Breeding approaches to improving seedling establishment of wheat

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SUMMARY
The time from sowing to emergence represents a key period in the development of high-yielding wheat crops. Commercially grown semi-dwarf wheats have the potential to produce high yields when sown shallow but can produce poor stands to reduce crop yields when sown deep. A number of CSIRO long coleoptile, semi-dwarf wheats were grown at three depths (5, 10 and 12 cm). Deep sowing marginally reduced plant number and vigour for all lines. However, even with sowing deep, to 12cm, two lines produced grain yields equivalent to Frame sown in an adjacent trial at 5cm. These two wheats are now being used in a backcross breeding program to introduce the long coleoptile trait into Australian wheats.

A good stand containing many plants will (1) promote rapid leaf area development to maximise light interception; (2) compete more effectively with weeds; and (3) shade the soil surface to reduce water loss through soil evaporation. Australian wheat crops are typically sown under a range of environmental conditions and tillage practices. But even with the best management and use of expensive precision seeders poor wheat stands are regularly reported. To ensure good establishment, a wheat variety must first have the potential to emerge under a range of conditions. Older, standard-height wheat varieties such as Bencubbin and Stockade were selected to produce coleoptiles up to 13cm in length whereas coleoptile length of current semi-dwarf varieties is *ca.* 30-50% shorter. The shorter coleoptiles of Australian semi-dwarfs can deter growers from deep sowing and making use of soil moisture lying below the soil surface so that sowing can commence at the optimum time. The ability to sow deep would also help in avoiding problems of herbicide damage such as occurs with some pre-emergent herbicides such as trifluralin. A longer coleoptile would also be beneficial where soil temperatures are high, and where stubble retention is practised.

The shorter coleoptiles, of semi-dwarf wheat varieties stems from the presence of the *Rht1* and *Rht2* dwarfing genes. These dwarfing genes are widely used in Australian breeding programs for reducing plant height. However, presence of these genes is also linked to shorter coleoptiles and poorer seedling vigour. There exists alternative dwarfing genes that decrease plant height to the same extent of *Rht1 and Rht2* but do not affect coleoptile length or early vigour. We have been using these dwarfing genes with longer coleoptile genes from older varieties Halberd and Insignia in a breeding program to increase coleoptile length and early vigour of Australian wheat crops.

METHOD

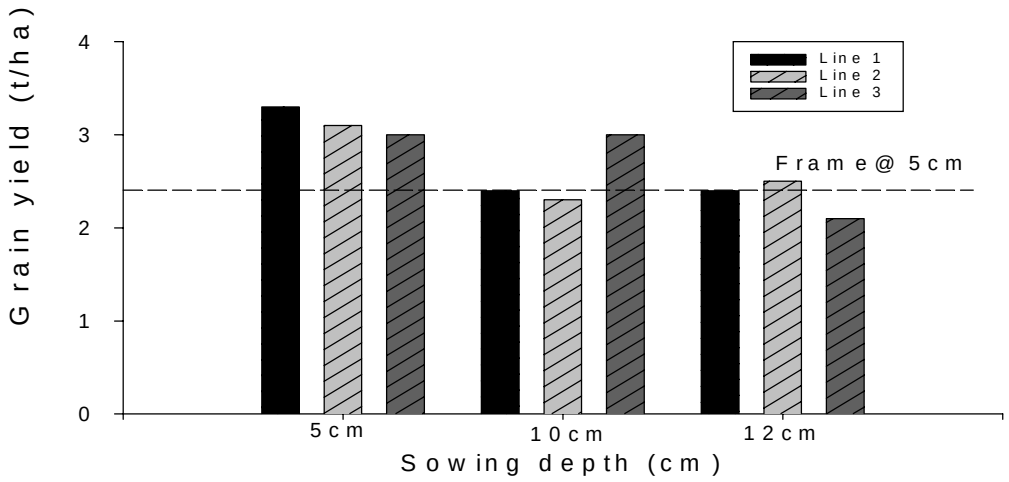
The experiment was established at Birchip after fallow. At sowing, 80kg/ha of Mallee Mix 1 was drilled with seed of six CSIRO Plant Industry lines to three sowing depths (4, 8 and 12cm). The lines were developed from crosses between an *Rht8* dwarfing gene parent, Mara, and long coleoptile Australian wheats Insignia and Halberd.

RESULTS

Increases in sowing depth were associated with small reductions in the numbers of emerged seedlings of all tested lines (data not shown). This reduction in plant number was commonly small at the deepest sowing depth being only 20% of total plant number at 5cm sowing depth. Increased sowing depth was associated with reduced grain yield. This may reflect either fewer plants with deeper sowing, or delayed emergence when plants are sown deep. For example, deep sowing to 12cm is commonly associated with a delayed emergence of up to 10 days. In

turn, plant height is shorter, and both tiller number and plant biomass are reduced. Notwithstanding, yields of long coleoptile wheats at 10 and 12cm sowing depth were as high as grain yield of Frame sown at 5cm sowing depth in an adjacent study.

Figure 5.8 Change in grain yield with increasing sowing depth of three long coleoptile lines. The yield of Frame sown at 5cm sowing depth (2.4t/ha) is also included for reference.



INTERPRETATION

This experiment demonstrates the benefit of long coleoptile wheats for deep sowing. While there was some reduction in yield with deep sowing, other studies have shown this reduction in yield is likely to be much greater with short coleoptile, commercial semi-dwarf wheats. The reduction in yield in the Birchip study was likely due to delayed emergence of plants with deep sowing.

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