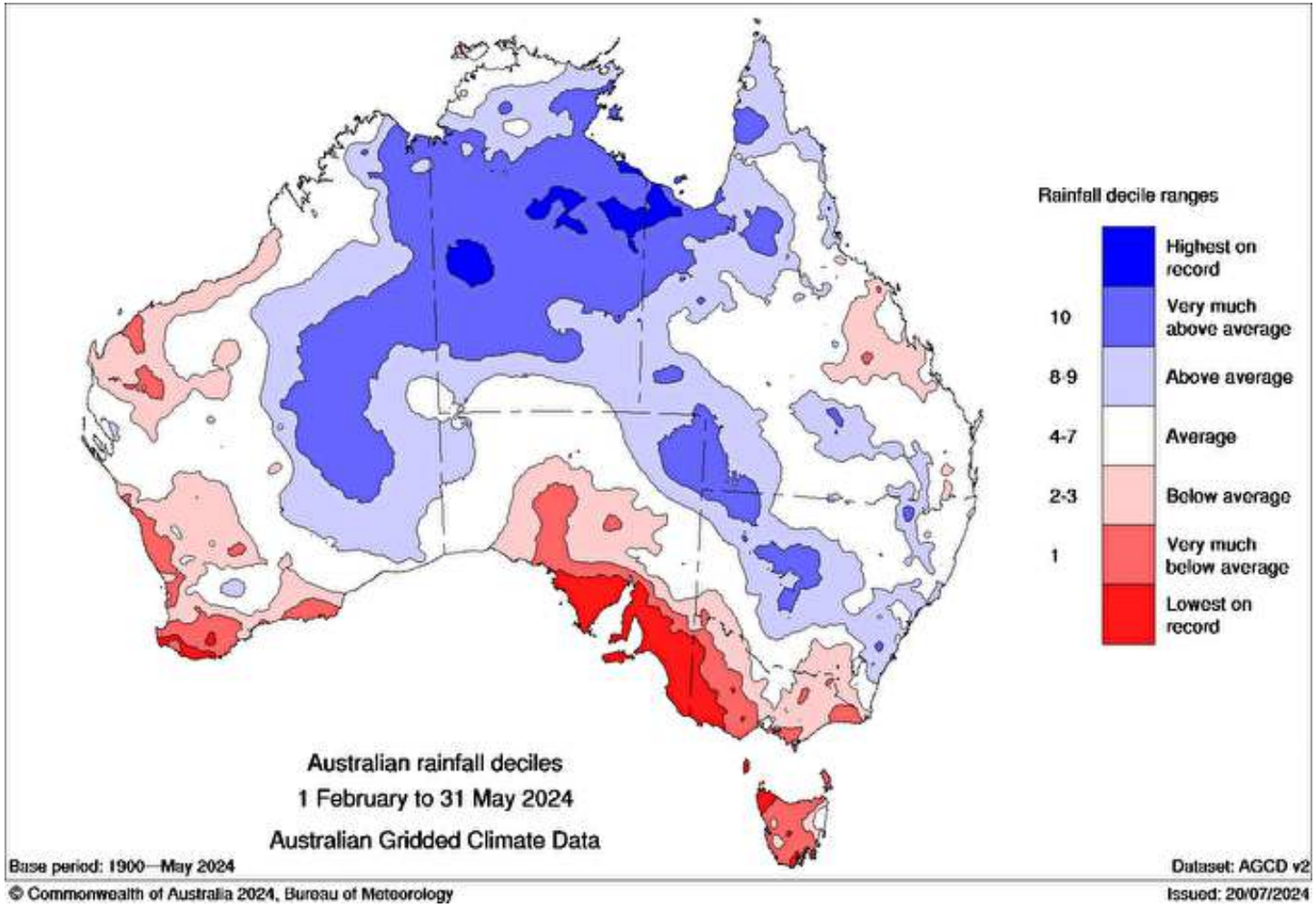
What about 2024! Driest Feb-May in 100 years delivering the latest of sowing breaks!!



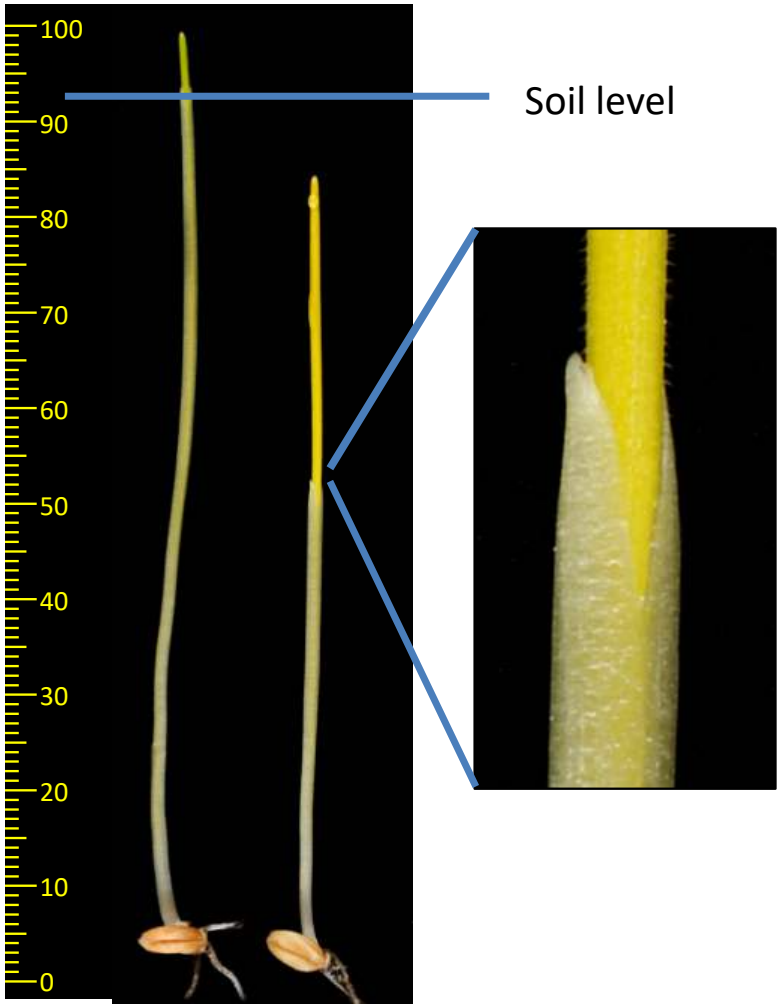
(Source: BOM 2024)

2024 - Driest Feb-May in 100 years!!



(Source: BOM 2024)

The coleoptile provides the link from seed to soil surface



Coleoptile length determines how deep seed can be sown

Two sets of genes affect coleoptile length:

- ‘Larger cell and faster growth’ genes
- Dwarfing genes

Coleoptile: what genetics better link the seed to soil surface?

Coleoptile length determines how deep seed can be sown

Two sets of genes affect coleoptile length:

- 'Larger cell and faster growth' genes
- Dwarfing genes

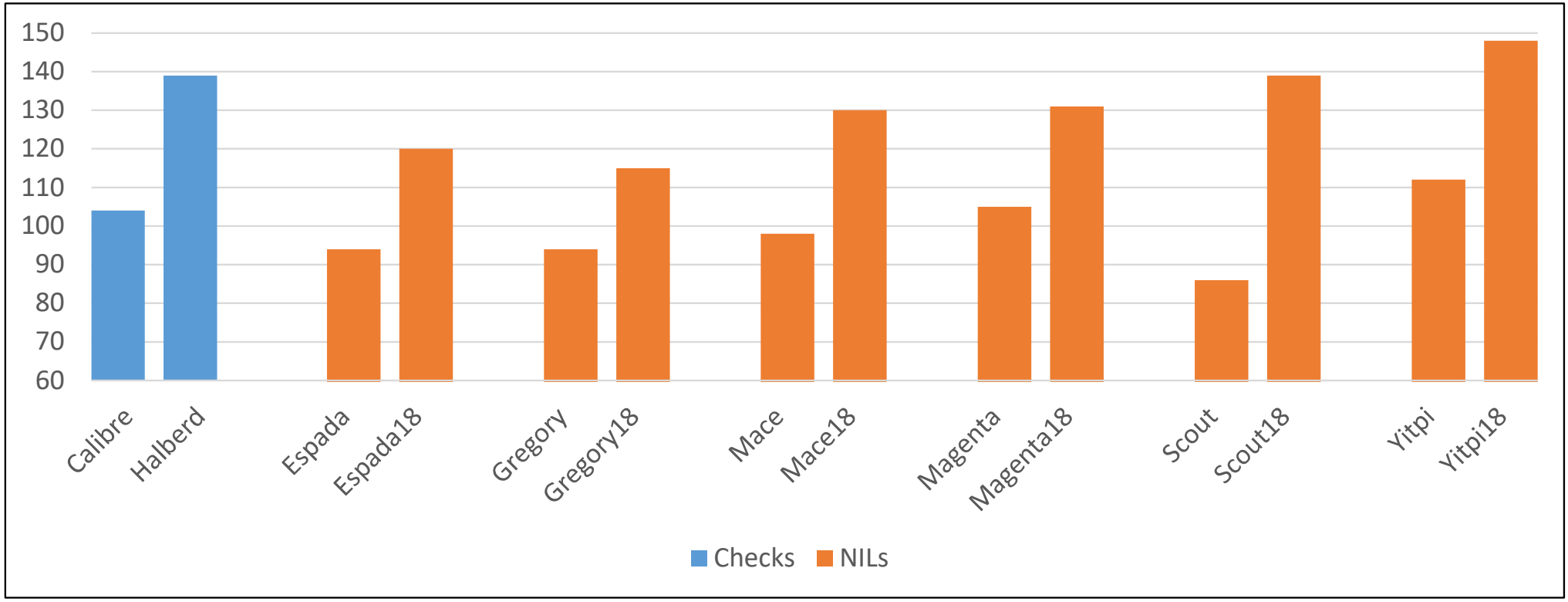
Since the early 1960s, coleoptile length was known to be shortened with Green Revolution dwarfing genes and particularly in warmer soils (e.g. Allan et al. 1962)

