Improving wheat establishment with deep sowing

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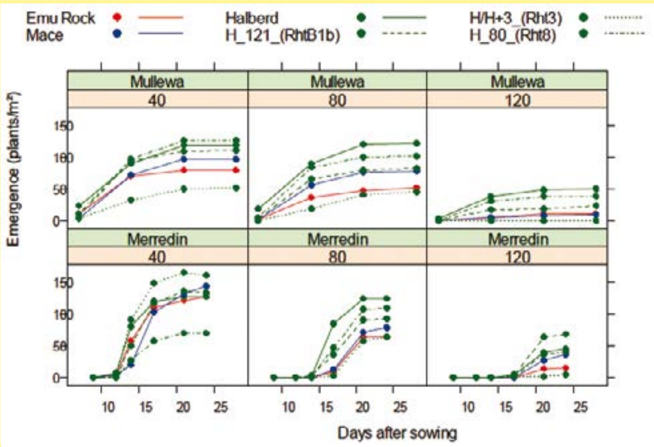
AT A GLANCE…

- Current Australian wheat cultivars contain dwarfing genes that reduce coleoptile length by 40 per cent. New dwarfing genes are available that reduce plant height but don't reduce coleoptile length.
- Deep-sowing studies in NSW and WA show benefit with new dwarfing genes in increasing emergence at sowing depths of up to 120 mm but without changing plant height.
- Moisture-seeking points coupled with new genetics should reliably allow seed placement and emergence from sowing depths of 100 mm or greater, and/or in warmer soils which reduce coleoptile length.
- Large, plump seed containing larger embryos should be used when sowing deep and/or where potential for soil crusting could impede seedling emergence.

IN rainfed environments typical of the eastern and southern wheatbelts, crops are typically sown on the first breaking rains but sometimes soil moisture accumulated on the last rainfall event(s) prior to sowing is too deep for sowing with conventional varieties and drilling systems. Key to good leaf area development for tillering, growth and weed competitiveness is good crop establishment.

An ability to establish wheat crops from seed placed 80 mm or deeper in the soil would be useful in situations where the subsoil is moist but the surface dry. Seeding onto moisture at depth extends the opportunities for a greater portion of the cropping program to be sown within the targeted sowing window. A separate but concerning issue is the influence of increasingly warmer soil temperatures on reductions in coleoptile length.

FIGURE 1: Patterns of emergence of wheat genotypes with different dwarfing genes sown at target depths of 40, 80, or 120 mm at Mullewa and Merredin in 2016



Earlier sowing into warmer soils will reduce coleoptile length by as much as 60 per cent, so that a variety such as Mace with a 75 mm coleoptile at 15°C will likely have a 40 mm coleoptile at 25°C soil temperature.

Some seed dressings and pre-emergent herbicides also reduce coleoptile length with capacity to amplify adverse impacts on crop establishment.

The green revolution Rht-B1b and Rht-D1b dwarfing genes reduced plant heights to reduce lodging and increase grain yields and so are present in most wheat varieties worldwide. Their presence also reduces the length of the coleoptile by as much as 40 per cent. This reduces crop emergence when sown at depths greater than 50 mm. Tiller number and leaf size is also reduced which in turn reduces water-use efficiency and weed competitiveness.

New dwarfing genes

A range of alternative dwarfing genes have been identified in overseas wheats with potential to reduce plant height and increase yields while maintaining longer coleoptiles and greater early vigour.

Some of these genes (e.g. Rht8 and Rht18) have been used commercially overseas but had not been assessed for use here in Australia. We reduced the larger global set of alternative dwarfing genes to Rht4, Rht5, Rht8, Rht12, Rht13 and Rht18, and then developed linked DNA-markers to assist with breeding of these genes in a commercial breeding program.

Separately, we then bred these genes using conventional and DNA-based methods into the old, tall wheat variety Halberd for testing and disseminating to Australian wheat breeders.

Preliminary sowing depth field study

Field studies have commenced on these Halberd-based dwarfing gene lines, and show that lines containing these genes produced coleoptiles of equivalent length to Halberd (up to 135 mm in length; Figure 1) and established well when sown at 100 mm depth in deep sowing experiments conducted at Mullewa and Merredin in WA in 2016 (Figure 2).

Grain yields of lines containing the new dwarfing genes were equivalent to the yields of lines containing the commonly used Rht-B1b and Rht-D1b dwarfing genes, while previous studies have shown the new dwarfing genes were linked to greater grain yields when sown deep owing to greater plant number with improved establishment.

On-farm sowing depth field study

A proof-of-concept' study was undertaken in 2020 on a grower's farm at Southern Cross in the eastern wheatbelt of WA.

The experiment was sown using grower planting equipment – the seed-bin was modified on a Gessner Landmaster planter containing curved points permitting sowing of small experimental seed-lots to depths of up to 200 mm.

Plots of size 60 × 4.5 m were sown in a two-replicate experimental design at two sowing depths: 40 mm (dry-sown) and 120 mm (sown into moisture at the depth of sowing Figure 3).