Delivering new BC_3+ *Rht18* dwarfing gene sister wheats to breeders

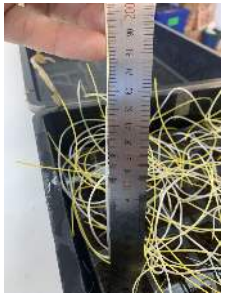
Delivering new BC_3+ *Rht18* dwarfing gene sister wheats to breeders

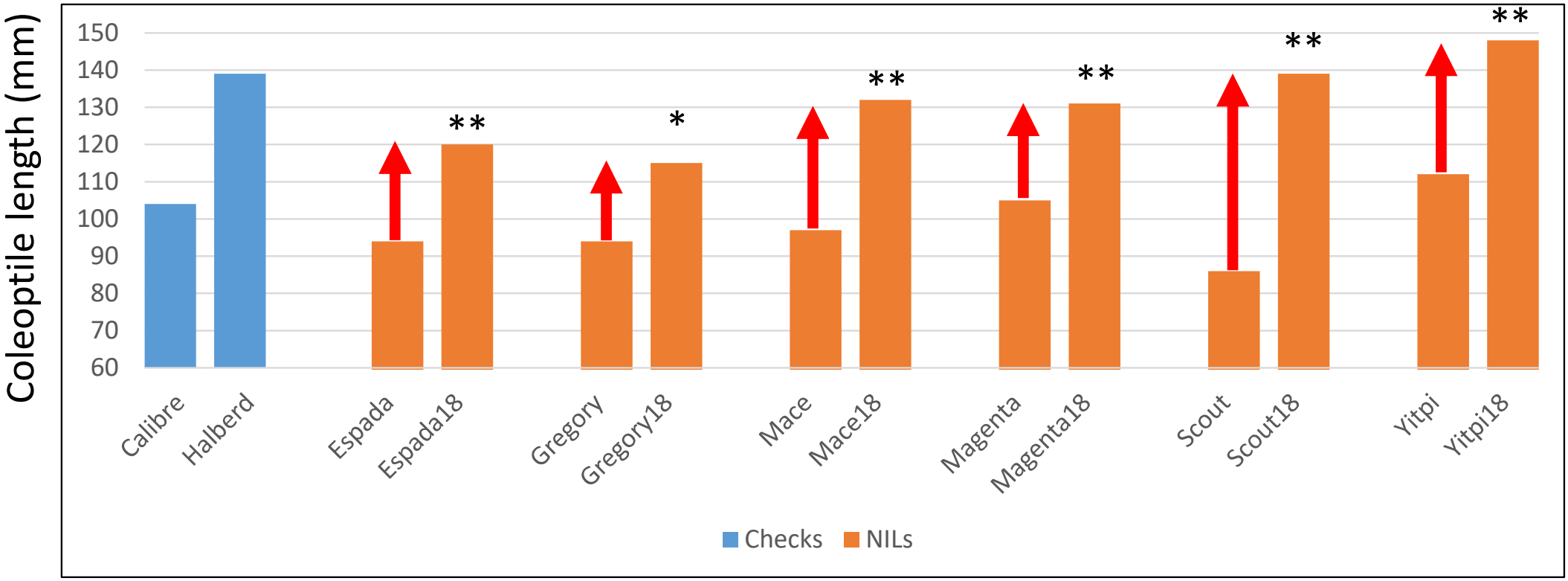
+ *Rht18* durum sibs developed in National Durum Wheat Improvement Program

Coleoptile length – First look (growth cabinet, 15°C)



Coleoptile length – First look (growth cabinet, 15°C)





<u>Changing the dwarfing gene alone increased coleoptile length an average 33mm (or 34%)</u>

On-farm grower trials - Seedling emergence with deep sowing

Photos courtesy Callum Wesley

18 days earlier emergence with deep sowing - subsequent growth with 105mm stored summer moisture and 76mm in-crop rainfall

Photos courtesy Ty Henning and Callum Wesley

18 days earlier emergence with deep sowing - subsequent growth with 105mm stored summer moisture and 76mm in-crop rainfall

Delayed development with later emergence

Photos courtesy Ty Henning and Callum Wesley

On-farm impact on yield and water productivity

2020 at Southern Cross, WA:

A decile-1 rainfall year!

- 105 mm January rainfall
- 76 mm in-crop rainfall

Water-use efficiency:

120 mm sowing depth – 24 kg/ha/mm (1.2 t/ha)

40 mm sowing depth – 15 kg/ha/mm (0.7 t/ha)

More spikes/m² and earlier maturation in avoiding terminal heat/drought

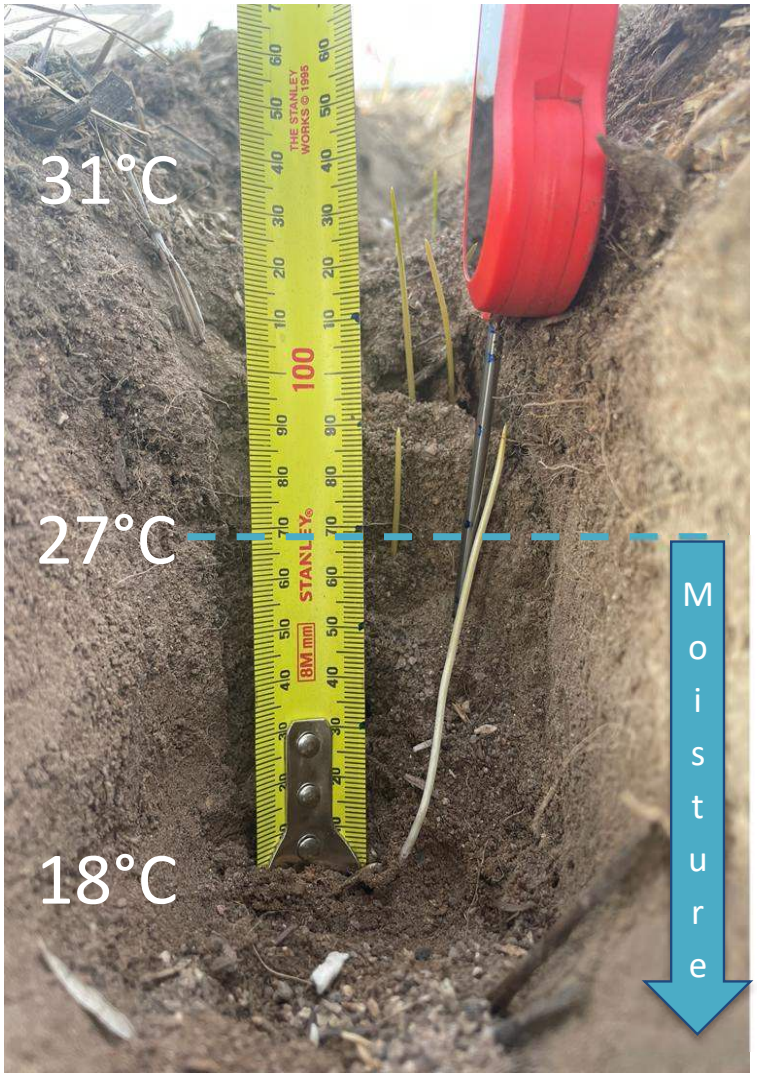
"Ensuring a crop two out of three years compared with one in three now!" (Callum Wesley, grower)

‘LRPB Dual’ sown >10cm depth at Bindoon, WA

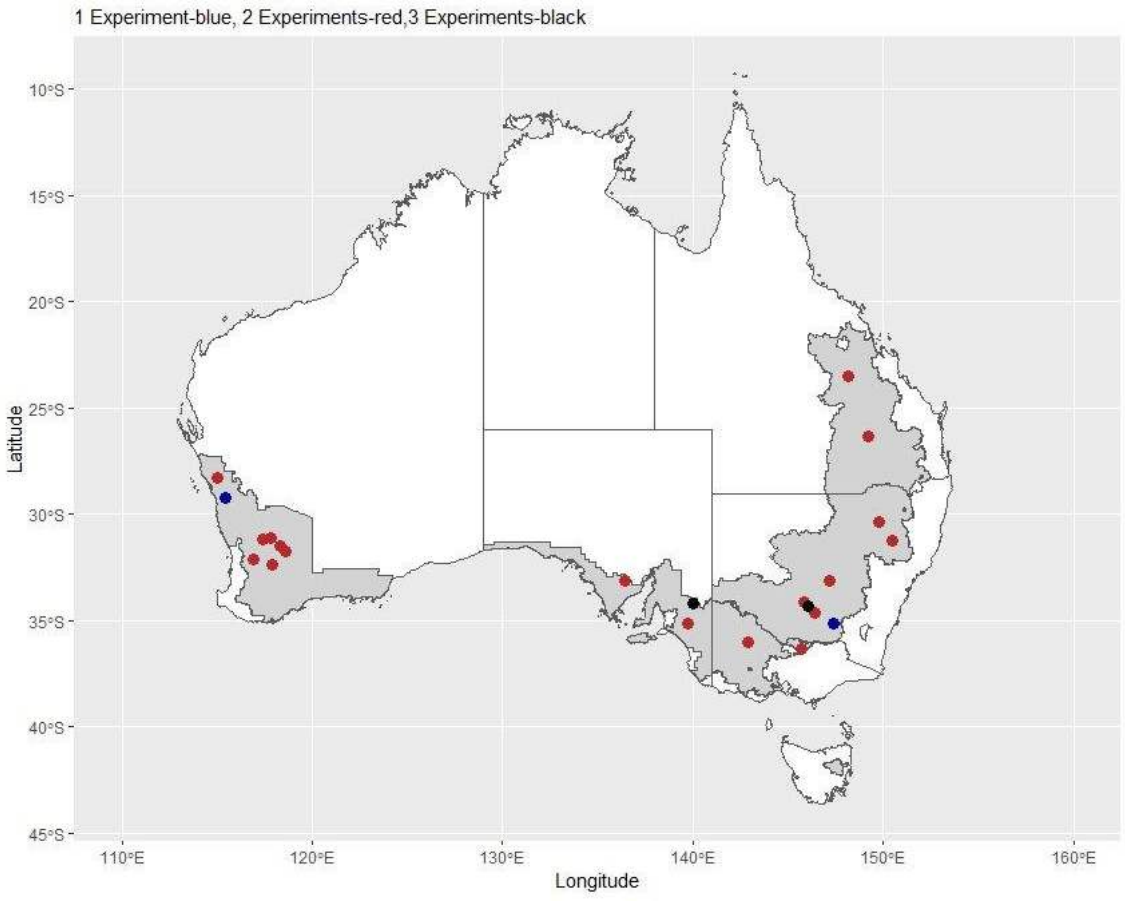
GRDC Long Coleoptile Wheat project (2023+)

Addressing limitations to adoption. Specifically, influence on emergence with deep sowing:

- Genotypic differences in coleoptile length
- Seed quality (weathering damage, seed size and source)
- Herbicide interactions
- Fertiliser application (placement, amount and timing)
- Seed-soil contact (press-wheel pressures)
- Impact of soil-borne disease (infection *vs* escape)
- Soil-type dependence (non-wetting, soil amelioration, soil strength)
- Machinery design
- Learnings to growers



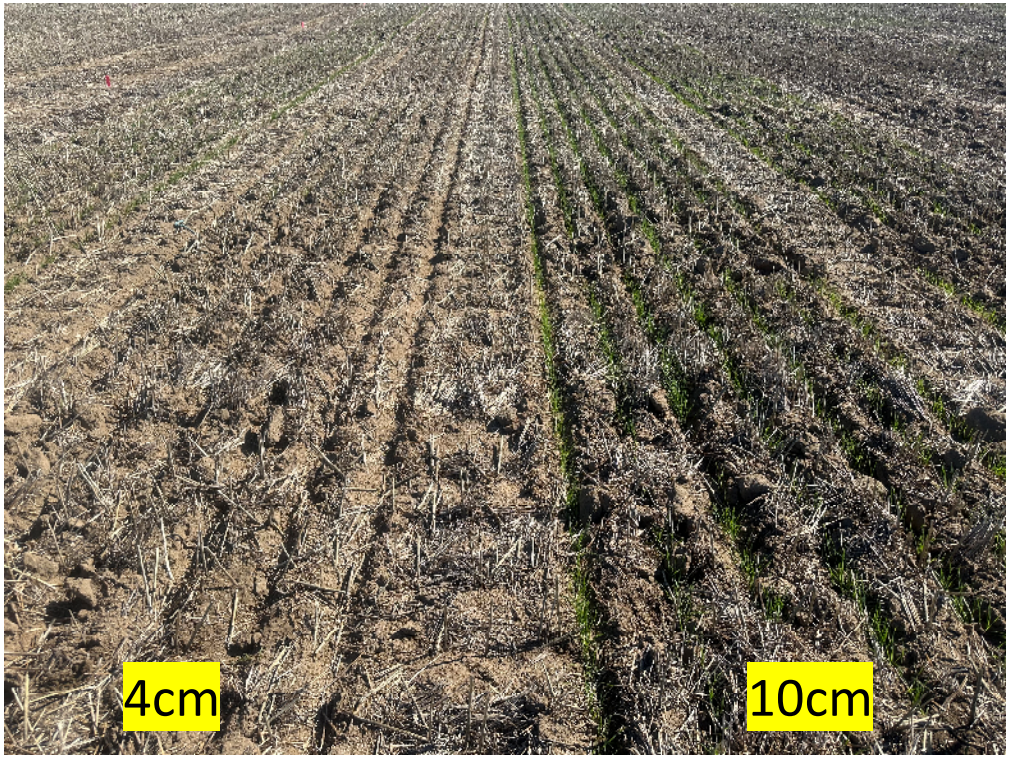
Location of field experiments (bread and durum wheats)



Modified points to reliably achieve deep sowing

2024 – Long coleoptile wheats deep-sown 16 April (photos 7 May)

Muntadgin



Corrigin

Mace+*Rht2* Deep (emerged)

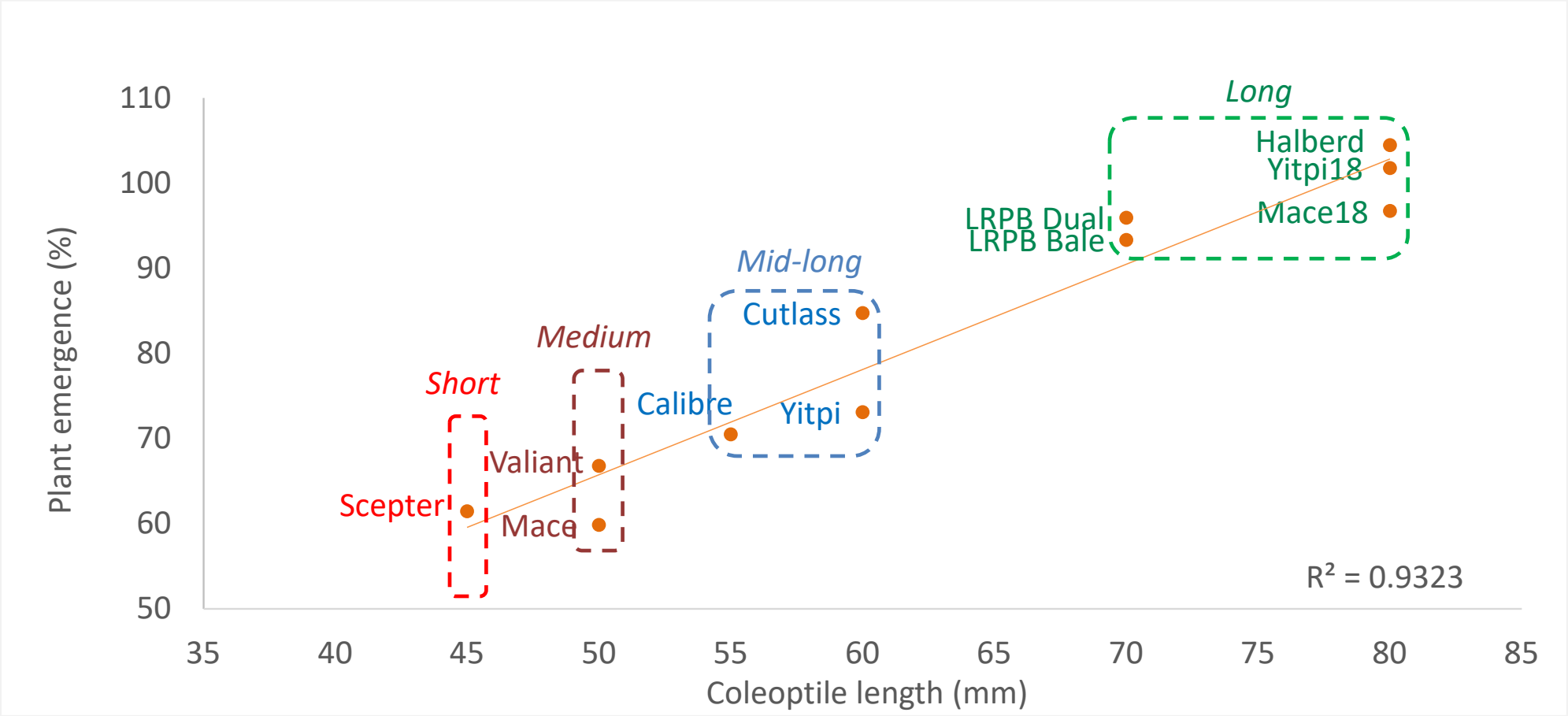
Mace+*Rht18* Deep (emerged)

Mace+*Rht2* Deep (unemerged)

Mace+*Rht18* Deep (unemerged)

(Source: SLR WA)

Field validation - Coleoptile length with deep sowing (100 mm) (Pingaring 29 DAS)



LRPB Bale and Dual contain *Rht18*

(Source: SLR WA)

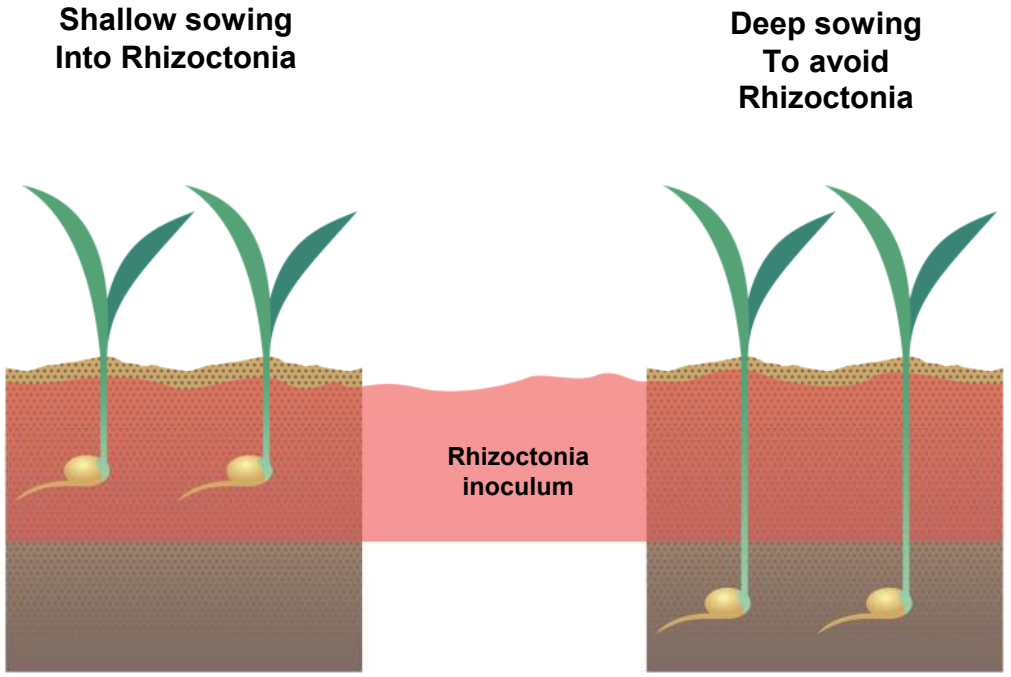
Variable sowing depth and greater ground cover following deep soil amelioration (Yuna WA, 2024)

Depth 40mm, no-till

Depth 110-140mm, spaded

(Courtesy: Dr Steve Davies, DPIRD)

Deep sowing to escape ‘bare patch’ (Rhizoctonia root rot)



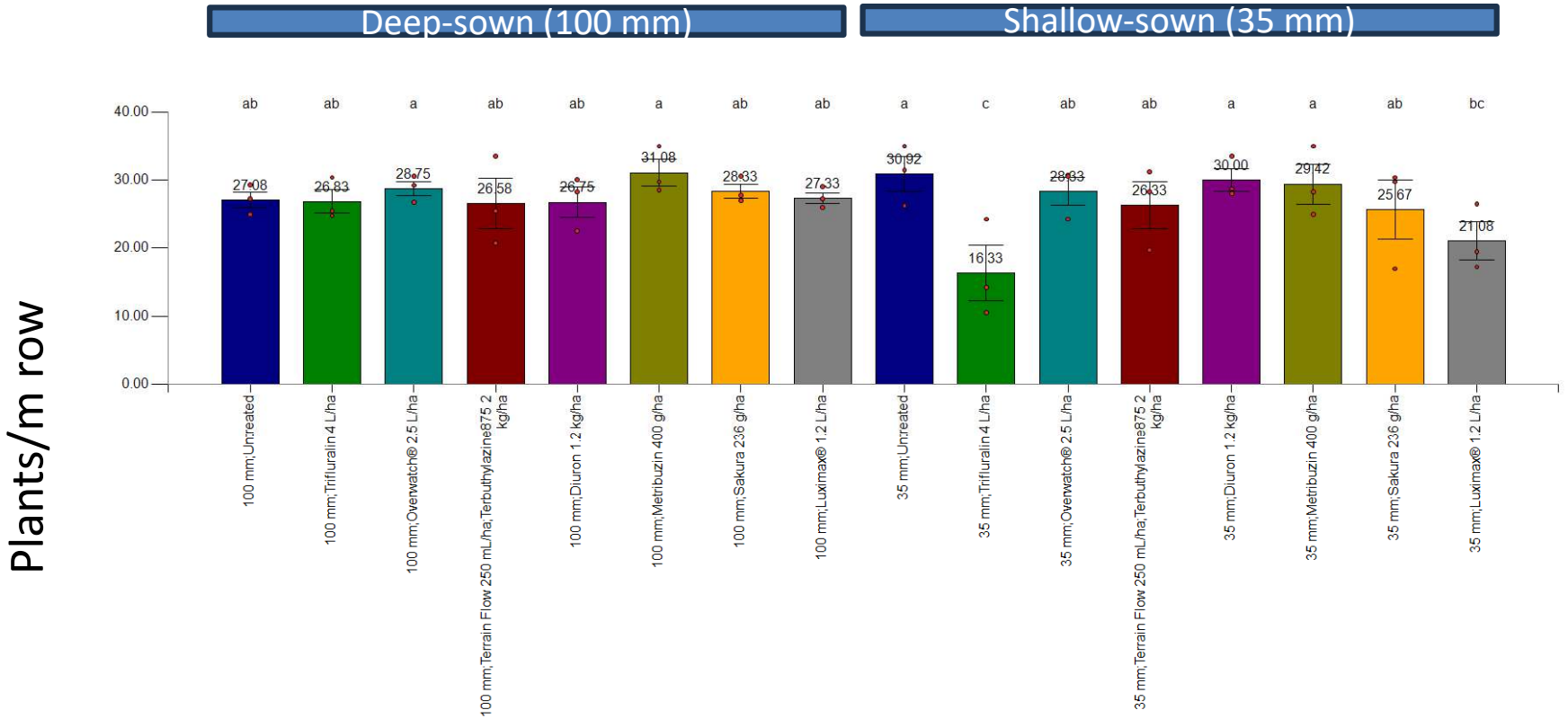
Reduced Rhizoctonia infection with deep sowing of long coleoptile wheats

Rhizoctonia with shallow sowing

Escaping Rhizoctonia with deep sowing?

(Source: SLR WA)

Deep sowing Mace+*Rht18* to avoid damage from pre-emergent herbicides



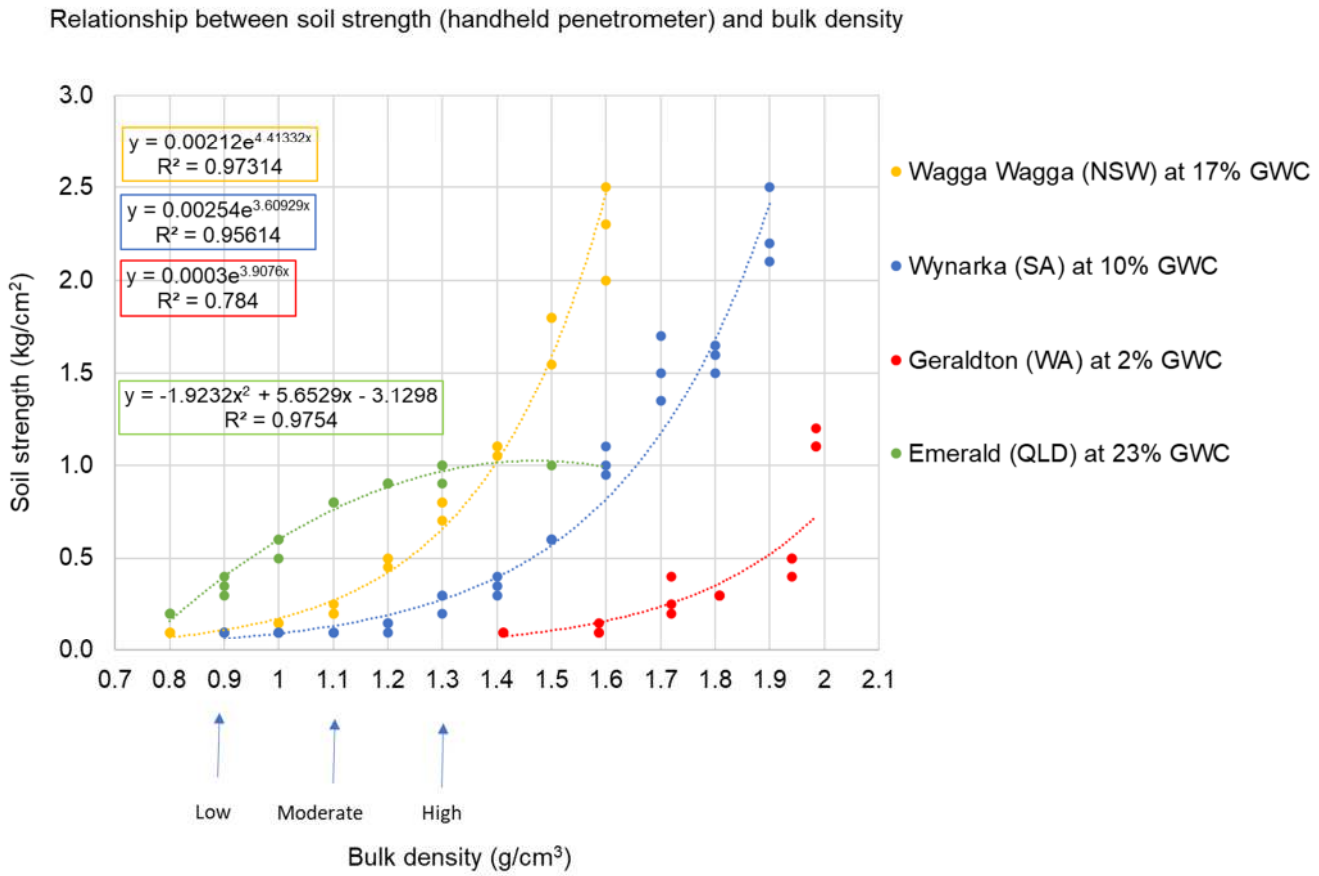
** Corrigin 2024, Mace18. Various pre-emergent (IBS) herbicides at 2x tolerance rates (as per industry standard)

Extending findings to growers

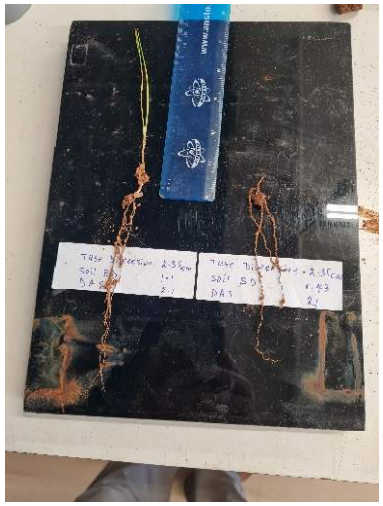
Early messages

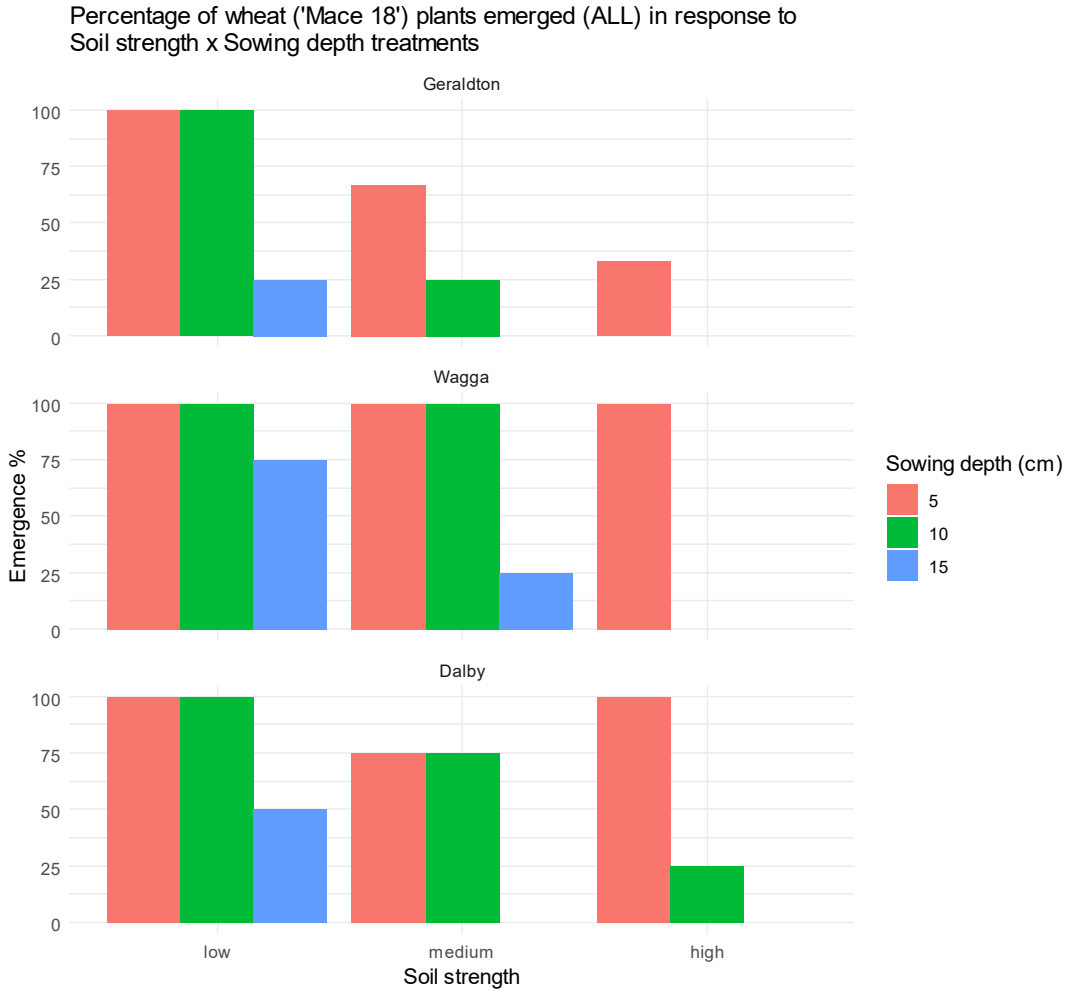
- Changing rainfall is challenging the notion of a traditional sowing break
- Opportunities to increase coleoptile length and deep sowing into moisture (and avoid warmer soil temperatures) in future wheat varieties
- Demonstrated long coleoptile emergence capacity with deep sowing and furrow infill together with uneven soil depth following soil amelioration and with non-wetting
- Increasing evidence with deep sowing in avoiding rhizoctonia and crop damage from pre-emergent herbicides
- Methods underway to better understand tailored solutions in fertiliser placement, soil-seed contact (press-wheel pressures), disease management and soil strength
- Communication with growers and close links with commercial breeders is ensuring uptake from the pre-breeding pipeline

Soil-focussed dependencies



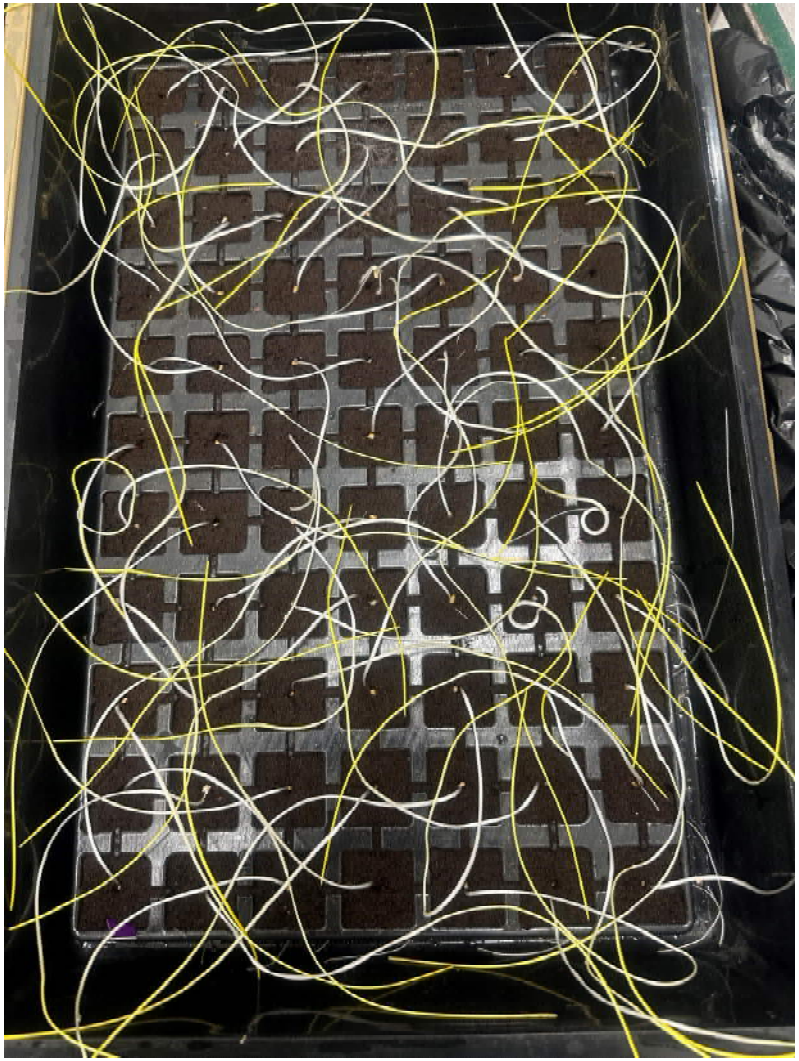
High throughput soil strength coleoptile growth assay

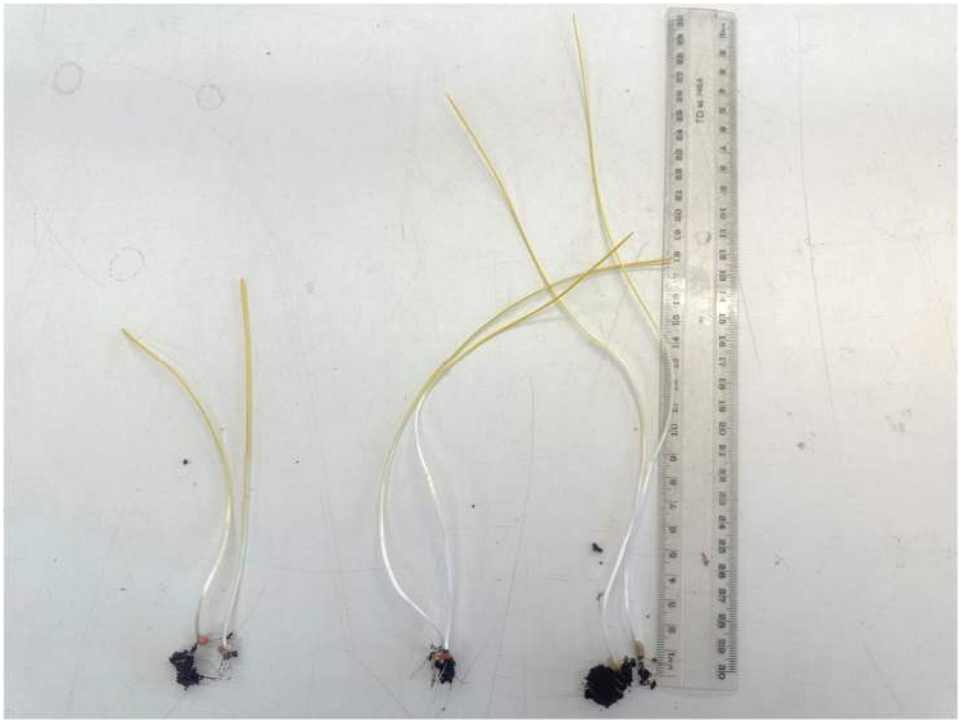




(Courtesy: Laura Goward and AJ Haddis, CSIRO)

Figure 4. A) Visual browning of tiller bases associated with FCR infection with plus FCR (left) vs minus FCR (right); B) whitehead expression in FCR plus plots Narrabri 2023; C) staff processing post-harvest stubble samples collected from each plot





Mace18 +Hombre

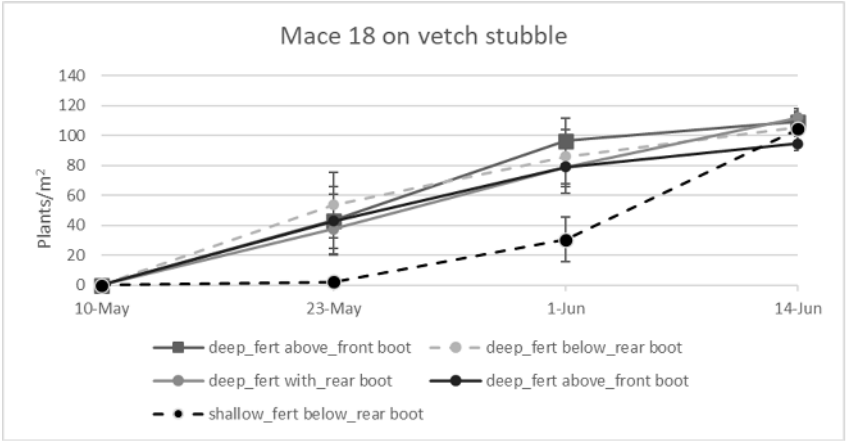
Mace18 +Evergol

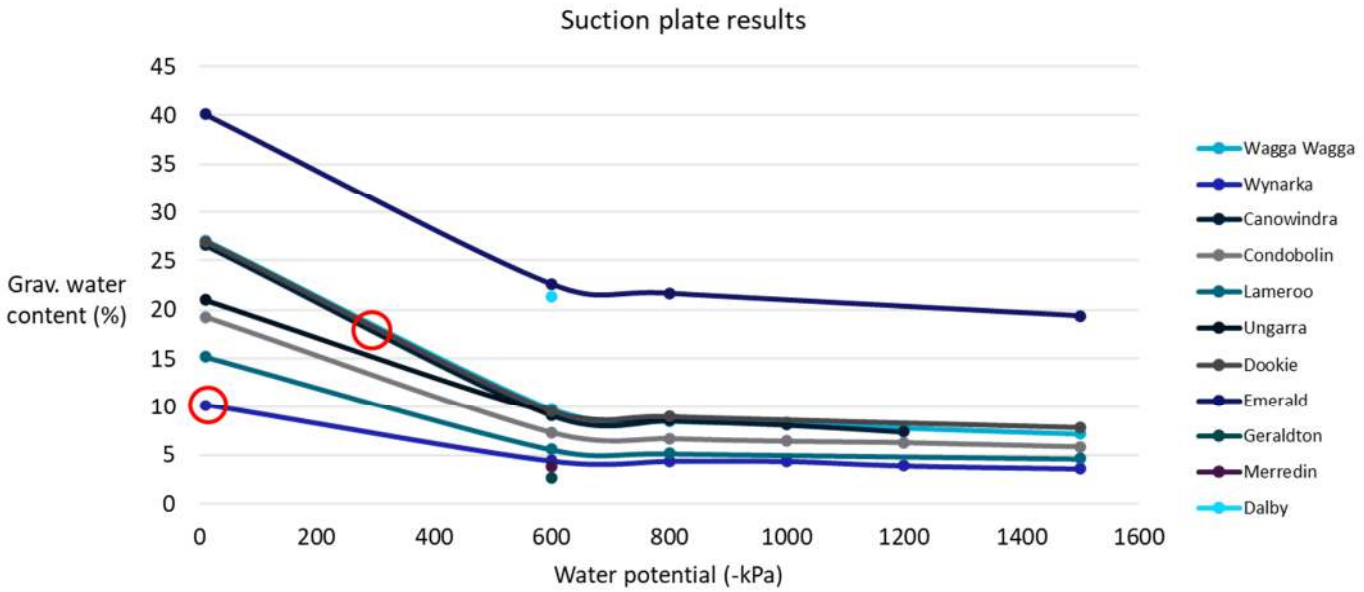
Mace18 +Water

Contrasting soils representing the soil types across Australia (including soils from northern and central WA, central and eastern SA, southern and central NSW, central QLD) were sampled and sent to Canberra for use in controlled environment seedling assessment studies toward development of improved hydrothermal models. Systems developed for high-throughput phenotyping of soil type × water and temperature with deep and shallow sowing of long and short coleoptile wheats in controlled environments have been optimised and will continue through 2024.

Fertiliser placement with deep and shallow sowing

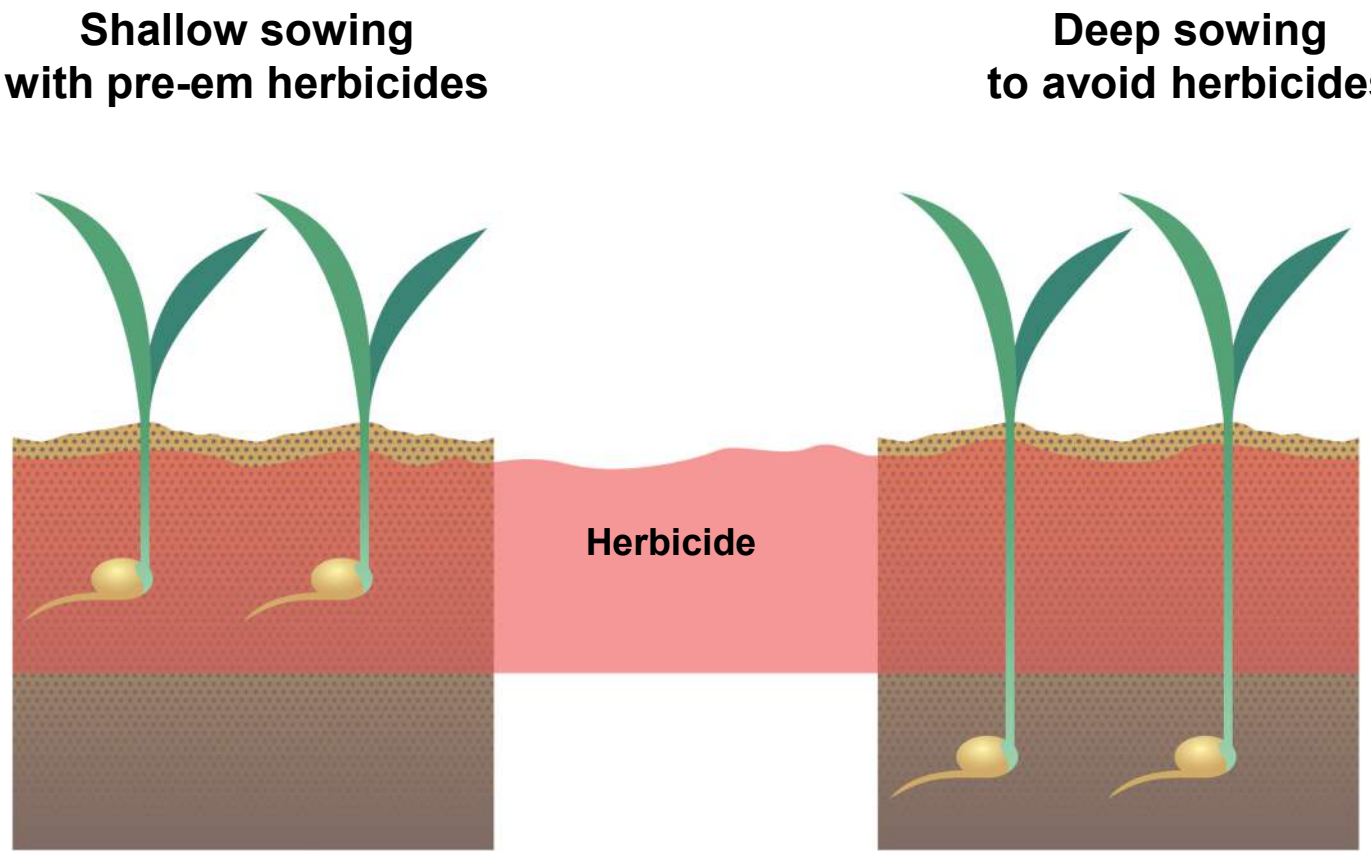
Wheat emergence in response to fertiliser and seed placement at two locations in the same field (Mace18 on vetch stubble, top and Dual on wheat stubble) at Waikerie in 2023.





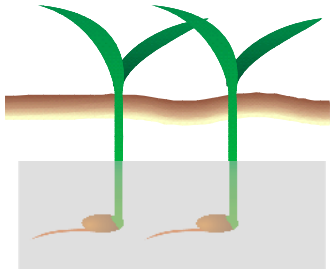
Soil water potential and gravimetric water content for the different soil types

Deep sowing to avoid plant damage with pre-emergent herbicides (with/out furrow infill)

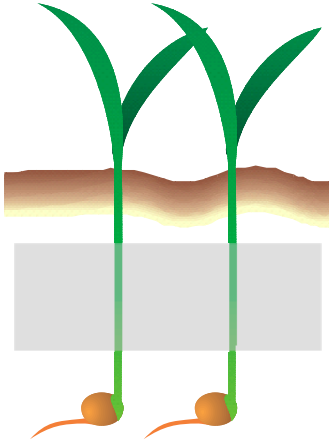


Deep sowing to escape ‘bare patch’ (Rhizoctonia root rot)

Shallow sowing with small seed



Deep sowing large seed to avoid Rhizoctonia inoculum



(David Roget, SARDI pers. Comm.)

Reduced Rhizoctonia infection with deep sowing of long coleoptile wheats

+ Rhizoctonia with shallow sowing

- Rhizoctonia with deep sowing

(Source: SLR WA)

Establishment after deep soil amelioration

Deep-spading

Non wetting, compact acid sandy soils

Yield benefits of 24% in no-till; 74% in spaded soil (7 expts)

Isolines sown deep in 2024, Yuna WA

Dr Stephen Davies
DPIRD, WA

Department of Primary Industries and Regional Development

Rebetzke, Witham, Lamond, Davies (submitted)

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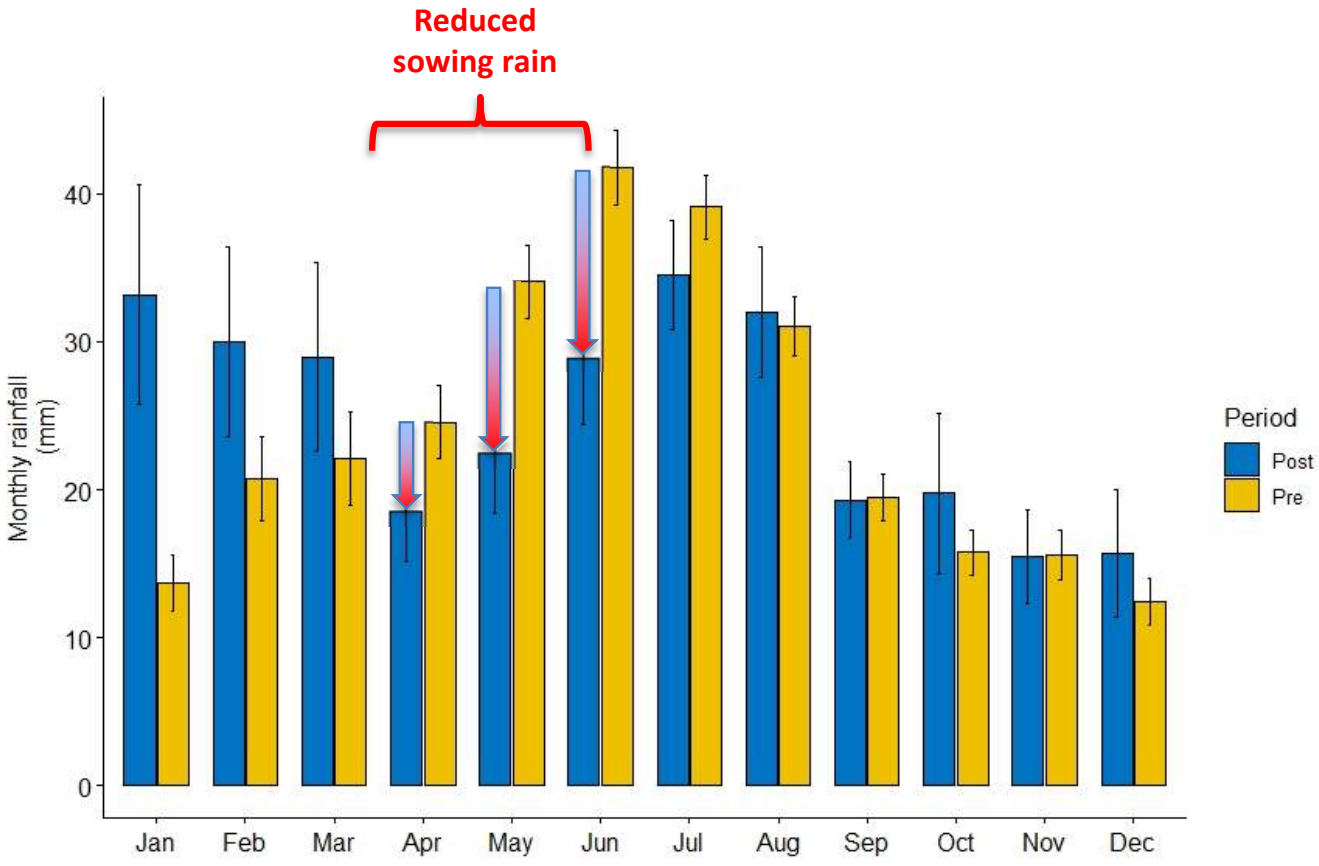
- 50-60% of cost with growing a winter cereal is at sowing
- Insurance with implement throw
- Pre-em herbicide mgt
- High soil temps
- Disease avoidance/escape
- Non-wetting – Berrin’s photos/video

[1] Commonwealth Scientific and Industrial Research Organisation Agriculture and Food, Canberra ACT
[2] Commonwealth Scientific and Industrial Research Organisation Agriculture and Food. Adelaide SA
[3] Commonwealth Scientific and Industrial Research Organisation Agriculture and Food, Floreat WA
[4] SLR Agriculture, York WA
[5] Department Primary Industries and Regional Development, Geraldton WA
[6] Department of Agriculture and Fisheries, Emerald QLD
[7] Eyre Peninsula Agricultural Research, Port Lincoln SA
[8] University of Melbourne, Melbourne Vic
[9] New South Wales Department Primary Industries Tamworth NSW
[10] Birchip Cropping Group, Birchip Vic
[11] University of South Australia, Adelaide SA
[12] Grains Research and Development Corporation, Perth WA

Changes in long-term monthly average rainfall for Southern Cross (WA) (pre-2000 and post-2000)



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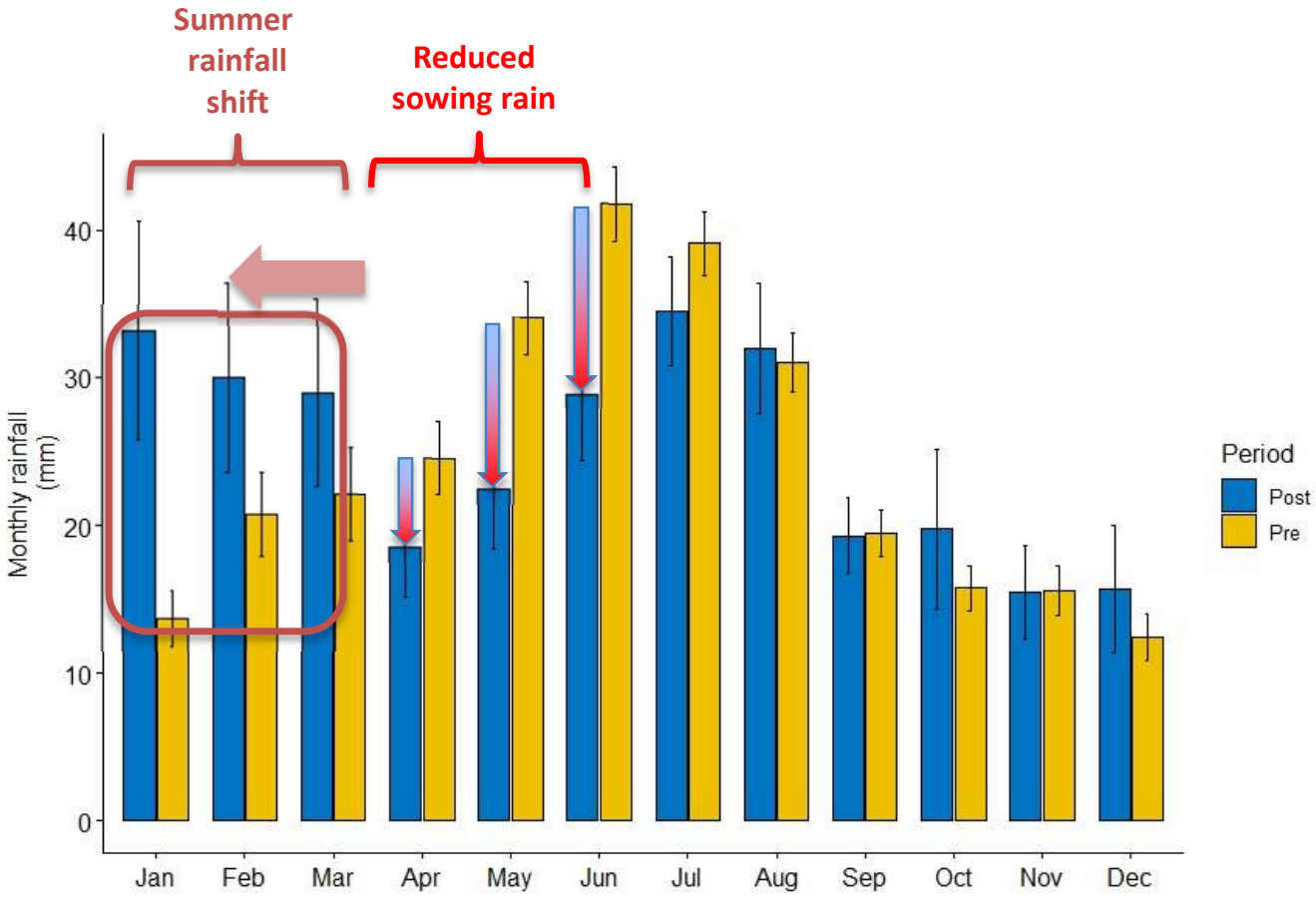
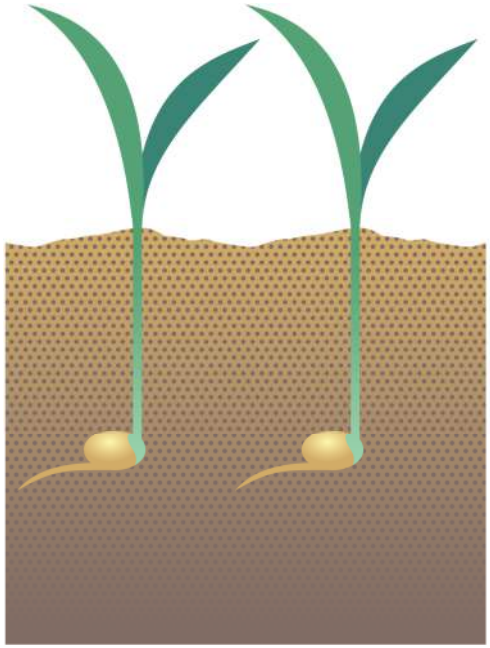
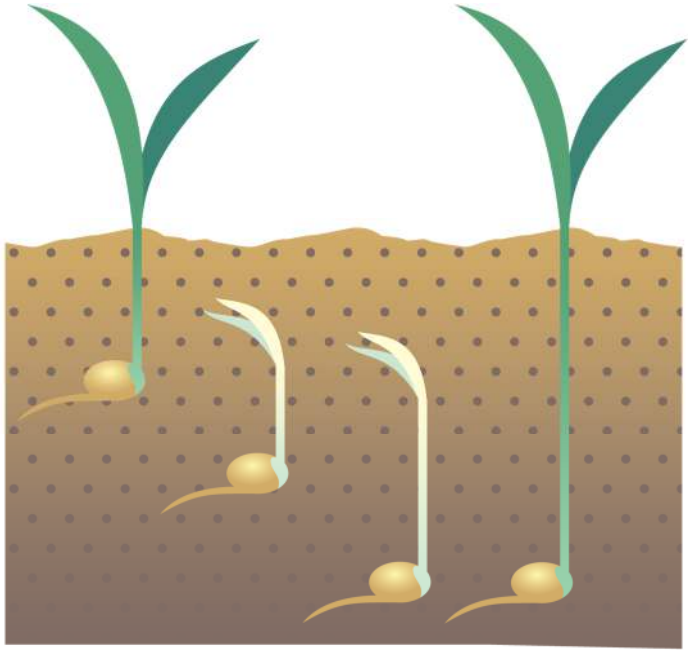
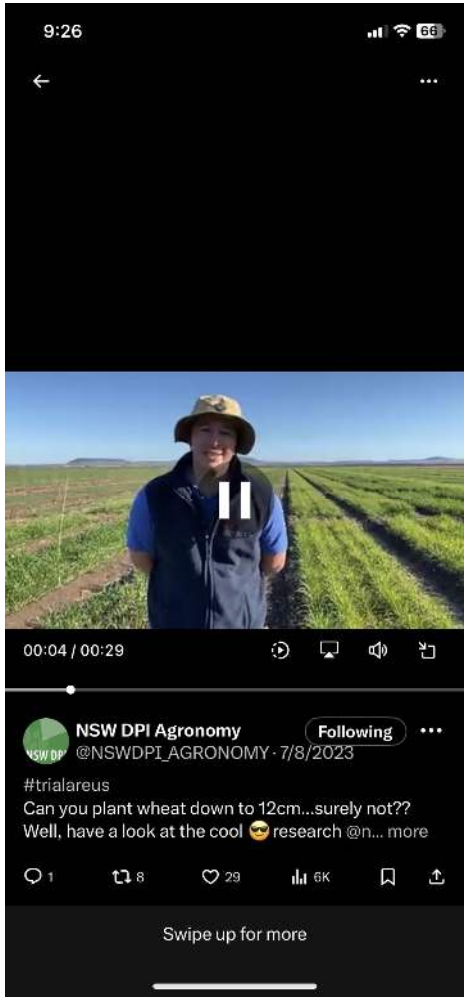


Firm soil **versus** **Ameliorated soil**






9:26
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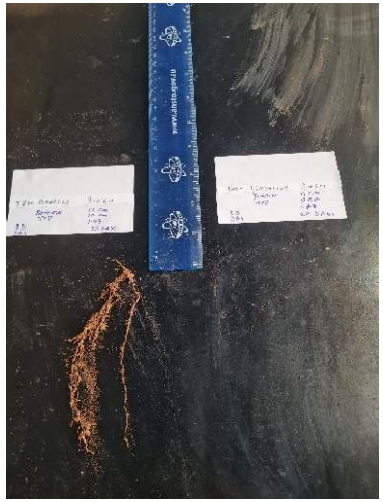
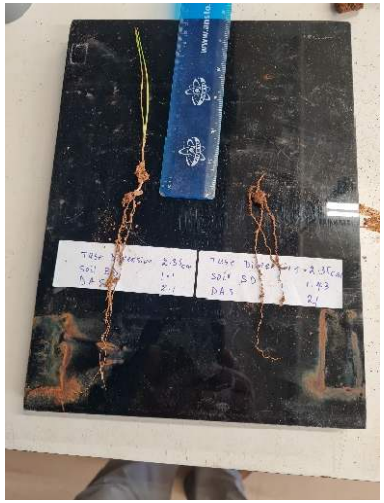
NSW DPI Agronomy
Following
@NSWDPI_AGRONOMY · 7/8/2023
#trialareus
Can you plant wheat down to 12cm...surely not??
Well, have a look at the cool 😎 research @n... more
1
8
29
6K
Swipe up for more





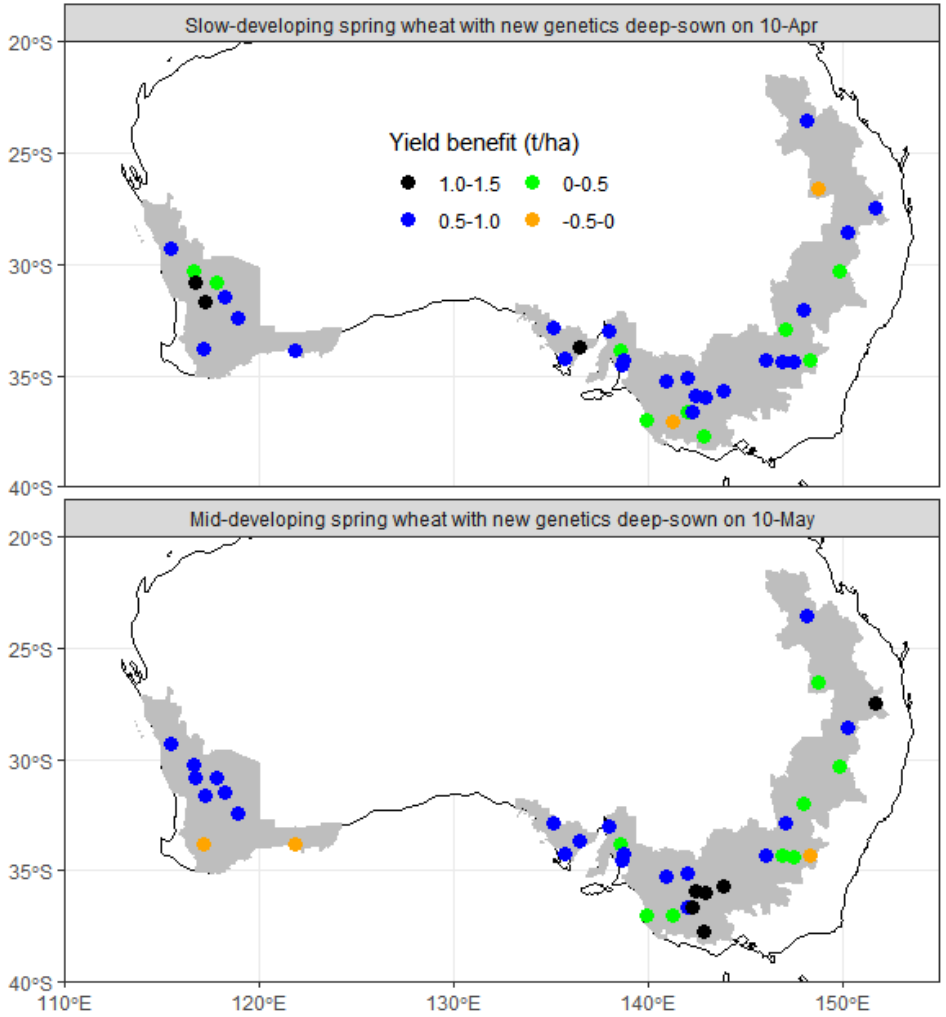
L = Firm, R = Loose

L = Loose, R = Loose

L = Firm, R = Loose

Fig. 1.1 Wheat growth using different diameter tubes. Shoot growth up the side of the tube visible in 'D'

An 18-20% Modelled Yield Benefit with Long Coleoptiles Across Australia



Mean annual yield benefit (1901-2020) of wheat with new genetics (long coleoptiles and greater early vigour) sown at 120mm depth compared to baseline wheat sown at 45mm depth at 37 sites

(Zhao et al. *Nature Climate Change*)